International Journal of Applied Engineering and Management Letters (IJAEML). Vol. 7, No. 4, 2023

Tech-Business Analytics in Secondary Industry Sector

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Subject Area: Information Technology.
Type of the Paper: Exploratory Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10040970
Google Scholar Citation: IJAEML

How to Cite this Paper:
Kumar, S., Krishna Prasad, K., & Aithal, P. S., (2023). Tech-Business Analytics in Secondary Industry Sector. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 1-94. DOI: https://doi.org/10.5281/zenodo.10040970

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0194

Received on: 20/07/2023
Published on: 25/10/2023

International Journal of Applied Engineering and Management Letters (IJAEML), ISSN: 2581-7000, Vol. 7, No. 4, October 2023

SRINIVAS PUBLICATION

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ABSTRACT

Purpose: *Businesses in all sectors, including the secondary industry, will turn to tech-business analytics as a crucial tool. Tech-Business Analytics' role in the secondary industrial sector is to support companies in making data-driven decisions that optimize their operations, boost productivity, and boost profitability. Businesses may optimize their supply chains by accessing data on suppliers, inventories, logistics, and other aspects to spot inefficiencies and areas for improvement. Organizations can use this information to reduce downtime and boost production to schedule maintenance in advance and predict when machinery and equipment will likely break. Examining data on product flaws, customer complaints, and other aspects can help firms improve their quality control systems by identifying root causes and implementing corrective measures. Studying data on consumer behaviour, industry trends, and other factors can help organizations optimize their sales and marketing activities and find chances for expansion and higher profitability.*

Design/Methodology/Approach: *Businesses can use several processes in the tech-business analytics methodology to help them make decisions based on data in the secondary industry sector. This secondary industry sector can entail enhancing the effectiveness of the supply chain or decreasing equipment downtime. After identifying the issue, the necessary data must be gathered and prepared. Once the data is collected, it must be analyzed using statistical models and other analytical methods. This collected data might entail looking for relationships between multiple variables, spotting trends in consumer behaviour, or predicting outcomes using predictive models.*

Findings/Result: *It is described in the article how tech-business analytics in the secondary industrial sector will have managed the growth itself from its inception to the present. The Tech-Business Analytics technique in the secondary industry sector offers a structured approach to problem-solving using data analysis to assist in better decision-making and improve business outcomes.*

Originality/Value: *Exploring the evolutionary path of business analytics transforms into the advanced realm of technology-driven business analytics within the secondary industry sector. A generic architecture also examines 130 recently published Tech Business Analytics in Secondary Industry sector research projects for technical purposes. Tech-Business Analytics is a new field that applies ICCT-underpinning technologies in Tech-Business Analytics (TBA). TBA is intended to provide businesses with unprecedented opportunities for growth and innovation in secondary industry sectors.*

Paper Type: *Exploratory research.*

Keywords: Business Analytics (BA), ICCT underlying technologies, Tech-Business Analytics, TBA, Secondary industry sector, Production industry, Industry Performance, Data Science, Big Data Analytics, Research gap in Business Analytics, ABCD Analysis.

1. INTRODUCTION :

In today's rapidly evolving business landscape, data-driven decision-making has become the cornerstone of success. The Secondary Industry Sector, which includes manufacturing, construction, and industrial production, is no exception to this transformation. Tech-Business Analytics refers to applying advanced technologies and data analysis techniques to extract valuable insights from vast amounts of data generated within the Secondary Industry. By leveraging cutting-edge tools such as artificial intelligence, machine learning, big data processing, and predictive modeling, businesses in this sector can gain a competitive edge by making informed and strategic decisions. This dynamic field empowers industries to optimize processes, enhance production efficiency, minimize waste, and improve product quality. It enables companies to identify and address operational bottlenecks, predict maintenance needs, and streamline supply chains, ultimately leading to increased profitability and reduced operational costs. Moreover, Tech-Business Analytics is pivotal in driving innovation within the Secondary Industry Sector. By leveraging data-driven insights, businesses can identify new market opportunities, analyze customer preferences, and develop personalized products to cater to the ever-changing demands of consumers. As the volume of data continues to grow exponentially, the importance of Tech-Business Analytics in the Secondary Industries Sector becomes increasingly apparent. This Introduction provides a glimpse into the vast potential of data-driven decision-making and its transformative impact on the future of manufacturing, construction, and industrial production businesses. With Tech-Business Analytics, companies can unlock the true potential of their data, enabling them to thrive and stay ahead in today's data-centric world. The competitive landscape for companies in this sector has significantly changed as a result of Tech-Business Analytics. Tech-Business Analytics analyzes company data using state-of-the-art data analytics methods, machine learning algorithms, and artificial intelligence to produce insights that boost productivity, profitability, and efficiency. In the past, to make business decisions, manual procedures, knowledge, and intuition were in the secondary industrial sector. Yiu, L. M. D. et al. (2020) [1] claim that by examining data on production processes, supply chain management, and other components, inefficiencies can be reduced, and adjustments can be made to increase operational efficiency. According to Hallikas et al. (2021) [2], companies may identify the root causes of issues and implement corrective measures to increase the caliber of their output by analyzing data on product faults and customer complaints. Yu, J. et al. (2019) [3] found that businesses can employ machine learning algorithms to analyze data on machine performance and predict equipment breakdowns to reduce downtime and enhance production. According to Karanci (2018) [4], businesses may develop targeted marketing efforts that are more likely to convert leads into customers, increasing sales and profitability by looking at data on consumer behavior.

2. ABOUT SECONDARY (MANUFACTURING/PRODUCTION) INDUSTRY SECTOR AND ITS IMPORTANCE :

According to Sengupta T. et al. (2018) [5], the secondary industrial sector boosts economic growth by creating jobs, increasing productivity, and fostering innovation. A nation's economy can grow when finished products add value and generate business income. The secondary industry sector significantly contributes to global trade by exporting finished items to other countries. According to Verma S. et al. (2017) [6], the secondary industry sector is crucial to the supply chain as a significant supplier of raw materials and intermediate goods to other industries, such as construction and agriculture. For the economy to run, finished goods are produced by the secondary Industry.

According to Ahmad, A. (2015) [7], technical advancement is influenced by the secondary industrial sector, where businesses constantly seek ways to improve their production processes and products. As a result, innovative concepts and technologies have surfaced, assisting numerous economic and social areas. With the secondary industries sector, the economy as a whole could function. The secondary sector is vital since it is a nation's primary source of wealth. Economists often link this Industry and a nation's wealth. Making is thus playing a more significant role in economic growth and development. The main emphasis is on the acquisition of raw materials from natural resources. The secondary sector will be our main focus today. This sector is the entire economic sector involved in construction and producing a valuable final product. The primary sector supplies raw materials for the goods.

It will analyze the secondary sector's characteristics, pursuits, and utility. Secondary industries require specialized equipment, facilities, and energy to convert raw materials into finished products. The secondary sector is one of the most significant polluters of the environment on a global scale. According to Thake, A.M. (2021) [8], the secondary sector supports primary and secondary education. It is in charge of turning items produced in the primary sector into those produced in the tertiary. Through the sale of local products, foreign businesses export goods to other countries. In the secondary Industry, there are several engineering jobs available. A sizable portion of middle- and upper-class occupations are well-paid in the secondary sector in most industrialized countries. According to Oliva et al. (2019) [9], the secondary sector supports education's primary and secondary sectors. It transforms primary sector output into tertiary sector products. Foreign businesses export goods made locally and sell them abroad. As a result, the secondary Industry has several openings for engineers. The secondary sector offers many well-paying positions in most industrialized countries for the middle and upper classes.

3. EFFECT OF ADVANCES IN TECHNOLOGY IN SECONDARY INDUSTRY SECTOR :

Technology developments, which have led to better output, efficiency, and innovation, have tremendously impacted the secondary industrial sector.
(1) This can perform repetitive tasks and boost production efficiency, examples of automation technologies made possible by technological advancements. Automation also makes businesses work more reliably, promotes safety, and reduces the chance of errors.
(2) Companies can now more easily monitor and control the quality of their products thanks to technological improvements. Automated inspection systems, for instance, can immediately identify weaknesses, allowing businesses to fix issues before they worsen.
(3) The ability to customize items to each customer's unique needs has been made possible by technical breakthroughs. One example is the quick and affordable production of personalized goods using 3D printing technology. Technology improvements have made supply chain management simpler for businesses, allowing them to reduce lead times and improve inventory management. Using technology like RFID (Radio-Frequency Identification), businesses can track things quickly, improving their supply chain visibility.
(4) Thomas, A. (2020) [10] states that a minor detrimental impact on the environment is now achievable for businesses thanks to new technology. Ingenious manufacturing techniques, for instance, can reduce waste and energy use while optimizing resource utilization. Consequently, the secondary industry sector has reaped the benefits of technical improvements, which have raised output, boosted efficiency, and promoted innovation. As businesses continue incorporating new technology, this could predict more significant developments.

3.1 Technology in Secondary Industry Sector:

Businesses in the secondary industrial sector today operate in a very different way, according to Thomas, A. (2020) [10], due to developments in automation and robotics. Welding, painting, and assembly are just a few of the jobs that robots can now do. IoT is a technology that enables software, hardware, and sensors to communicate with one another and exchange data across a network. The secondary industrial sector uses IoT technology to track inventory, monitor and control production operations, and achieve maximum energy efficiency.
The use of augmented reality (AR) and virtual reality (VR) technologies for training, product creation, and simulation is growing in the secondary industrial sector, according to Sumbal, M.S. et al. (2019) [11]. Product development is sped up and made more productive when companies can test and visualize their products before construction.
According to Parihar, A. S. et al. (2021) [12], technical progress and well-being are two distinct but related challenges, respectively, and productivity is not a metric of either. Productivity is based on GDP, a measure of output or production. Instead of raising productivity, technological progress can raise well-being. Data also suggests that long-term organizational adjustments and reorganization of corporate activities are required to adopt new technology. A classic economic sector is the production of raw materials. Industries that heavily rely on technological advancements include computers and electronic communications, both based on information technology.

Furthermore, it's critical to remember that these companies demand workers with sophisticated knowledge and abilities, according to Marshall, A. et al. (2020) [13]. This technical modification has significantly impacted service quality. Modern technology has led to changes in the operational paradigms of most traditional services. The modern economy is no longer referred to as a service economy but instead as a super-industry or third-industrial-revolution economy due to this expansion, which has increased the requirement for factor capital across the service manufacturing process.

According to Bresciani, S. et al. (2021) [14], suppliers must employ more complex productions and assist consumers in decision-making. As a result, to produce and sell goods and services using new technology. The most notable effect of new communication and information technologies is how many services are offered. This is the case, as most services involve data conversion and dissemination. According to a survey, employees who work in the service sector devote 45–80% of their time to sharing and converting.

Homogeneity of services is a side effect of using contemporary communication and information technology to boost productivity. The following strategy is used to create and offer services as efficiently as feasible: the service is codified and standardized. Because of this, manufacturing is widespread, economies of scale are achievable, and marketplaces are global. However, service standardization also makes content simpler. As a result, the market is divided into two categories of services: custom and conventional. To suit the specific needs of specific user groups, personalized services are developed in contrast to the minimal standard services developed for a large clientele. Manufacturing strategies are affected by this.

New technology has made it possible for this to assess data, carry out tasks, and communicate cheaply across long distances. In large groupings, the distribution of administrative responsibility is typical. These are all viable options: working from home, shopping online, and banking online. To access various remote services, homes, and businesses can use Teletext, the internet, and videotext systems. The distance restriction will remain in place even though the quality of telework will increase since teleworkers will still need to travel to corporate offices frequently.

According to Maavak, M. (2020) [15] state, that focused on providing private services. Industrial activity will continue to be crucial to our society in its manifestations. For instance, a more segregated society may have more internationalized markets.

According to Ghosh, A. et al. (2021) [16], the expansion of cooperative and partnership relationships and heightened rivalry occur concurrently. The white-collar and blue-collar sectors have an increasing number of highly qualified employees—an efficient system with multiple business models. Corporate and customer communication is pretty constrained in sectoral systems with hyper-specialized businesses and ultra-sectoral diversity. The utilization of recently externalized and internationalized services is rising, there are more cordial interactions inside organizations, and business ties are improving. This process has already started and will continue unabatedly with the advancement of technology, the economy, and society.

According to Kashive, N. et al. (2020) [17], the Industrial Internet of Things (IIoT) is quickly gaining momentum as it improves connectivity, creates data, and unlocks hitherto untapped potential. It's time to use this information entirely now. Altair understands how to use data to spark creativity, open new avenues, and hasten the transition to intelligent manufacturing.

Chowdhury, L. A. M. et al. (2018) [18], disclose essential details about the product's durability and design or production quality. Manufacturers could improve current products, create new ones that are more reliable, and increase revenue by using this data correctly.

According to Chakraborty, A. et al. (2020) [19], the remainder of this section uses the application of Business Analytics to optimise energy usage as a compelling example. Resource optimization and this application both share some characteristics.

According to Aithal, P. S. (2020) [20], despite extensive research into the elements of an enterprise's information infrastructure, the literature needs a list of the components that make up the Business Analytics ecosystem.

3.2 Effect of ICCT Underlying Technologies including Business Analytics in Manufacturing/Production Industry:

Information communication and computing technology (ICCT), particularly business analytics, has dramatically impacted the manufacturing and production industries.

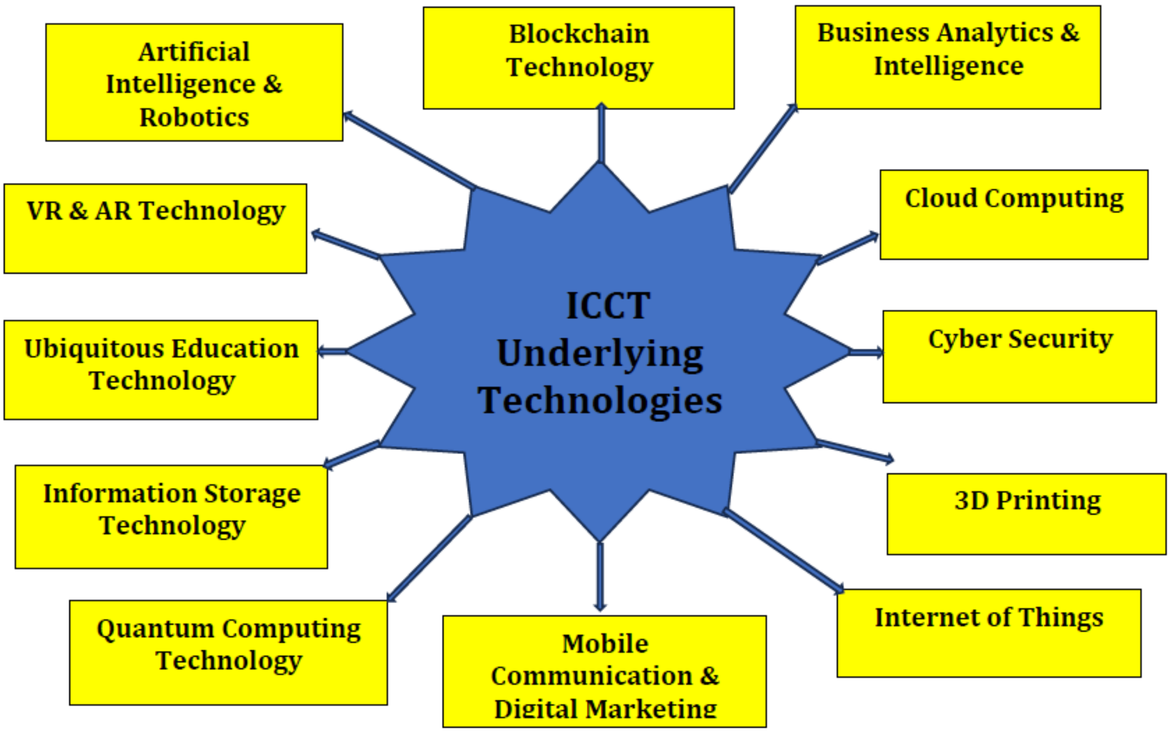

Fig. 1: Block diagram representing ICCT Underlying Technologies [20]

Industries have been revolutionized, and human experiences have been enhanced by investigating ICCT-underpinning technologies [20 -32]. ICCT's foundational technologies (figure 1) cover several important domains, including:

Organizations need help surviving and expanding in the twenty-first century because of several difficulties and uncertainties they must face when conducting business, according to Aithal, P. S. (2023) [20]. For a business to be sustained over the long term, it must keep its current clientele and draw in new ones. To do this, it must employ various tactics for delighting, educating, and satisfying its current clientele and techniques for generating a voluminous demand for luring in new clients through developing business value. Finding ways to provide value to the business to keep its current clients and draw in new ones is a problem for all decision-makers.

Aithal, P. S. (2018) [21] claims that Information Communication and Computation Technology (ICCT) and Nanotechnology (NT) are two recently identified Universal technologies of the 21st century that are anticipated to significantly contribute to the development of society by addressing the fundamental needs, forward-thinking wants, and aspirational desires of people. In this paper, the potential applications of ICCT and the ten key emerging technologies that underpin it—artificial intelligence, big data & business analytics, cloud computing, digital marketing, 3D Printing, Internet of things, online ubiquitous education, optical computing, storage technology, and virtual & augmented reality—are explored.

The rising patterns of applications of the ICCT above underlying technologies in the society's primary, secondary, tertiary, and quaternary industry sectors are examined, assessed, and projected using a newly constructed predictive analysis model, according to Aithal, P. S. (2019) [22]. From the perspectives of many stakeholders, the advantages, benefits, limits, and disadvantages of such technologies are discovered and analyzed to satisfy human wants to lead luxurious and comfortable lifestyles.

According to Aithal, P. S., et al. (2015) [23], the potential technological advancements of the twenty-first century that will have a significant impact on how people live their lives include: (1) Nanotechnology-based human life comfort; (2) High speed computation through optical computers; (3) Embedded Intelligence; and (4) HIV Antivirus. (5) Pseudo Senses - Existence perception in virtual reality and created environments, Off-Planet Production in Microgravity, (7) Protein Maps, which reveal the number of living organisms' active genes that code for proteins; (8) Customised Kids, which

tailor children's physical and mental development; (9), the creation of Chameleon Chips, reconfigurable photonic circuits based on the concept of optical solitons, (10), the control of gravity to enable flying cars (11), the possibility of eternal life through nanotechnology and stem cell research (12), fractal models for fragmented geometry shapes (13), and (13), universal access to space.
Information Communication and Computation Technology (ICCT) and Nanotechnology (NT) are two recently identified Universal technologies of the 21st century, according to Aithal, P. S. (2019) [24]. These technologies are anticipated to significantly contribute to the development of society by addressing the fundamental needs, forward-thinking wants, and aspirational desires of people.
Aithal, P. S., et al. (2019).[25] claim that Information Communication and Computation Technology (ICCT), also known as Digital Technology, is regarded as a general-purpose universal technology because of its capacity to address a wide range of issues in human society related to fundamental needs, cutting-edge wants, and aspirational desires. At the beginning of this chapter, we listed several quality characteristics of digital services and several notable published works in digital service innovation.
The complex nature of brick-and-mortar lifestyle retailing, both from the supply-side and demand side, is due to the sheer vast number of unique designs, products, brands, and categories the retailer must offer in their stores as part of their product assortment. This is added with limitation in terms of the opportunity for the store to retain customers for a more extended period simply because of increasing competition from online retailers, according to Ganesh, H. R. et al. (2020) [26]. Most lifestyle merchants in India think they have implemented the most recent ICCT tools and solutions and are producing accurate results that can be interpreted and used to inform decisions.
The influence of information communication and computation technology (ICCT) is growing daily among many communities worldwide for learning about numerous concerns, challenges, and solutions, according to Revathi, R., et al. (2019). [27]. The rise of ICCT has transformed many facets of society, and it is now helping to address issues about peoples' fundamental requirements, as well as their future aspirations and advanced demands. Every business and society is significantly impacted by the importance of and use of information, communication, and computing technologies. This study attempted to ascertain the impact of ICCT on different industrial sectors, including primary, secondary, and tertiary levels.
According to P. S. Aithal et al. (2018). [28], technology is used in various ways to address society's many complex problems. Some technologies have developed and broadened their branches into numerous fields and industries of practice, earning the title of "General-Purpose Technologies." General Purpose Technologies (GPT) is characterized by pervasiveness, where they have the potential for technical advancements, and innovation complementarities, where the productivity of research and development in related industries rises due to creative applications made possible by such general-purpose technologies. Because of this, as general-purpose technologies developed, they spread throughout the economy and eventually led to generalized productivity improvements.
Technology is a tool to tackle numerous societal difficulties for a comfortable life-leading process, claims Aithal P. S., et al. (2020) [29]. Technology has advanced steadily since the beginning of time, and various generations have been created. These generations have greatly influenced society and changed how people live and how comfortable they are. In this essay, we have provided a thorough overview of the history of technological advancement and its impact on civil society. The technology generations of the twenty-first century are named, and their significance in societal change and comfortability for the daily lives of humans is examined.
Aithal, P. S. et al. (2022) [30] claim that Technology makes it possible to execute various techniques for resolving environmental issues. Nanotechnology (NT) and information, communication, and computation technology (ICCT) are two new, emerging general-purpose technologies with the potential to creatively and effectively address a wide range of societal issues. These technological advancements promise to manage the earth's ecological and natural environment to support resilient living things. This went into great detail to analyze how the ICCT's underlying technologies contribute to preserving the planet's sustainable living systems.
According to Aithal, P. S., et al. (2019) [31], it has been seen that some technologies have developed and spread their branches to numerous fields and industries of practice, leading to their designation as general-purpose technologies. These all-purpose technologies are recognized and used in numerous industries to conduct business and address or mitigate industry-specific issues. It has been noted that

during the past few years, two general-purpose technologies—Nanotechnology (NT) and Information Communication and Computation Technology (ICCT)—have grown more quickly than the rest of the general-purpose technologies and produced a large number of underlying sub-technologies. These two technologies are further referred to as "Universal Technologies" because they can address issues relating to society's basic requirements, cutting-edge ambitions, and aspirational desires of people. ICCT and nanotechnology have paved the way for widespread solutions to various production and service industry issues by providing autonomous mobility, stability, and sustainability.
Information Communication and Computation Technology (ICCT) is a 21st-century name for Information Communication Technology (ICT), according to Aithal, P. S., et al. (2020) [32]. It encompasses about twelve underlying emerging technologies and a broader definition of advancements in computer science technologies. The Universal Technology System is constructed from components such as ICCT and Nanotechnologies. These 12 underlying technologies include 3D Printing, the Internet of Things, information storage technology, mobile business technology, online education technology, quantum computing, virtual and augmented reality, blockchain technology, data science and business intelligence, cloud computing, cybersecurity, and forensic science. Therefore, these ICCT-underpinning technologies are regarded as emerging technologies of the 21st century and are anticipated to transform the existing human generation into a tech generation by altering the current solutions for various challenges in industry and society.
(1) AI & Robotics Technology: Artificial Intelligence (AI) and Robotics represent the forefront of technological advancement. These fields involve creating intelligent machines capable of mimicking human-like cognitive functions, enhancing automation, and revolutionizing various industries, from manufacturing to healthcare.
(2) Blockchain Technology: A decentralized and tamper-proof digital ledger, Blockchain transforms how data is stored, shared, and secured. It has paved the way for cryptocurrencies and revolutionized industries by enabling transparent and immutable record-keeping.
(3) Business Analytics Technology: In the era of data-driven decision-making, Business Analytics, and intelligence play a crucial role. These technologies leverage data analysis and visualization tools to extract meaningful insights, aiding businesses in making informed and strategic choices.
(4) Cloud Computing Technology: Cloud technology has revolutionized storing and accessing data and services. Offering scalability, cost-effectiveness, and flexibility, Cloud Computing allows businesses and individuals to access resources and applications over the Internet.
(5) Cyber Security Technology: Cyber Security has become paramount with the growing digital landscape. It encompasses technologies and practices to protect systems, networks, and data from cyber threats and attacks.
(6) 3D Printing Technology: Also known as Additive Manufacturing, 3D Printing enables the creation of three-dimensional objects from digital designs. This Technology is transforming manufacturing processes, healthcare, and even architecture.
(7) IoT (Internet of Things) Technology: IoT refers to the interconnection of everyday objects through the Internet, enabling them to collect and exchange data. It revolutionizes industries such as home automation, healthcare, and transportation.
(8) Mobile Communication & Marketing Technology: As mobile devices have become an integral part of daily life, mobile communication, and marketing technology drive targeted and personalized advertising, enhancing consumer experiences and engagement.
(9) Quantum Computing Technology: Quantum Computing harnesses the principles of quantum mechanics to process information exponentially faster than classical computers. It holds the potential to tackle complex problems in fields like cryptography, drug discovery, and climate modeling.
(10) Information Storage Technology: With the explosive growth of data, efficient Information Storage Technology has become vital. Innovations in this domain cater to scalable and secure data storage solutions.
(11) Ubiquitous Education Technology: Transforming the education landscape, Ubiquitous Education Technology encompasses e-learning platforms, interactive content, and personalized learning experiences, making education accessible to learners worldwide.
(12) Virtual & Augmented Reality: Virtual Reality (VR) and Augmented Reality (AR) merge the digital world with reality, creating immersive experiences. These technologies have found applications in gaming, training simulations, and various industries for visualization and interaction.

The ICCT's exploration and research in these underlying technologies foster a technologically advanced society, driving progress and reshaping the future across diverse domains.

3.2.1 Artificial Intelligence & Robotics and BA in Production Industry:

According to Zhan Y. et al. (2018) [33], humans, the only creatures capable of doing it, used to perform every aspect of production manually. It was a long, tedious process that needed to be science because individuals can make mistakes and get exhausted. Building primary automated machines that could only complete one specific duty at a time was the next logical step after this. These robots were still limited in their abilities, even though it was an improvement over individuals performing the same task continuously. Since each of these machines is built and programmed to carry out a particular task, numerous machines would need to operate independently to accomplish the same task. Artificial intelligence and machine learning are the following significant developments in how we approach the industrial sector.

3.2.2 Big Data and BA in Production Industry:

Because industrial earnings groaningly depend on maximizing the value of assets, performance improvements can lead to considerable productivity improvements, even if they only boost margins. Similarly, a decrease in asset breakdowns can reduce inefficiencies and halt losses. Because of these factors, manufacturers emphasize maintenance and continually enhance asset performance. These data may be of great value to manufacturers, but many are surprised by their sheer volume. To learn things that will improve their performance, they can collect, clean up, and comprehend machine data.

3.2.3 Blockchain Technology and BA in Production Industry:

Manufacturing is typically dispersed throughout the world to take advantage of the durability of anyone crucial connection can put the operation as a whole to the test because enterprises are tied closely together by ample, global supply and demand chains, according to Van Oorschot, J.A. et al. (2020) [34]. Blockchain provides reliable data sharing and process automation across organizational and governmental boundaries.

3.2.4 Cloud Computing Technology and BA in Production Industry:

The promise of a wide range of benefits has sparked interest in the business, and IT worlds in the next-generation cloud computing architecture. Gartner estimates that the cloud market will be valued at more than $148.8 billion by 2014. Despite this, cloud computing is still alien to many individuals.

3.2.5 Cyber Security & Forensic Science and BA in Production Industry:

Zhang Z. et al. (2014) [35] claim that a branch of cybersecurity known as "digital forensics" or "digital forensic science" is tasked with recovering and investigating data from digital devices and cybercrimes. "Digital forensics," formerly only used to describe computer forensics, is increasingly used to analyze all devices holding digital data.

3.2.6 Digital Marketing and Business and BA in Production Industry:

In 2018, 86% of manufacturing marketers who participated in a survey used content marketing, according to Virtanen, J. (1988) [36]. Knowing that only 22% of content creators believed their company was "advanced" or "mature" in this area is in your best interest. According to this report from the Content Marketing Institute, if you still need to, you still have time to utilize the benefits of content marketing. There is a wide variety of forms available for content marketing.

3.2.7 3D Printing and BA in Production Industry:

3D printing can help your business with prototyping and small-batch manufacturing. Additional applications include design, biological devices, and mechanical components. You need to ensure that your supply chain and products are of high quality to prevent unlawful 3D printing. Working only with applicants with credentials and experience relevant to your 3D printing pursuits is another important rule.

3.2.8 The Internet of Things (IoT) and BA in Production Industry:

Verhoef E.T. et al. (2002) [37] state that (IoT) envisions a seamless connection between the natural world and the internet. This is good since it opens the door to developing robust manufacturing services and applications. Numerous academics are currently conducting active studies on the topics in this discipline.

3.2.9 Data Storage and BA in Production Industry:

Even though business analytics techniques have been successfully applied in various specialist applications to improve specific business units, it is evident from the literature that a holistic enterprise strategy is necessary.

3.2.10 Quantum Computers and BA in Production Industry:
Applying quantum computing may have limitless potential across various industries, including manufacturing. Increased strength-to-weight ratios in materials, more efficient synthetic and catalytic processes, and very energy-dense batteries could all be made possible by quantum computing.
3.2.11 Online Education and BA in Production Industry:
Due to its simplicity in scaling, online learning is widely employed in Indian schools, universities, and even businesses, according to Duc T. A. (2007) [38]. The Indian government now permits colleges to provide online degrees, which may restructure the nation's educational system.
3.2.12 VR & AR and BA in Production Industry:
According to Ren, as digitization advances, consumers reportedly lose awareness of their actual physical surroundings. W. (2003) [39]. However, they are submerged in virtual reality, perhaps with VR glasses. Users can now navigate a virtual environment and view movies or photos from a confined, 360-degree perspective. An increasing number of applications have been created due to improved graphics cards, camera quality, and quicker, more potent computers. These programs include training simulators, VR games that reflect reality more realistically than ever, and product configurators for brand-new cars.

4. REVIEW BASED RELATED RESEARCH WORK :

This is a review-based description of all ICCT underlying technology within the production industry that should come under the secondary industry sector and be compared with tech business analytics from Table 1 to Table 13.

Table 1: Business analytics in Production Industry

S. No.	Area	Issue	Outcome	Reference
1	An investigation into business intelligence and operational capacity in high-tech companies.	The importance of BI systems is determined by the quantity and sophistication of the technology used by the high-tech organization.	Knowing the surrounding factors makes it more likely for a business to reap additional benefits from implementing BI solutions.	Zeng, D. Z. (2009). [40]
2	As procurement moves more and more online	The current study advances our grasp of this subject by examining how data analytics and data analytics competence influence the development and accomplishment of digital supply chains.	Data analytics' importance and role in the development and success of the digital supply chain are made abundantly evident.	Brulhart, M. (2009). [41]
3	Is there a connection between the occupational community and corporate internal control? As an example, take high-tech CFOs.	By merging occupational communities (OCs) and upper echelons theory, the study examines how shared morals and behavioral standards from many sources affect executive decision-making.	As a result, a fresh viewpoint on CFO judgment is offered, emphasizing the importance of OCs among higher echelons.	Connolly E. et al. (2010). [42]
4	Review of Turkish	By merging multiple sorts of data, researchers function as curators and co-create.	Professionals are expected to take risks, move quickly as leaders, and actively	Wang, Z. et al. (2006). [43]

	Market Research	People's perspectives on market research have altered due to the new job; This is expected to actively participate in advancing their profession by taking chances and rushing.	contribute to the progress of their specialty.	
5	Using big data analytics wisely	In addition to academic implications for scholars interested in BDA adoption in developing countries.	The relationship between the technological, organizational, and environment.	Liang X. et al. (2007). [44]
6	How Knowledge Management Systems Can Help You Retain	The study's uses may also be expanded by introducing it into new research disciplines and geographical areas.	According to the study, supply chain integration can lead to a more organized production process and a more sustainable economy, society, and environment.	Xi Y. et al. (2012). [45]
7	The Maltese ICCT sector	This study looked at how foreign workers contribute to the ICT sector, where there is a greater need for skilled workers due to the unsustainable growth of the ICT sector.	ICT is among the sectors of the Maltese economy that is expanding the quickest. Labor issues could obstruct economic expansion if they are not resolved. ICT graduates per year need to be increased.	Pei L. (2018). [46]
8	Brazil's business sectors	The study's main contribution is the sectoral innovation standard classification of companies representing Brazil's major economic sectors.	The development of a conceptual model is the main theoretical contribution.	Qiyun F. et al. (2015). [47]
9	Differentiation in the marketplace is made possible by digital technology convergence and synthesis.	One suggested strategy for enabling creative and effective workflows is when management disciplines, technologies, and applications converge and blend as digital technology is more closely tied to company operations.	New opportunities and risks, new business models, and distinctive growth strategies for firms result from the technical union of developing technology and digital tactics.	Zhang K. et al. (2019). [48]
10	One example of a big data application	The findings demonstrate the factors the oil and gas sector should consider while implementing and utilizing big data.	Implementing knowledge obtained from big data is crucial.	Wu Y. et al. (2012). [49]

Table 2: ICCT in Production industry

S. No.	Area	Issue	Outcome	Reference
1.	The acceptance of new working practices is	The format consists of 79–99 working persons involved in various jobs, including the manufacturing sector.	IT is acceptability is influenced by the behavioural intention variable, which in turn is influenced by moderator	Qu W. et al. (2016). [50]

	influenced by culture.		variables like age and gender that influence users' behavioural intention, such as profitability of usage, usability, and mental standards.	
2.	It is significant to observe how China manages its IT human resources.	More than 400 of the 5,600 executives who took part in the survey came from China, and they came from 18 different multinational industries. This study on the availability of IT talent in China was built on the perspectives of more than 400 Chinese CEOs.	By China's particular market conditions. MNEs also need help to retain employees due to various factors, including the fact that other companies, usually Western MNEs, lure workers with more lucrative salaries.	Wang Q. et al. (2013). [51]
3.	The bubble's dark undercurrents are visible in the panoptic view of the data stream.	One of the most crucial conclusions was that the significant data sector is undergoing a trillion-dollar market bubble. There will be significant effects on societal stability and global access to the internet.	Big data must move from a bubble to a panoptic phase by potentiating numerous changing processes.	Tongbin Z et al. (2016). [52]
4.	According to the study, patterns, and developments in IoT have potential use in the building industry.	These details could be utilized to pinpoint the main impetuses of adopting digital and IoT technology.	Draw attention to the information gaps in the current studies, particularly a more thorough assessment of the organizational changes needed to support the usage of the IoT, economic analyses, and obstacles to broader adoption.	Chen J. et al. (2016). [53]
5.	Crowdsourcing is used to get information on employee opinions for company branding.	This is to look at how social media may assist any company in developing a more desirable employer brand. In these reviews, there is a lot of information about employer branding.	The study found that businesses can use information from crowdsourced polls on workplace branding to gauge their desirability as an employer. They can use cutting-edge data analytics techniques like sentiment analysis and text visualization to create intelligence-based employer branding initiatives.	Wu. Huang C.Z. et al. (2019). [54]
6.	Information about how intellectual capital works	Using descriptive statistics and multiple regression approaches, it was determined how IC efficiency affected financial	This might adhere to the study's findings. Repercussions for daily life Managers, corporate owners, and regulators	Yangjun R. et al. (2019). [55]

		performance. Annual reports' secondary data are used in this study.	must connect IC with performance management in conditions of globalized competition to sustain the competitive advantage.	
7.	Big Data Analytics in Healthcare: India's Development and Challenges	BDAs have been researched and found to benefit the health field in wealthy nations, offering a wide range of long-term treatments for the most prevalent and persistent disorders.	It has demonstrated how BDAs could bring about gradual reforms in the Indian healthcare sector while outlining the current circumstances and any arising issues.	Bin J. et al. (2015). [56]
8.	The importance of AI-based transformation initiatives	The implications of artificial intelligence on organizational performance, particularly regarding the financial value of AI-based transformation efforts.	Artificial Intelligence can fully realize its promise thanks to its capacity to enhance the impacts of automation, information, and change and recognize, anticipate, and interact with people.	Zeng X. (2011). [57]
9.	Evidence and new Chinese trends offer credibility to a proposed paradigm for rapid creation in data-driven scenarios.	This document makes six suggestions for leveraging data analytics and information and communication technologies (ICTs) to foster creativity.	It generated six suggestions for how ICTs, in particular, and data analytics could assist for research.	Zhang J. et al. (2004). [58]
10.	Use of technology in the housing sector	Three objectives have been set for this investigation. A taxonomy of advancements in housing is required to begin.	This summarizes the data on innovation uptake in the housing sector.	Xie, L. (2010). [59]

Innovative uses of ICCT can develop new sales channels, product features, and ways to differentiate items. ICCT may also increase productivity, reduce expenses, and improve the framework for risk management and strategic decision-making. These discoveries ought to improve corporate performance.

Table 3: Artificial Intelligence and Robotics in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Artificial intelligence, machine learning, and deep learning in contemporary robotics	Robots are becoming more productive, safe, and intelligent thanks to the contributions of Artificial intelligence, machine learning, and deep learning.	Thanks to integrating AI, ML, and DL into advanced robotics systems, this may now be examined and changed in various applications to boost productivity in advanced robotic businesses.	Soori, M., et al. (2023). [60]
2.	Knowledge of AI's possible	To cultivate better crops, control pests, monitor soil	The most effective AI-based crop health	Javaid, M., et al. (2023). [61]

	applications in the agricultural sector	and growth conditions, and analyze data for farmers, artificial intelligence (AI) technology is being employed in agriculture.	strategies involve hyperspectral imaging and 3D laser scanning. For analysis, these sensors that are powered by AI gather more detailed information about the health of the crops.	
3.	A platform for modifying and improving production systems through the use of digital twins and modular AI	Artificial intelligence and digital twins could improve the productivity, reactivity, and robustness of industrial systems. However, traditional digital twin solutions are usually restricted to improving isolated, static systems when optimizing a specific process.	Artificial intelligence, used to optimize production lines and make decisions, offers a framework for various manufacturing applications.	Mo, F., et al. (2023). [62]
4.	The Banking Sector and Artificial Intelligence	management institutions, given the technological advancements of today, which involve automating practically all processes from start to finish. Banks are missing out on the chance to modernize some of their business models, freeing people from repetitive work, preventing fraud, enabling better decisions, and reducing losses because they are out of step with current trends and times.	Banks interact daily with many clients while still using antiquated Institutions that can improve overall performance and human dependency while increasing profits thanks to automation. In short, Artificial Intelligence-powered Virtual Assistants improve the efficiency of business processes across all business sectors, but especially in the banking sector, making them quick, dependable, and not dependent on humans.	Umamaheswari, S., et al. (2023). [63]
5.	Modern analysis of wire arc additive manufacturing's applications for artificial intelligence research	For the fabrication of medium to significant metal components with high value-added for numerous industries, including the aerospace and maritime industry, a recent development. The typical WAAM method isn't widely used in the manufacturing industries.	It explores how to apply fresh AI techniques and how to improve AI techniques. It is anticipated that through AI approaches and the results of this systematic research.	He, F., et al. (2023). [64]
6.	Artificial Intelligence's Increasing Contribution to Collaborative Robots for Industrial Use	Close collaboration is made possible by collaborative robots (cobots), which allow direct human-to-robot interaction without the usual obstacles. Industrial robots and people used to	Costs can be reduced, customer satisfaction can be increased, and they can adapt quickly. They are determining the current and prospective future functions of artificial	Borboni, A., et al. (2023). [65]

		be separated by fences while they worked.	intelligence in commercial robots.	
7.	Customer perceptions of service production and service operations' resilience	Artificial intelligence is used more frequently in service sector operations. Production systems and operations management academics have yet to investigate the preference of service customers for AI-powered service operations.	Customer interactions with mechanical AI have an asymmetrical effect on customer satisfaction with service operations.	Mariani, M. M., et al. (2023). [66]
8.	An intelligent production management system for resources that conserve energy based on data mining	The intelligent production management system is constructed using data mining and energy-efficient artificial intelligence resources.	The optimal workstation assembly plan highlights the intelligent elements of the production control system for clever manufacturing and is displayed on the system's front end.	Guo, Y., et al. (2023). [67]
9.	A Review on Industry 4.0 Design.	AI is gaining popularity due to its success in resolving particularly challenging issues in industrial chemistry and chemical engineering.	The use of AI in automated synthesis, route planning for synthetic materials, and research of structure-function relationships. The difficulties and prospects for AI in producing chemical products are discussed in the final section.	He, C., et al. (2023). [68]
10.	AI-based software methods for improving the trajectories of mobile robotic platforms	Various control strategies for robots' autonomous navigation have been developed during Industry 4.0.	The DQN functions in a simulated environment because of the randomness, which resulted in better autonomous learning performance than previous control approaches.	Escobar-Naranjo, J., et al. (2023). [69]

Table 4: Blockchain in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	The use of blockchain technology to create a transparent and consumer-trust-based food sector of the future	well-being, and transparency will govern the food industry's trends. Inaccurate and deceptive assertions are a current problem that undermines customer confidence.	Blockchain have the potential to fundamentally alter how business operations and processes are carried out across all sectors, including the public ones, with the correct amount of time and effort. This article examines how the Blockchain can help the food industry become future-ready, enabling	Singh, V., et al. (2023). [70]

			customers to check product claims and guard against food fraud.	
2.	The analysis demonstrates promises about sustainability, health, and Applying Blockchain Technology to Food Supply.	Food supply chains are heterogeneous, diverse, collaborative, and widely scattered regarding the product, method, and destination.	In the food supply chain, blockchain can be utilized to enable traceability, origin monitoring, transparency, and low environmental impact. It also aids in achieving the UN's sustainable development objectives.	Chandan, A., et al. (2023). [71]
3.	Blockchain technology offers opportunities for the Chinese industrial hemp industry.	This significant cash crop can help reduce poverty and raise farmers' incomes. However, the safe expansion of the industrial hemp sector needs to be improved by risks associated with drug loss and public policy.	The feasibility study recommends creating a consortium blockchain comprising market players, financial institutions, and anti-drug organizations to solve the industrial hemp sector issues.	Liu, H., et al. (2023). [72]
4.	How can the retail sector choose the optimum replenishment plan using blockchain technology as support?	Product correctness and supply chain management transparency are two significant problems that practitioners must deal with. Data storage via blockchain is highly safe and reliable. If reliability is poor, it is imperative to incorporate radio frequency identification. By increasing product visibility for the appropriate replenishment plan, radio frequency identification can enhance SCM.	This can boost profits by 40% if holding costs are higher. Even though the lowering rate is relatively sluggish, the detrimental impact of misplacement is lessened with rising demand. Only if there is such a significant demand that it can lessen the impact of misplacement may the decision to forgo radio frequency identification be successful.	Saxena, N., et al. (2023). [73]
5.	Pharma supply chain industry solution using blockchain	Modern pharmaceutical supply chains are intricate, including producers, suppliers, and customers on various continents. The movement and sale of medicinal items that are sold online are now markedly opaque. The absence of openness, a lack of trust in teamwork, and a reluctance to share data can be significant obstacles for this international industry.	Smart contracts also govern interactions between vendors and customers by keeping track of IoT containers containing prescription drugs and thoroughly informing customers. Our intelligent contracts manage unique situations, including consumer reimbursements, in case contract terms are broken to guarantee the secure delivery of medications.	Abdallah, S., et al. (2023). [74]

6.	When should remanufacturing platforms employ blockchain for platform operations?	Blockchain technology is now being used in many industries. Currently, one of its uses is remanufacturing. The business uses blockchain technology to save the data on discarded products before producing new ones.	For social welfare, coordination between the producer, online platform, and the third-party company is conceivable in the market or resale mode.	Xu, X., et al. (2023). [75]
7.	We are incorporating Industry 4.0's next-generation environment with IoT, ML, and blockchain technology.	The concept of "Industry 4.0" is revolutionizing many different industries and sectors worldwide. Through methodical adaptation and the use of cutting-edge engineering tools from the next generation, Industry 4.0 serves as a technical accelerator for increased growth.	Due to Industry 4.0's quicker adoption, authors have tried to describe every associated concept and explore a prospective roadmap, specifically focusing on its implications in the current market.	Shrivastava, A., et al. (2023). [76]
8.	Blockchain and federated learning are used in FusionFedBlock to protect privacy in Industry 5.0.	Modern technology, including the Internet of Things (IoT), is required for application in the industrial setting. The sector can collect, transfer, and evaluate large amounts of data utilizing state-of-the-art technologies. When employed with industrial infrastructures, IoT still has various issues, including centralized control, privacy protection, latency, and security.	By miners in Blockchain networks, this global model is validated. Federated learning ensures privacy protection among the many divisions and sectors it covers.	Singh, S. K., et al. (2023). [77]
9.	Relationship analysis between the evaluation of the circular economy	This is done to compare the relative influence of blockchain technology on various metrics. A general study strategy is offered for contrasting blockchain capabilities with CE performance evaluation.	It is crucial to research and evaluates practises in this area; much more analysis is required to advance CE.	Kouhizadeh, M., et al. (2023). [78]
10.	Supply chains for producing textiles that use blockchain storage and sharing Internet of Things data.	The distribution of goods globally and how makers exchange value are being reinvented. As an illustration, IoT technology aids in gathering, storing, processing, and improving the effectiveness of operational data. However, the information systems used in textile production	Blockchain-based computing has several benefits, including quick scaling, distant data storage, and service delivery in a dynamic context.	Pal, K. (2023). [79]

		based on IoT technology and its supply chain are highly susceptible to security, privacy, and trust problems.		

Table 5: Cloud Computing in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	A green cloud? Energy efficiency and cloud computing: an empirical analysis	The technology's rapid, widespread adoption during the past ten years has generated discussions on cloud computing's environmental effects.	As shown by examining firm-level survey data, SaaS promotes energy-efficient production, enhancing operations.	Park, J. et al. (2023). [80]
2.	An examination of the environmental, financial, and Social advantages	This is to discuss the benefits of cloud computing for the environment, including its ability to use less energy, produce fewer carbon emissions, and possibly include renewable energy sources.	To fully realize its potential, further study, and policy action are required. This is because cloud computing has the potential to play a significant role in fostering sustainable development.	Yenugula, M., et al. (2023). [81]
3.	Governing Through Infrastructure Control: Cloud Computing and Artificial Intelligence	Digital data is crucial to how societies, organizations, and persons are observed, comprehended, and managed. States and governments have used numerical data to monitor and administer their borders and populations.	As evidenced by their infrastructure forays into education, Amazon, Google, and Microsoft now hold the position of state-like corporations with the social, technical, economic, and visionary power to influence how institutions, people, and entire systems are measured, evaluated, rated, predicted, controlled, and governed.	Williamson, B. (2023). [82]
4.	In the direction of a secure cloud architecture for smart industrial IoT based on blockchain and SDN	Several significant new technologies have been the focus of recent research.	The traits used in experimental evaluations of our SDN and BC-based implementation's effectiveness.	Rahman, A., et al. (2023). [83]
5.	Observation Based on the Cloud to Follow the Digital Thread	A list of critical technologies is provided to help people understand the digital thread concept. Using the chosen technology as a foundation,	Additionally, the design offers a cloud-based observation that blends enterprise products (like SAP products) with cloud infrastructure (like	Daase, C., et al. (2023). [84]

		cutting-edge options for digital threads are investigated. The research project also provides a high-level architecture for realizing the digital thread by the finished technological analysis.	Google Cloud). Based on the work undertaken to conclude the research conducted here, a forecast is given regarding anticipated future developments.	
6.	A social platform called Nurilo uses cloud computing and blockchain to sell and buy framework products.	A delivery chain is a network of organizations, individuals, tasks, information, and resources used to move. Most industries, including healthcare, economics, food, and education, centrally administer statistical systems.	Blockchain's potential could be used to change the features of the supply chain that affect efficient execution. This can improve the simplicity of financial transactions, increase the adaptability of system operation, and enable handling robotization.	Kumar, A., et al. (2023). [85]
7.	Smallholder farmers in Sub-Saharan Africa are utilizing big data and cloud computing.	Information processing in numerous economic areas, including agriculture, has made cloud computing and big data technologies increasingly popular.	The lack of access to and processing information and farmers' resistance to implementing modern farming techniques and digital technologies are the leading causes of Africa's agriculture productivity problems.	Mupaikwa, E. (2023). [86]
8.	A social analysis of Industry 4.0 technology in connection to goals for sustainable development	This will build an evaluation framework after identifying the SDGs connected to I4.0.	The findings provide a starting point to assist order investments in different technologies based on the SDGs. We identify logical steps that can help invest in and plan for adopting I4.0T to achieve SDGs more effectively.	Bai, C., et al. (2023). [87]
9.	Industry 4.0 implementation in Indian banks	Digitalization and intelligence are needed to improve the state of the earth.	The study aims better to understand banks' challenges in the digital age. We are putting customers first while adjusting to the digital age in banks.	Gupta, R. (2023). [88]
10.	They are integrating blockchain, ML, and the next-generation environment of Industry 4.0.	The concept of "Industry 4.0" is revolutionizing many different industries and sectors worldwide. Through methodical adaptation and cutting-edge engineering tools from the next generation, Industry 4.0 is a technical accelerator for increased	Because this technology is being adopted more quickly than in the past, authors have worked hard to clarify every concept associated with Industry 4.0 and examine a potential roadmap, paying close attention to how it will	Shrivastava, A., et al. (2023). [89]

		growth—the Internet of Things, blockchain, and AI.	affect the market in the present.	

Table 6: Forensic Technology & Cyber Security in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Bibliometric examination of studies on cyber forensics and security	Cybersecurity has become one of the most significant issues with the development of internet-based technology, goods, services, and networks. If cybersecurity is a kind of prevention, then cyber forensics is a treatment. In terms of digital security, both are crucial pillars.	Cybersecurity and forensics are shown here, including the authors, organizations, nations, keywords, sources, and documents with the most vital international collaboration connection strengths. Present are also the most recent trends, unexplored subjects, and future directions.	Sharma, D., et al. (2023). [90]
2.	A global framework for memory forensics for programmable logic controllers	This automates physical operations in essential infrastructure and numerous other industries and manufacturing sectors. Cybersecurity was not considered when PLCs were being developed, and they were initially totally cut off from the Internet.	In the event of a cyberattack or system failure, the Python memory profile implementation can assist in reducing the time and effort needed for human investigation.	Awad, R. A., et al. (2023). [91]
3.	Do ChatGPT and Deepfake Algorithms Put the Cybersecurity Sector at Risk?	Cybersecurity has become a primary global concern in this digital age. Hackers employ deepfake algorithms and the development of Massive Language Models (MLMs) like ChatGPT to produce codeless fake content that spreads online dangers. Natural language processing and deep fake algorithms make up the technology frequently used in movies, pictures, and the film business. The capacity to tell actual photos from fraudulent ones is in jeopardy since the technology uses machine learning to change real photographs and movies using neural networks.	Technology threatens cybersecurity because it makes it easier for thieves to commit crimes like vishing and business email compromises that are difficult to detect. This study provides a detailed description of the various neural networks that facilitate the creation of deep-learning algorithms while considering both social and technological implications.	Dash, B., et al. (2023). [92]
4.	Cybersecurity Concerns in the FinTech Sector:	With examples from the Indian financial industry, this will examine privacy, information security, and	Digital payment fraud prevention strategies are provided.	Pachare, S. M., et al. (2023). [93]

	Problems, Challenges, and Solutions	cyber security. A fundamental framework for cyber security is addressed in the chapter, along with an iterative procedure that considers actions.		
5.	Was the crime committed by the AI system, according to the discipline of AI forensics?	Artificial intelligence (AI) is becoming increasingly autonomous and making choices that influence our daily lives. Their actions may lead to accidents, injuries, or, more generally, legal violations.	This aims to concentrate on grey box analysis and AI that may be "malicious by design." Convolutional neural networks were used in our study to highlight problems and suggest solutions for identifying harmful AI.	Schneider, J., et al. (2023). [94]
6.	Framework for digital forensic preparation for 3D printing using material extrusion	Critical parts for cars, planes, and other vehicles are increasingly printed in industry. Cyberattacks on the printed object are encouraged by the potential for severe damage to the system and the environment if a 3D-printed element (like a turbine blade) fails while it is in use.	A post-incident inquiry is made more accessible by forensically-ready printing equipment.	Rais, M. H., et al. (2023). [95]
7.	Techniques and Issues in Machine Learning for Cybersecurity	Using cybersecurity data to identify patterns or insights regarding security events and creating the appropriate data-driven models is the key to automating and intelligently constructing a security system. The use of data to examine real-world events is known as data science. The names of numerous scientific methodologies, machine learning procedures, and systems also refer to it	Increasing performance and periodically updating the training dataset are essential to include new phishing techniques. These activities will improve the detection of phishing.	Bharadiya, J. (2023). [96]
8.	An IoT forensic concept based on blockchain is called BLOFF. Blockchain, the Internet of Things, and Security: Research Anthology	IoT is an intriguing technology for consumers and attackers because of its many benefits. The tools and technology are available to hackers now allow them to carry out millions of complex attacks.	Further, the vast bulk of the evidence used by forensic investigators comes from service providers, which raises the possibility of corrupted evidence. The authors proposed an IoT forensic method based on blockchain that would address this problem by barring the use of tampered logs as proof.	Agbedanu, P., et al. (2023). [97]

9.	I am using forensically sound risk management to combat insider attacks.	Insider cyberattacks are hard to thwart with traditional security methods. Such attackers usually exploit lawful access to the system for malicious purposes, or an external attacker may pose as an insider or use other cunning methods to get access and bypass security measures. Software solutions that support the inevitable forensic investigation and are forensically equipped could solve this problem.	To determine the necessary forensic preparation for insider assaults, the FR-ISSRM risk management technique is proposed. When the requirements are implemented, they help improve security posture overall while reliably identifying the attack's root cause, perpetrator, and damage. Three instances involving common insider attacks are used to illustrate the method.	Daubner, L., et al. (2023). [98]
10.	A small nation-state's remapping of cybersecurity skills	As all industrial sectors continue to become more digital, cybersecurity (CS) significantly impacts the general public's well-being. A sufficient number of CS experts with the necessary skills are required for information system security. A critical component of the strategy for workforce development is a cyber-competency map..	Two semi-structured qualitative field professional interviews are used to present and validate the competence map.	Bukauskas, L., et al. (2023). [99]

Table 7: Digital Marketing and Business in Pthe roduction Industry

S. No.	Area	Issue	Outcome	Reference
1.	The Financial and Sustainability Performance During the COVID-19	MSMEs' financial and sustainability success is impacted by the e-commerce platforms they use and the digital marketing tactics they employ. MSMEs had to learn and use a variety of business-sustaining practices.	Our findings add to the body of work already available on technology adoption. This study has various lessons for managers and decision-makers of small firms, who can discover how important it is to work.	Gao, J., et al. (2023). [100]
2.	Digital advertising to its full potential as an online marketing technique. Digital Entrepreneurial Start-up	To increase consumer interest in purchasing, this study will examine the best strategies for using Internet advertising.	Digital marketing is the most significant medium because it is the most efficient way to advertise and may dramatically enhance sales volume.	Wuisan, D. S., et al. (2023). [101]

3.	Determinants, Research Perspectives, and Evolutions	The marketing strategy must be changed, especially the brand management paradigm.	Internal branding and outside customer impression directly affect the firm's success. The link between brand and market orientation currently exhibits synergy instead of mutual substitution.	Li, S., et al. (2023). [102]
4.	The APIAT Trade Fair's MYPES for the footwear industry.	This study, which employed a quantitative research technique and a correlational research design, sought to understand how digital marketing affected MYPES's entrepreneurship in the footwear industry at the APIAT trade show.	Normative, referential, conceptual, and philosophical frameworks have a less substantial impact on entrepreneurship than the framework. The conceptual framework is another area that is greatly influenced by entrepreneurship.	Castillo, S. A. P. (2023). [103]
5.	Following the COVID-19 era, marketing plans for the United Arab Emirates' tourism sector are needed.	The effect of the COVID-19 pandemic on the tourism industry in the UAE will be studied through a theme assessment. It focuses on using transformative tactics by tourism-related businesses to resurrect the industry.	This is subject to both supply-side and demand-side disruptions. As part of designing tourism products, it also considers the most critical socioeconomic issues.	Seshadri, U., et al. (2023). [104]
6.	The Development of the Travel and Tourism Sector: From Digital Marketing to the Metaverse Network	This is being suggested as a result of this change and would take the shape of a substitute tourist type that would allow people who live in different countries to visit the same or different countries in the virtual world.	The conceptual framework for digital tourism marketing and the metaverse network, which the department provided, is expected to support the industry and upcoming scholarly research.	Garda, B. (2023). [105]
7.	Training in Digital Marketing to Boost Village-Owned Businesses' (BUMDes) Competitiveness in the South Buton Regency	Since the Internet has been widely used, digital marketing has grown exponentially. The affordability of cell phones contributes to this degree of use. However, it is only sometimes understood that business people, such as firms controlled by villages, employ digital marketing (BUMDes).	The social media platforms used for digital marketing include those owned by BUMD's employees and those built mainly for the company—product sales at BUMDes.	Lawelai, H., et al. (2023). [106]
8.	Energy Use, Climate Change, and Sustainability	Today, the word "sustainability" permeates all economic sectors, but it	Climate change includes an assessment of potential environmental harms brought on by the	Thangam, D., et al. (2023). [107]

	Affected by Digital Marketing Practises	is especially prevalent in business.	practice, reasons why digital marketing companies need a sustainable business strategy, and upcoming efforts required to ensure a sustainable environment.	
9.	Artificial intelligence and digital technologies are advancing and changing digital marketing and branding, and the metaverse universe is also experiencing these changes.	The customers don't need to leave their houses to interact with items in an augmented reality environment. In-store encounters can become actual in the Metaverse.	Businesses must be prepared to compete in digital and virtual environments as part of the digital transformation process if they want to succeed in a world that is becoming increasingly competitive.	Nalbant, K. G., et al. (2023). [108]
10.	Artificial Intelligence and the Metaverse in Marketing: Digital Transformation 4.0. Eduzone	The main objective of the fashion sector's digital transformation was to attain sustainability by utilizing a variety of digital tools. A new virtual reality environment called the metaverse, which was just created, has expanded the possibilities for digital clothing.	Studies on the metaverse and artificial intelligence have been conducted in several academic disciplines, including literature, art, music, and education. Two of the most important modern technologies are artificial intelligence and the metaverse.	Rathore, B. (2023). [109]

Table 8: 3D Printing in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Challenges and possibilities for the construction industry with 3D printing using cementitious materials	Both conventional and non-conventional materials have been analyzed, many of which are alkali-activated materials (geopolymers).	Results from the development and research phases are encouraging and are anticipated to become an industrial reality soon. The key issues and potential solutions for using additive manufacturing are discussed in this study.	Robayo-Salazar, R., et al. (2023). [110]
2.	Agri-food processing waste streams can be valued using a 3D printing method.	Food-processing waste streams are becoming increasingly recognized as a topic of study and commercial interest due to mounting evidence of their importance for resource recovery.	This highlights the technology's main benefits and how it might be used for food printing applications.	Yoha, K. S., et al. (2023). [111]

3.	Analyzing the financial and environmental consequences of supply networks utilizing 3D printing technology	The tire business is one of many that the 3D printing technology is expected to transform. The fundamental reason is that tires are a large product requiring intensive transportation and inventory management procedures.	3D printing technology may provide a 9–10% reduction in the chain's carbon emissions. Future distribution and manufacturing of tires may be cleaner as a result. Extensive sensitivity analysis is also undertaken to comprehend how model outputs change with altering input parameters.	Shahpasand, R., et al. (2023). [112]
4.	Recent developments and potential in polylactic acid 3D printing	A type of polymer known as "bio-based polymers" is produced by living things, albeit only a small number of these are now known and used commercially. They have not seen widespread application due to inadequate mechanical strength and financial limitations. Instead, they have been a strong contender for biological applications.	This study evaluated PLA's chemical composition, production processes, standard features, and market environment. This review focuses on 3DP processes that use PLA filaments in extrusion-based 3DP technology. Several recent articles have highlighted products made of PLA using 3D printing.	Joseph, T. M., et al. (2023). [113]
5.	As examples of modular product architecture for sustainable, flexible manufacturing in Industry 4.0,	Modular products are adaptable to changing requirements and maximize resource use. In this study, a method was suggested and applied to two goods, a 3D printer and an electric toothbrush, with a modular architecture, several product variations, and customizability to help develop adaptable, sustainable manufacturing systems.	The factory must be modified or reorganized to accommodate the modular design as it evolves. To establish the connections between goods and processes for a flexible, sustainable manufacturing system.	Habib, T., et al. (2023). [114]
6.	Designing a 3D-printed emergency mechanical ventilator for crises with advanced manufacturing techniques	For the industry to handle such events and increase resource conservation and avert shortages, increased collaboration efficiency is required. Technology advancements in additive manufacturing are poised to alter how goods are created fundamentally. They can support the earth's fight against catastrophe from	Another thing that was assessed was a mix of production technologies. When a high volume of output is needed, the adjustments made it possible to cast (injection mold) the pieces optimally, which sped up production rather than printing each part individually.	Kalkanis, K., et al. (2023). [115]

		material and use perspectives.		
7.	What impact does 3D printing have on residential construction project success using structural equation modeling?	Applying 3D printing to construction could improve the project's overall result. However, Malaysia's home building industry typically uses traditional techniques, which could improve the environment, public health, and public safety.	Malaysian officials may view the outcomes of using 3D printing in home construction as a cutting-edge strategy for advancing environmental sustainability, public health, and safety.	Waqar, A., et al. (2023). [116]
8.	In light of the scope and context of the 3D printing revolution, supply chain management, and operations should be re-evaluated.	For at least three decades, people have predicted that 3D printing will revolutionize additive manufacturing.	This document lists variables on three levels for a company to gain from the use of additive manufacturing.	Beltagui, A., et al. (2023). [117]
9.	Personalized Medicine with Magistral Compounding and 3D Printing	Pharmacy practice has traditionally included the use of magisterial compounding. A rise in medicinal compounding could help to meet the rising need for individualized medication therapies on a global scale. The new, adaptable 3D printing technology might advance this procedure even further.	Relevant Dutch stakeholders, including those from boards and ministries of health, trade associations, and various pharmacies, participated in semi-structured interviews. Participants were found using deliberate sampling. Using content analysis, the key topics were found.	Beer, N., et al. (2023). [118]
10.	Identifying Obstacles to the Development of a Local Medical Supply Chain Ecosystem Supported by 3-D Printing	Separating the areas is necessary to build a local supply chain, and this process results in a new business model due to alliances made with local partners and clients. The factory buys raw materials, components, and preassembled components in local supply chains from regional vendors. Then, it sells the finished goods to consumers in the region by lowering inventory and transportation costs and switching the manufacturing process from manufacture-to-stock to make-on-demand.	The necessity for a change in company strategy, strong stakeholder participation, and rapid backing from the local government has been identified as the main forces behind developing 3DP-enabled localized supply chain ecosystems.	Kamble, S., & et al. (2023). [119]

Table 9 : The Internet of Things (IoT) in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Analysis of Internet of Things (IoT) security concerns and solutions	The scenarios necessitate intelligent devices; it is necessary to consider how the dynamics of protection will change due to the various demands of these practical applications. This study includes an introduction and thoroughly describes the connections between the main security requirements, implementations, and network safety.	By looking at a few recent studies in the IoT field, it is possible to exhibit and talk about fresh IoT ideas from the scientific, educational, and industrial sectors regarding specific facts.	Rekha, S., et al. (2023). [120]
2.	Big data analytics problems arise when the Industrial Internet of Things (IIoT)	The sharp rise in IoT-connected devices and the exponential rise in data consumption is a clear indication of how significant data growth and IoT growth are interwoven.	We are building intelligent IIoT systems in an industrial 4.0 environment while addressing the challenges given by BDA.	Qi, Q., et al. (2023). [121]
3.	IoT applications in the construction sector have undergone a thorough investigation that reveals new aspects.	IoT has been rapidly adopted in many industries in this digital age, but its use in the construction sector is still only slightly prevalent. Construction 4.0 safety is integrated with IoT devices to create a framework that effectively supports applications that increase operational and construction efficiency.	With the aid of this study, construction managers will be better ready to spot issues, and experts will be better able to evaluate the potential for IoT hybridization within the context of Construction 4.0.	Khurshid, K., et al. (2023). [122]
4.	Utilizing the Industrial Internet of Things, blockchain, and artificial intelligence to assist small and medium-sized businesses in their move to the digital economy	Automating SME transaction execution grows increasingly difficult as more SME stakeholders connect, access, trade, add, and edit transactional executions. SMEs demand high levels of efficiency, stable manufacturing, excellent financial management, privacy, and security, among other things.	The goal is to use artificial neural networks with ML-based AI to manage and optimize the daily volume of SME transactions.	Khan, A. A., et al. (2023). [123]
5.	To support the industry, build a smart factory based on IoT and cyber-	As Industry 4.0, which stands for the digital transformation of manufacturing and uses cutting-edge intelligent and potent technology, arises, society, business, and other	The creation of an intelligent cyber-physical system using essential industrial, computer, informational, and communication	Ryalat, M., et al. (2023). [124]

	physical systems. 4.0.	industrial sectors are strongly influenced.	technologies, built on the ground-breaking brilliant factory architecture of Industry 4.0.	
6.	The role of supply chain transparency as a mediator.	The alleged connections between operational performance (OP), supply chain visibility (SCV), big data analytics (BDA), and the Internet of Things (IoT) in Jordan's pharmaceutical manufacturing sector. The conceptual model linked to SCV's indirect impacts is also investigated in this research.	The study's results demonstrate a favorable and statistically significant association between the IoT and BDA on SCV and OP. A statistically significant correlation existed between the SCV and OP. In addition, it was demonstrated that SCV mediates the connection between IoT, BDA, and OP.	Al-Khatib, A. W. (2023).[125]
7.	Blockchain and Internet of Things (IoT) technology help pharmaceutical supply chains remain resilient in the post-pandemic era.	Blockchain and the Internet of Things (IoT) help to solve complex, interrelated problems by increasing the flexibility, visibility, and transparency of PSC activities in the IT sector.	It is creating a PSC management paradigm with a hospital-specific focus that incorporates blockchain and IoT.	Chen, X., et al. (2023). [126]
8.	Workers' Opinions on the Olive Oil Industry's Performance Improvement Potential with the Internet of Things	Systematic and distributed, the world's food supply is now. A rise in business productivity is predicted due to information technology adoption and reasonable use.	The approach's development used decision trees and self-organizing map (SOM) clustering. Respondents who know how to incorporate new technology into the sector were surveyed for the data. The outcomes showed that olive oil companies' performance was greatly enhanced by implementing IoT.	Alsayat, A., et al. (2023). [127]
9.	Aspects of the Industrial Internet of Things (IIoT), including benefits, needs, and challenges.	This is altering how businesses operate and how we live our lives. Only a third of the estimated 75 billion devices online by 2025 will likely include tablets, PCs, smartphones, and wearable technology.	Shortly, human communication will significantly improve thanks to the "Internet of Things" (IoT).	Banafa, A. (2023). [128]
10.	Using IoT-enabled devices, healthcare help is provided to	IoT could lead to disruptive medical innovation. Searching for research articles on the COVID-19 pandemic and IoT in healthcare allows one to	The focus of IoT in the field of medicine is on providing proper treatment for a variety of COVID-19	Mukati, N., et al. (2023). [129]

	COVID-19 patients.	investigate the viability of this technology. Professionals may solve connected issues with this literature-based research and stop the COVID-19 pandemic.	circumstances. Lowering risks and improving overall performance makes the surgeon's job easier. Using this technology, physicians can quickly spot changes in COVID-19's vital characteristics.	

Table 10: Data Storage in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Industry 4.0 refers to how medical manufacturing companies are utilizing technology.	These are extensively used by businesses wanting to grow to enhance their reputation and offerings. Additionally, there is automation using trustworthy server storage and databases.	In the age of digital transformation, information systems are crucial for assuring the technical integration of all business operations, particularly management-related ones.	Guadalupe Mori, V. H., et al. (2023). [130]
2.	Cost analysis for the temple's manufacture	The data on business operational activities at Tempe Agro-industry UD Mawar Sari were studied and reported using a quantitative descriptive approach in this Field Work practice. This practice was primarily focused on those activities related to production costs, such as raw material costs, labor costs, and overhead costs.	According to the findings, the Tempe Agro-industry UD Mawar Sari produced a temple at the cost of Rp. 420,775,433.3, which included Rp. Three hundred forty-two million sixty thousand for raw materials and Rp. 31,559,200 for labor.	Sinta, I., et al. (2023). [131]
3.	Blockchain and federated learning are used in FusionFedBlock to protect privacy in Industry 5.0.	Industries are going through considerable changes in the digital world, or "Industry 5.0.".	Federated learning enables privacy protection due to the multiple departments and defined areas. The cloud layer's Distributed Hash Table (DHT) offers decentralized, safe storage.	Singh, S. K., et al. (2023). [132]
4.	Real-time optimization is made possible by Industry 4.0 technologies.	Based on recent developments, this examines the component- and system-level technologies needed to achieve ROOPVC. The paper explicitly covers the two critical components of ROOPVC: modeling, simulation, optimization, and DT technology.	The main conclusions of this review point to ROOPVC as being suitable for deployment on any size field, offering more stable output while allowing significant carbon savings, and swiftly installing thanks to its modular (microservices) architecture.	Singh, H., et al. (2023). [133]
5.	Driving force behind the	Natural disasters such as abrupt climate changes,	A service unit's performance is compared to comparable	Li, X., et al. (2023). [134]

	development of the low-carbon sectors in the digital economy. Technology and Assessments for Sustainable Energy	earthquakes, typhoons, storms, and snowstorms have become more common in recent years, posing a severe threat to human life and advancement. Many nations worldwide strive for a development that strikes a balance between economic growth and the preservation of the environment. The most popular option among them is the low-carbon economy, which all nations on Earth support.	units offering the same service to maximize efficiency.	
6.	Industrial 4.0's use of data visualization is one of the newest mechanical and industrial engineering trends..	Manufacturing industries are concentrating on enhancing their production in every way due to the escalating market rivalry. The manufacturing industry's procedures may deviate with time. Therefore, effective process monitoring aids in understanding how the process is developing and forecasts the direction that existing operations and practices will take.	Before adopting SPC improvement and quality assurance in assembly lines, trend analysis can be utilized as a first research. Using statistical and process control techniques, we can use the deviation in the processes that are being watched to enhance the process.	Nair, V. R., et al. (2023). [135]
7.	Modern IoT and machine learning decision support systems for Industry 4.0 shift from knowledge-based to big data analytic methodology.	Most cutting-edge ML techniques for PdM anticipate the remaining valuable lifetimes of the components using run-to-failure data and a variety of condition monitoring data, including vibrations, currents, temperature, and others.	The suggested DSS's main pillars, in particular, are data collection, feature extraction, predictive modeling, cloud storage, and data analysis.	Rosati, R., et al. (2023). [136]
8.	Construction Industry's Production Chains Offer Opportunities for Inter-Company Collaboration on Transparency and Data Value.	In Germany, the building industry receives a sizable portion of every euro spent. Despite being one of Germany's leading economic activities, construction is mainly overlooked in the public's image of its economy because it typically involves small and medium-sized businesses building in specific regions.	This is sometimes criticized for needing to be more active in adopting new technologies, which can buck this trend. Existing obstacles must be lessened, and knowledge gaps must be filled.	Brell-Cokcan, S., et al. (2023). [137]

9.	A description of the sequestration and storage of products related to subsurface energy.	The energy supply chain's capacity for reserves, resiliency, and security are all improved by storing energy-related things in subsurface geology. Energy-related products can be sequestered to offer long-term isolation from the environment and, in the case of CO2, a decrease in air emissions.	The continuous energy transition towards net-zero or low-carbon economies can be made more sustainable by considering broader factors, including life cycle analysis, ecological, social, and governance (ESG) impact, and effective stakeholder involvement. These factors can also lower project uncertainties and costs.	Schultz, R. A., et al. (2023). [138]
10.	Opportunities and Difficulties in Using Industry 4.0 and Sensors in Product Design	The operational efficiency, organizational capacity to monitor and regulate activities, cost savings, and product quality have all significantly increased due to the interconnected systems and processes.	The systematic literature review with bibliometric analysis (SLBA) method is used to research and synthesize data on how Industry 4.0 and sensors might aid product creation.	Rosário, A. T., et al. (2023). [139]

Table 11: Quantum Computers in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Quantum computing is driving innovation in the healthcare sector for sustainability in COVID-19.	Even simple medical concerns can become difficult due to conventional medical procedures, and the healthcare business is home to various stakeholders.	Healthcare, pharmaceutical, and hospital organizations and patients can solve issues precisely and quickly using quantum computing.	Gupta, S., et al. (2023). [140]
2.	A summary of the significant issues with quantum communications and computation.	Quantum computing's power keeps expanding. As a result, there have been many research papers and other publications about race.	Four significant issues are structured into the essential components of a quantum internet, and each is carefully examined.	Yang, Z., et al. (2023). [141]
3.	Applications of quantum computing in medicine and health at the moment	Hardware and software developments for quantum computing have been astounding over the past few years. Regarding the effects of quantum computing on science and society, the emphasis has switched from "if" to "when/how." The 2020s have been termed the "quantum decade." In the years to come, it is anticipated that the first manufacturing solutions	Particularly in recent medical research, quantum machine learning (QML) has quickly developed and proven to be competitive with traditional benchmarks. Quantum support vector classifiers and quantum neural networks, for example, have been trained using a variety of clinical and real-world data sets. This covers investigations into developing novel molecular entities as	Flöther, F. F. (2023). [142]

		that have value for both science and business will become available. Although it is debatable whether or not medicine and quantum theory have been connected since Schrödinger's cat, there has recently been a rush of quantum-related activities and experiments in the medical profession, including topics in healthcare and the life sciences.	therapeutic candidates, diagnosing based on the classification of medical images, predicting patient persistence, predicting treatment effectiveness, and customizing radiation.	
4.	Quantum Computing and IS Potential of Emerging Technologies	Emerging technologies are significant because they have a great deal of potential to affect the information systems (IS) community. As there currently needs to be more understanding regarding the adoption, use, and effects of new technologies during their early stages, the IS discipline has not been able to be a leader in the research and teaching of emerging technologies.	With the assistance of academics from various fields, IS researchers thoroughly examine emerging technologies. In our view, IS researchers can participate in the scholarly study of emerging technologies and integrate those technologies into the IS curriculum.	Chipidza, W., et al. (2023). [143]
5.	Multiple-Knapsack Problems and Quantum Computing	Numerous industrial settings involve optimization issues, and multi-knapsack optimization is one such ongoing challenge that many businesses deal with regularly. With the potential to provide better and quicker solutions for particular types of problems, quantum computing has created a new paradigm for computationally demanding activities. By examining some of the most renowned and cutting-edge quantum algorithms employing various quantum software and hardware tools, this paper analyzes quantum computing approaches for multi-knapsack situations.	The ramifications of our findings about applying quantum optimisation in the future for industrial applications. Our findings underline the need for additional and better quantum optimisation techniques, particularly for multi-knapsack situations and better quantum hardware.	Awasthi, A., et al. (2023). [144]
6.	We are enhancing the	Its high oxygen content and intricate chemical makeup	The results suggested that Fe and Zn could alter	Li, C., et al. (2023). [145]

	yield of bio-aromatics in bio-oil made from bamboo residues.	prevent pyrolysis bio-oil from being used as a liquid fuel.	HZSM-5's high acidity and pore size distribution.	
7.	The Taxonomy, Review, and Challenges of Modern Quantum Computing	The limitations and drawbacks of quantum computing applications are now on the market, and to identify potential future research areas in this exciting field, quantum computing aims to create a thorough understanding of these applications.	The knowledge gap between physicists and non-physicists is closed by detailing the conceptual and notational distinctions between quantum and traditional computing.	Singh, J., et al. (2023). [146]
8.	Tools to ensure that economic systems are managed according to Industries 3.0, 4.0, and 5.0.	The concept of the following three key categories—the 3.0, 4.0, and 5.0 industrial revolutions—and the transition implementation mechanism are being developed for the phase transition to a new socioeconomic formation.	The emergence of internet-of-things technologies, the growth of cyber-physical systems, and the miniaturization of financial assets. The standards of the information group.	Melnyk, L. H., et al. (2023). [147]
9.	They are utilizing quantum computers to study the material characteristics at restricted temperatures.	Even though current quantum algorithms for calculating the thermal properties of these systems incur high computational costs because they either prepare the entire thermal state on the quantum computer or they must sample a large number of pure states from a distribution that grows with system size, quantum computers can successfully simulate quantum many-body systems.	The algorithm's efficiency in calculating the thermal characteristics of quantum materials has been demonstrated. This method is projected to permit finite temperature examinations of critical quantum materials on short-term quantum computers due to its rising accuracy with system size and adaptability in implementation.	Powers, C., et al. (2023). [148]
10.	Logistic transport optimization via adiabatic quantum computing	The foundation and backbone of current global trade is a robust and healthy supply chain, where logistics play a crucial role in creating and supplying the essential commodities and assets that sustain civilizations and economies. The importance of logistics and the need for fine-tuning transport functions to maintain the supply chain has increased	The Travelling Salesman Problem is a well-known optimization issue, and the Vehicle Routing Problem is a variant. Our goal is to approach the vehicle optimization problem from the last-mile logistic scenario application from the perspectives of classical and quantum techniques and offer a hybrid solution that includes both approaches.	Sales, J. F. A., et al. (2023). [149]

		due to the world's current geopolitical and hygienic issues. Taking on transport optimization benefits both business and society because the challenge will only become more prominent.		

Table 12: Online Education in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Digitalization of career education in times of crisis	Rapid technological advancement and adoption across all economic sectors are necessary for enhancing the standard of vocational training. Digital technologies, on the other hand, allow for the diversification of training approaches to the needs produced by various conditions.	Because computers now run most modern machinery, digital technologies influence all manufacturing processes and operations in the service industry. Digital technology is used to operate and base contemporary military weaponry. Therefore, a high level of digital literacy is necessary for employment in contemporary sectors and services, which poses a problem for the vocational education system.	Kovalchuk, V. I., et al. (2023). [150]
2.	Based on IOT and mobile wireless communication networks, online education in engineering colleges is improved.	Engineering is a profession that demands a lot of critical thought, technical expertise, and intuition. Due to the existence of sufficient and practical frameworks and procedures for student assessment, the caliber of graduates from engineering faculties is rapidly declining.	The proposed system is being implemented using a Python simulation tool, and performance benchmarks have also been evaluated. According to the study's findings, the proposed conceptual model surpassed the ones already in place in terms of enhancing the online learning process.	Kadhim, J. Q., et al. (2023). [151]
3.	Evaluating important institutional aspects of Industry 4.0 for educational reform	Educational institutions must rethink education and emphasize building human capability in light of the fourth industrial revolution.	According to the poll, the top institutional facilitators and barriers are attitudes hostile to changing education for Industry 4.0, which are national programs mainly targeted in this direction—the results from the Delphi exercise help to create a national strategy for education reform.	AlMalki, H. A., et al. (2023). [152]
4.	University-based software firm that creates graduates with	It can be challenging to provide authentic learning opportunities, and there are discrepancies between what students have learned in	Answers are provided based on 15 semi-structured interviews with SDA alums. Working with the software of production quality and	Tenhunen, S., et al. (2023). [153]

	industrial experience.	school and what employers expect them to know once they graduate. In an internal software startup run by a university called Software Development Academy (SDA), we offer a novel approach to teaching skills relevant to the industry to address this difficulty.	handling various duties were deemed the most crucial aspects of SDA since they provided students with a strong foundation of future-ready skills.	
5.	Effects of COVID-19 on Education	The COVID-19 sickness, which is highly contagious, has been dubbed a pandemic by the WHO. Now that the disease is hitting India, a developing country. The only preventive measure everyone can implement is social isolation since COVID-19, also known as the coronavirus, is a disease that passes from person to person.	The government has implemented a national lockdown as a means of separating individuals. But how will this shutdown likely affect various parts of our nation? This essay examines how COVID-19 has affected India's educational system.	Kaur, M. (2023). [154]
6.	Is it ready for this new teaching and learning approach?	Since March 2020, instruction has been provided online. Students missed out on campus life. As a result, teamwork was minimized, fieldwork, industrial tours, and community service were overlooked, and most importantly, the learning outcomes could have been better.	The consequences of these modifications must be thoroughly considered because they might affect the caliber of graduates. This study will examine how the COVID-19 epidemic has affected the educational system and highlight some workable solutions that the academic community and HEI top management may want to consider to mitigate the negative consequences of current practices.	Othman, A. K, et al. (2023). [155]
7.	Gender characteristics: Implications for online cross-cultural learning. The Future of Online Education: A Research Anthology on Distance Learning	The populations of higher education have changed in terms of demographics. Online education now has a predominantly female student body. While yet distinct, genders are similar in physiology and psychology.	It can address how biological, environmental, and technological factors influence gender disparities in behavior and learning. Online learning strategies are offered to help students with their requirements and obstacles. Finally, the chapter offers ideas for further study on gender issues that cut across cultures in the context of online learning.	Chuang, S., et al. (2023). [156]
8.	Using Industry 4.0 Technologies	Because of the COVID-19 pandemic, the higher education industry has been	Institutions of higher learning are implementing technology from Industry 4.0	Aderibigbe, J. K. (2023). [157]

	to Advance Education 4.0 and Practical Hybrid E-Training for Successful Post-Epidemic Higher Education	pushed to use hybrid pedagogical practices rather than conventional in-person teaching and learning methods. The transition from traditional classrooms to online teaching and learning environments has started at nearly all higher education institutions.	(I4.0). This move is a component of the Education 4.0 (EDUC4) higher education development for the twenty-first century. In light of this, this chapter addresses ways to support EDUC4 for effective higher education during an epidemic.	
9.	A call for educational reform and the effects of Industry 4.0 on the workplace. The Frontier of Chinese Education Reform and Development	Industry 4.0 is the subject of intense discussion among worldwide academics and professionals. But up until now, the prospects, underlying technology, and applications have only been conceptually described by worldwide research institutions.	The development of primary education that is ability-oriented, the reformation of vocational education teaching methods, and the reformation of higher education.	Yang, J. (2023). [158]
10.	Effective methods for enhancing soils' ecological condition. Technological advancements, intellectual education, and cutting-edge digital tools	Industries' effects on soils and how to safeguard them. At the same time, details about how to effectively use the land near industrial sectors are provided.	Information on the efficient use of land near industrial areas is provided.	Turgunovich, J. B., et al. (2023). [159]

Table 13: Virtual and Augmented Reality in Production Industry

S. No.	Area	Issue	Outcome	Reference
1.	Using augmented reality, a cutting-edge study on digital twins helped industries shift their focus from products to people.	The promise of digital twins (DT) and augmented reality (AR) has recently started to take shape, sparking an increase in academic and industry research interest. The chance for operators to participate in the future excites AR.	As part of the futuristic transformation of human-centric businesses, this study also promotes product design, robotics-related work, cyber-physical interaction, and human ergonomics.	Yin, Y., et al. (2023). [160]
2.	Guidance for product assembly and maintenance/repair from an augmented reality perspective	Product diversity is constrained by barriers to pre- and post-manufacturing stakeholder stakeholders' knowledge transfer. Augmented reality (AR), a recent innovation, can provide	The substantial challenges, like evaluating human movement and environmental experiences using tracking and rendering techniques, are expected to increase the technology's adaptability.	Eswaran, M., et al. (2023). [161]

		great adaptation and independence.		
3.	An investigation of data management and visualization methods using BIM and augmented or virtual reality to monitor the structural health	Most public infrastructure in use today is no longer needed for its original purpose. This circumstance has led to the requirement for more extensive inspections and continuing infrastructure monitoring to ensure structural integrity.	The goal and distinctiveness of this review study originate from the fact that, in contrast to SHM's diagnostic and prognostic methods, relatively little systematic assessment of the most recent data management and visualization tools has been done. Each subtopic explores state-of-the-art data management and visualization methods.	Sadhu, A., et al. (2023). [162]
4.	Applications for human-robot interaction that use virtual, mixed, and augmented reality using game engines	The primary papers in this study cover solutions for Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), which let users interact with real robotic platforms by extending their perception of reality through technology.	The publications are extensively utilized, easily accessible, current, and relevant. We performed a seven-year search of critical robotics databases for articles published between 2015 and 2022.	Coronado, E., et al. (2023). [163]
5.	Using dynamic digital models and augmented reality to lower occupational risks in industrial settings requires a human-centered conceptual approach.	By integrating augmented reality (AR) and dynamic digital models (DDM), training will be improved, and occupational dangers will be reduced in workplace settings.	The experts who participated in the discussion contend that the technology still needs to be ready, even though it is highly intriguing and would be very helpful in practice to reduce occupational risks.	Gualtieri, L., et al. (2023). [164]
6.	In the clothing industry, virtual and augmented reality	The research aims to use network visualization and bibliometric tools to synthesize the literature on augmented reality and virtual reality in the garment business.	Future augmented and virtual reality-related work in the garment sector will use the study as a springboard. Practitioners will also be taught everything there is to know about this scientific field.	Goel, P., et al. (2023). [165]
7.	It's necessary to consider trust in augmented reality apps and the purpose of shopping at online and offline locations to understand how mobile augmented	The question is whether elements of expectancy-value judgments (EVJ) of uses and gratifications, such as novelty, fashion/status, sociability, and relaxation, influenced trust in augmented reality (AR) apps, whether trust in AR apps influenced	To what extent EVJs of use and gratification of trusted AR apps depends on various factors, including novelty, status, and fashion. The EVJs' socialism of uses and gratifications damaged people's faith in AR applications. Users'	Kang, J. Y. M., et al. (2023). [166]

	reality is digitally changing the retail industry.	usage intention towards AR apps and online/offline store patronage intention, and whether the moderating effect of consumer self-determination affected these outcomes.	autonomy regulated the influence of users' trust in augmented reality applications on usage intention towards augmented reality apps and intention to shop at online and offline stores.	
8.	The viability of an augmented reality-based digitalization paradigm for architecture education in building construction	In response to emerging technologies in the era of digital transformations, the digitalization model (DM) for building construction courses has been developed.	The main conclusions are choosing the right digital tools, specifying the workflow and steps depending on the stages of a construction project, and determining how to define specific details successfully.	Seyman Guray, T., et al. (2023). [167]
9.	Using industrial augmented reality to display ergonomic evaluation data in a sophisticated manner	A fresh situation where the operator is an essential part of the industrial ecosystem is brought about by the shift to the 4.0 industrial paradigm.	The software tool uses a cheap D-RGB camera (Kinect v2) and an Augmented Reality (AR) visualization system based on Microsoft HoloLens 2 to monitor the human body.	Evangelista, A. et al. (2023). [168]
10.	Setting up augmented reality users: examining YouTube advertising to comprehend market expectations.	These promotional videos try to position AR technology and potential users by exhibiting techno-euphoric claims and hypothetical use scenarios with a situational and grounded theory analysis of the movie.	In construction operations, it is discovered that there are gaps between expectations and foreseen requirements. The results of our study may also help develop applications for AR that are socially resilient and provide a more comprehensive understanding of workplaces.	Wortmeier, A. K., et al. (2023). [169]

5. OBJECTIVES BASED ON REVIEW:

(1) To determine technology's role in the secondary industry sector.
(2) To organize the existing position of ICCT-UT in secondary industries.
(3) To create the idea of tech-business analytics in the secondary industries sector.
(4) To evaluate the tech-business analytics model in the secondary industries sector.
(5) The ABCD analytical paradigm will analyze the Pros, Cons, and Cons of Tech-Business Analytics in the Secondary Industries Sector.
(6) To investigate how tech-business analytics are used and how it affects secondary industrial sector productivity.

6. METHODOLOGY :

6.1 Primary Data:

Primary data refers to information that you gather on your own. The longer the data-gathering process, the more control you have over where the data comes from and how it is used. Primary data is original data collected for a specific research study or investigation. This data is gathered directly from sources such as individuals, organizations, or natural phenomena to address the research objectives and answer specific research questions. Primary data collection involves various research methods and techniques, considered the most accurate and relevant information for a particular study.

6.2 Secondary Data:

Secondary data refers to information collected by someone else or for a different purpose and is subsequently used by researchers for their studies. This data is typically gathered from existing sources, such as previous research studies, government reports, surveys, databases, academic publications, and other publicly available records. Unlike primary data, collected first-hand by researchers for their specific research objectives, secondary data has already been processed, analyzed, and made available.
Research scholars and Google search engines are the primary sources of this data. White papers, market studies, trade publications, newspapers, and websites can all be used to disseminate information. Although secondary data is simple, you need help to control how it was obtained or managed. Furthermore, the competitors will have easy access to the information they discover. Checking out competitors' websites is a fantastic place to start market research. Annual reports and other investor presentations by publicly traded companies can show how a reputable business performs in your preferred industry. Focus groups and online surveys can be beneficial for market research on technology. After determining their needs, develop detailed personas for your target audiences. These profiles will aid the marketing strategy and product creation.

7. CONCEPT OF TECH-BUSINESS ANALYTICS IN SECONDARY INDUSTRY SECTOR :

In the secondary industrial sector, TBA refers to applying cutting-edge technologies like automation, IoT, AI/ML, and data analytics to enhance corporate operations and decision-making procedures. Data must be gathered from many sources and analyzed to produce insights that might aid firms in streamlining their operations, lowering costs, increasing efficiency, and boosting profitability.

Tech-business analytics for secondary sectors involves the stages listed below:
(1) Sensors, machinery, industrial processes, and supply chain activities are just a few sources from which businesses gather data.
(2) To find patterns, trends, and insights, data is examined utilizing state-of-the-art technologies such as AI/ML and data analytics.
(3) Employing the information from data analysis, firms can decide how to manage their operations best, increase efficiency, and reduce costs.
(4) To identify areas that require improvement, businesses must continuously gather and evaluate data as part of the tech-business analytics process. The idea of tech-business analytics in the secondary industrial sector is becoming increasingly important as businesses battle to preserve their competitiveness in a market that is changing swiftly. Utilizing cutting-edge data collection and analysis technologies, businesses can learn more about their operations and make data-driven decisions that can boost productivity, enhance quality control, and increase profitability.
The TBA in the primary industrial sector, according to Kumar, S. et al. (2023) [170], is to organize the effectiveness and sustainability of agricultural extraction activities. As a result of the primary sector's reliance on resources and environmental factors, TBA can assist companies operating in this sector in making data-driven decisions that will improve operations and lessen their environmental impact. By accessing information from weather sensors, soil sensors, and other sources, TBA, for instance, can aid agricultural enterprises in optimizing their crop yields. Firms can use predictive analytics to foresee weather patterns and modify their planting plans and crop management techniques accordingly. Increased crop yields, better use of resources, and less negative influence on the environment can all result from this. Similarly, TBA's analysis of data from sensors, drones, and other sources can assist enterprises engaged in exploiting natural resources in streamlining their operations. Technology has grown in importance as a tool for resolving social and economic issues in contemporary society, according to Aithal, P. S. et al. (2023) [171]. The values of goods and services in virtually every industry and business practice have been revolutionized by information, communication, and computation technology (ICCT). In this chapter, we've discussed how ICCT's Tech-Business Analytics, which combines big data analytics with its underpinning technologies, may be used to generate business intelligence in higher education. Twelve different forms of TBAs are

proposed and analyzed, and their separate components and subset technologies are listed, along with potential applications for each type of tech-business analytics.
A new type of business analytics that can be used to solve semi-structured and unstructured problems of various industry sectors, such as primary, secondary, tertiary, and quaternary industry sectors, has been developed, according to Kumar et al. (2023) [172]. Tech-business analytics (TBA) is the name of the latest study. This study aims to gain a deeper understanding of the concept of TBA and how it affects an organization's innovation outcomes.
By Kumar, S., et al. (2022).[173], technology, in particular the intersections of artificial intelligence (AI), big data, and the Internet of Things (IoT), is advancing its capacity to help organizations produce better results with fewer resources. Utilizing technology, a business may produce a product faster and with fewer employees. Concerns with needs-based, want-based, sociocultural, and phantasmagorical desires are covered in this section. The use of technology to advance business in society has a promising future. People's struggles are examined here, and prospective future developments are considered. The effects of technology on society have been discussed, along with various technology generations, business models, and strategies. Business and ICCT technology have been examined, as well as the controversy surrounding nanotechnology and the model for technology adoption.
Kumar, S., et al. (2020) [174] state that this study explores the developing fields of data analytics and decision prediction using information gathered from various systems employing Internet of Things technology. The Internet of Things (IoT) is a grouping of interconnected computing devices, mechanical and digital machinery, items, animals, or people given unique identifiers and the capacity to send data over a network without human-to-human or human-to-computer interaction. Processing the vast and ongoing data created should have the specific goal of future prediction, as well as an explanation of the issue utilizing another high-tech system and model.
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According to Kumar, S. et al. (2020) [175], processing the massive and continuous data generated should have the specific goal of predicting the future, as well as an explanation of the issue using another high-tech system and model. This work discusses the feasibility of implementing (designing and developing) such systems for so-called Tech-Business-Analytics for various real-world applications of predictive business choices.
According to Kumar, S. et al. (2023) [173], integration of ICCT underlying technologies and big data technology to develop a new kind of business analytics that can be used to solve semi-structured and unstructured problems of various industry sectors, including primary, secondary, tertiary, and quaternary industry sectors. The new investigation is dubbed Tech-business analytics (TBA). Understanding the concept of TBA and how it affects a company's innovation outcomes is the main objective of this study.

8. DESCRIPTION OF MODEL OF TECH-BUSINESS ANALYTICS IN SECONDARY INDUSTRY SECTOR :

A typical tech-business analytics paradigm in the secondary industry sector comprises the following steps (figure 2):
(1) Data Gathering: Gathering data is the first step, and it involves a variety of sources, including production machinery, supply chain activity, and customer feedback. One can utilize sensors, RFID tags, and other data collection methods to collect this data.

(2) Data Consolidation: Consolidating the collected data and producing a single database or data warehouse is necessary. Data that is accurate, complete, and useable is essential for analysis. Hence, this is important.
(3) Data Analysis: Following that, the data will be examined using a range of analytical methods, including statistical analysis, machine learning, and data mining. Patterns, trends, and insights that can be utilized to improve organizational operations can be found using this study. Data analysis results need to be presented clearly and straightforwardly through visualization. Using charts, graphs, and other visual representations of the data can give decision-makers more straightforward insights to understand and act upon.
(4) Making Decisions: Decision-makers can select the best course of action for their company to boost productivity, reduce expenses, and streamline operations using the information obtained via data analysis and visualization. To do this, it might be necessary to alter the supply chain management, marketing strategies, or production procedures.

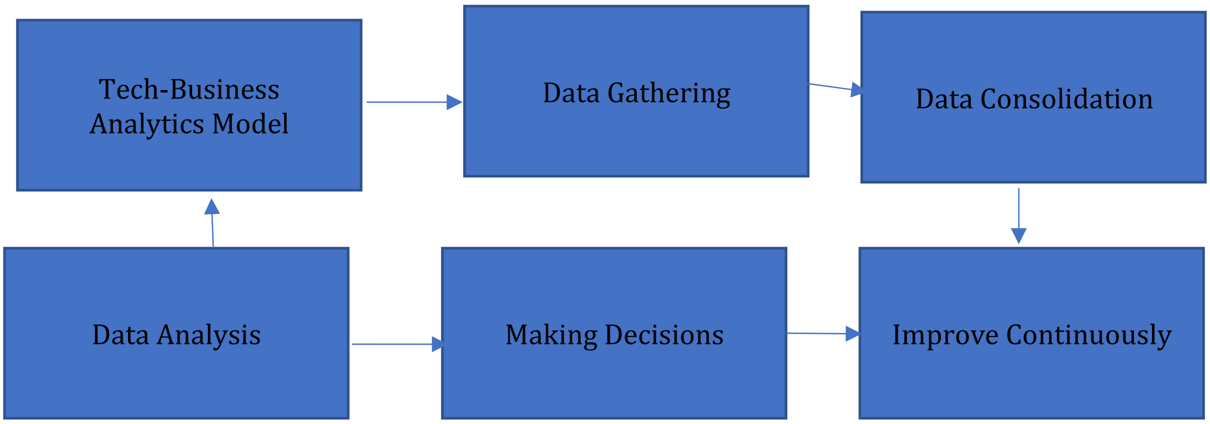

Fig. 2: Model of TBA in Secondary Industry Sector

(5) Improve continuously: To find opportunities for improvement, businesses must continuously gather and evaluate data as part of their business tech analytics process. Key performance indicators (KPIs) must be tracked to optimize performance, and processes must be modified as necessary. Therefore, the tech-business analytics paradigm in the secondary industrial sector entails gathering and interpreting data from many sources, comprehending business operations, and making wise decisions to enhance performance. This method can help businesses become more affordable, efficient, and lucrative.

8.1 Integration of BA with ICCT Underlying Technologies in Production Industry:

Integrating Business Analytics with Other ICCT Underlying Technologies in the Production Industry: Integrating Business Analytics with various ICCT underlying technologies presents a wealth of opportunities for the production industry. By leveraging data-driven insights and advanced technological tools, production processes can be optimized, efficiency can be enhanced, and decision-making can be significantly improved. Here are some of the critical opportunities that arise from this integration:

Table 14: Details of possible applications of Quantum Computing for Production Industry

S. No.	Application of Integration	Description
1	AI & Robotics in Production Efficiency	Production companies can achieve greater automation and efficiency by combining Business Analytics with AI and Robotics. AI-powered analytics can analyze vast production line datasets, identify bottlenecks, predict equipment failures, and optimize production schedules. Collaborating with Robotics can lead to autonomous

		manufacturing processes, reducing human intervention and production lead times.
2	Blockchain for Supply Chain Transparency	Integrating Business Analytics with Blockchain technology can revolutionize supply chain management in the production industry. The transparent and immutable nature of Blockchain allows for real-time tracking of raw materials, components, and finished products. Businesses can use Business Analytics to extract valuable insights from this data, enabling better inventory management, fraud prevention, and traceability of products throughout the supply chain.
3	Cloud Computing for Scalable Data Analytics	Cloud Computing offers scalable data storage and computing capabilities, making it an ideal partner for Business Analytics in the production industry. By harnessing the cloud's power, companies can analyze massive datasets in real time, enabling faster decision-making, optimizing resource allocation, and gaining deeper insights into production processes.
4	Cyber Security for Data Protection	As the production industry becomes more data-centric, cybersecurity becomes critical. Integrating Business Analytics with robust cybersecurity measures ensures that sensitive production data remains protected from cyber threats. Businesses can detect potential vulnerabilities and prevent data breaches by proactively monitoring and analyzing security logs and patterns.
5	IoT and Predictive Maintenance	Business Analytics integrated with IoT devices allows for predictive maintenance in the production industry. IoT sensors can continuously collect machine data, detecting anomalies and potential failures. Analyzing this data using Business Analytics enables companies to schedule maintenance proactively, reducing downtime and minimizing production disruptions.
6	3D Printing and Rapid Prototyping	Integrating Business Analytics with 3D printing facilitates rapid prototyping and iterative design processes. By analyzing market trends, customer feedback, and production data, businesses can identify opportunities for new product development and customization. This synergy leads to faster product launches and improved customer satisfaction.
7	Mobile Communication & Marketing Technology for Customer Engagement	Production companies can better understand customer preferences and behavior by integrating Business Analytics with mobile communication and marketing technology. Analyzing data from mobile apps, social media, and marketing campaigns enables targeted promotions and personalized customer experiences.
8	Information Storage Technology for Big Data Analytics	The production industry generates massive amounts of data daily. Companies can efficiently manage and analyze big data sets by integrating Business Analytics with advanced Information Storage Technology. This enables them to gain valuable insights into production trends, quality control, and supply chain optimization.
9	Ubiquitous Education Technology for Employee Training	Integrating Business Analytics with Ubiquitous Education Technology allows personalized and interactive employee training. Businesses can offer tailored training programs to improve workforce skills, productivity, and overall efficiency by analyzing individual learning patterns and performance.
10	Virtual & Augmented Reality for Simulation and Training	Integrating Business Analytics with Virtual and Augmented Reality enables realistic simulations of production processes and training scenarios. This immersive approach enhances employee training, reduces risks, and improves overall safety in the production environment.

11	Quantum Computing: Opportunity	Quantum Computing's immense processing power can significantly speed up complex data analysis in the production industry. Integrating Business Analytics with Quantum Computing enables manufacturers to solve optimization problems, such as supply chain logistics, with unprecedented speed and accuracy.

By harnessing the power of Business Analytics in conjunction with these ICCT underlying technologies, the production industry can achieve higher operational excellence, cost savings, and innovation, positioning itself at the forefront of the Fourth Industrial Revolution.

8.2 Integration of BA with AI & Robotics Technologies in Production Industry:

AI and robotics have many applications in the production industry, revolutionizing how businesses operate and improving efficiency, safety, and overall productivity. Here are some of the critical applications:

Table 15: Details of possible applications of AI & Robotics for Production Industry

S. No.	Application of Integration	Description
1	Automated Manufacturing Processes	AI-powered robots can perform repetitive and mundane tasks with high precision and consistency. This includes assembly, welding, material handling, painting, and packaging, leading to increased production rates and reduced errors.
2	Quality Control and Inspection	AI can be used to analyze and detect product defects during manufacturing. Computer vision systems can inspect items for flaws, ensuring only high-quality products reach the market.
3	Predictive Maintenance	AI can monitor and analyze equipment data in real time, predicting when machinery might fail or require maintenance. This enables proactive maintenance scheduling, reducing downtime and optimizing the use of resources.
4	Supply Chain Optimization	AI can analyze vast amounts of data to optimize supply chain operations. This includes demand forecasting, inventory management, and efficient logistics planning, ultimately leading to cost savings and improved delivery times.
5	Collaborative Robots (Cobots)	Cobots are designed to work alongside human workers safely. They can assist with heavy lifting, precision tasks, or potentially dangerous operations, enhancing productivity and worker safety.
6	Adaptive Manufacturing	AI can analyze data and adjust production processes in real time based on demand fluctuations, changes in raw material quality, or other external factors, enabling agile and adaptable manufacturing.
7	Warehouse Automation	AI-powered robots can automate warehouse tasks, such as order picking, packing, and inventory management. This helps streamline operations and reduce labor costs.
8	Product Customization	AI can facilitate mass customization by analyzing customer preferences and data to offer personalized products or configure manufacturing processes accordingly.
9	Process Optimization	Machine learning algorithms can optimize complex production processes, ensuring the most efficient use of resources and reducing energy consumption.
10	Human-Robot Collaboration	AI and robotics can enhance the collaboration between human workers and machines, leveraging the strengths of each to improve overall productivity and safety.
11	Waste Reduction	AI can analyze production data to identify areas where waste can be minimized, whether in raw material usage, energy consumption, or process efficiency.

12	Digital Twins	AI can create digital representations (digital twins) of physical production systems. These digital twins can be used for simulations, testing different scenarios, and optimizing production processes without disrupting the system.
13	AI-Driven Design and Innovation	AI can assist in product design by generating and evaluating multiple design options, leading to innovative and optimized products.

Thus, integrating AI and robotics in the production industry offers significant benefits, including increased efficiency, reduced costs, improved product quality, and safer working environments. These applications will become even more sophisticated and widespread as technology advances.

8.3 Integration of BA with Blockchain Technologies in Production Industry

Blockchain technology can bring several transformative applications to the production industry. Blockchain can address various challenges and streamline processes by providing a secure, decentralized, and transparent way to record and verify transactions. Here are some possible applications of blockchain technology in the production industry:

Table 16: Details of possible applications of Blockchain Technology for Production Industry

S. No.	Application of Integration	Description
1	Supply Chain Traceability	Blockchain can track and record every supply chain step, from raw material sourcing to final product distribution. This enables stakeholders to trace the origin of components, verify authenticity, and ensure compliance with quality and safety standards. It also helps to identify and rectify issues quickly, such as product recalls.
2	Provenance and Authenticity Verification	Blockchain can create an immutable record of a product's history, including details of its origin, manufacturing process, and ownership. This gives consumers confidence in the authenticity and quality of their products.
3	Smart Contracts for Automated Transactions	Smart contracts are self-executing agreements with predefined conditions. In the production industry, smart contracts can automate various processes, such as procurement, payments, and order fulfillment, reducing administrative overhead and ensuring adherence to agreed-upon terms.
4	Quality Control and Certification	Blockchain can store quality control data and certifications from different stages of the production process. This allows for easy verification of compliance with industry standards and regulations.
5	Inventory Management and Tracking	Blockchain can facilitate real-time inventory tracking, ensuring accurate and up-to-date stock levels and movement records. This helps optimize inventory management and reduce the risk of stockouts or overstocking.
6	Anti-Counterfeiting Measures	Blockchain can be used to create unique digital identities for products, making it difficult for counterfeiters to replicate or tamper with items. Consumers can verify the authenticity of products by scanning a QR code or accessing the blockchain-based record.
7	Data Sharing and Interoperability	Blockchain allows secure and permissioned data sharing among multiple stakeholders in the production ecosystem. This fosters collaboration and improves communication between suppliers, manufacturers, distributors, and customers.
8	Energy and Resource Management	Blockchain can facilitate peer-to-peer energy trading, where producers can directly sell surplus energy to consumers or other businesses, optimizing energy utilization and reducing waste.

9	Intellectual Property Protection	Blockchain can timestamp and record intellectual property rights, such as patents and designs. This provides a verifiable record of ownership and helps protect against infringement.
10	Environmental Sustainability	Blockchain can track and verify sustainable and eco-friendly practices in the production process, promoting transparency and accountability in environmental efforts.
11	Decentralized Manufacturing Marketplaces	Blockchain-powered platforms can directly connect manufacturers with suppliers and customers, enabling more efficient and cost-effective transactions without intermediaries.

Hence, blockchain technology holds immense potential for revolutionizing the production industry by enhancing transparency, security, and efficiency throughout the supply chain and production processes. As the technology matures and gains wider adoption, these applications will likely become more prevalent and impactful.

8.4 Integration of BA with Cloud Computing Technologies in Production Industry:

Cloud computing technology offers a wide range of applications and benefits for the production industry. Cloud computing can enhance efficiency, flexibility, and scalability for various production-related tasks by providing on-demand access to computing resources over the Internet. Here are some possible applications of cloud computing in the production industry:

Table 17: Details of possible applications of Cloud Computing Technology for Production Industry

S. No.	Application of Integration	Description
1	Data Storage and Backup	Cloud storage allows production companies to securely store and back up large volumes of data, including design files, production records, and customer information. This ensures data redundancy and protection against data loss due to hardware failures or disasters.
2	Collaborative Product Development	Cloud-based collaboration tools enable geographically dispersed teams to work together seamlessly. Engineers, designers, and other stakeholders can access and collaborate on the latest design iterations and share real-time feedback.
3	Resource Optimization	Cloud computing allows production companies to scale their computing resources up or down based on demand. Additional computing power can be quickly provisioned during peak production periods, and during off-peak times, resources can be scaled back to save costs.
4	Computer-Aided Manufacturing (CAM)	Cloud-based CAM tools can offer advanced machining simulations and optimization for the production process. This allows for faster and more accurate toolpath generation, reducing machining errors and improving overall efficiency.
5	Virtual Prototyping and Simulation	Cloud-based simulation platforms enable manufacturers to simulate product performance, manufacturing processes, and assembly procedures without expensive on-premises hardware. This helps in reducing physical prototyping iterations and time-to-market.
6	Industrial Internet of Things (IIoT) Integration	Cloud computing provides the infrastructure to collect, store, and analyze data from connected production equipment and sensors. This enables predictive maintenance, real-time monitoring, and process optimization.
7	Data Analytics and Business Intelligence	Cloud-based data analytics tools can help production companies gain insights from large datasets, such as production metrics, supply chain data, and customer feedback—these insights aid in making informed decisions and optimizing operations.

8	Software as a Service (SaaS) Solutions	Cloud-based SaaS applications offer a variety of production-specific software solutions, such as enterprise resource planning (ERP), customer relationship management (CRM), and product lifecycle management (PLM) systems.
9	Remote Monitoring and Control	Cloud computing allows manufacturers to monitor and control production processes and equipment remotely. This is particularly beneficial for companies with multiple production facilities or those needing real-time oversight of operations.
10	Production Line Simulation and Optimization	Cloud-based simulation platforms can model and optimize production line layouts, throughput, and efficiency, helping manufacturers identify bottlenecks and improve overall productivity.
11	On-Demand Training and Skill Development	Cloud-based learning platforms enable production industry professionals to access training materials, courses, and certifications from anywhere, facilitating continuous skill development.
12	Regulatory Compliance and Security	Cloud providers often offer robust security measures and compliance certifications, ensuring that production companies meet industry-specific regulations and protect sensitive data.

Hence, cloud computing technology empowers the production industry to leverage cutting-edge tools, streamline operations, and make data-driven decisions. It allows companies to focus on their core competencies while leaving the computing infrastructure management to specialized cloud service providers.

8.5 Integration of BA with Cyber Security Technologies in Production Industry:

Cybersecurity technology is crucial in ensuring data and systems' safety, integrity, and confidentiality within the production industry. With the increasing digitization and connectivity of industrial processes, there is a growing need for robust cybersecurity measures to protect critical infrastructure, prevent cyberattacks, and maintain operational continuity. Here are some possible applications of cybersecurity technology in the production industry:

Table 18: Details of possible applications of Cyber Security Technology for Production Industry

S. No.	Application of Integration	Description
1	Network Security	Implementing firewalls, intrusion detection and prevention systems (IDPS), and virtual private networks (VPNs) to secure the production network from unauthorized access and cyber threats.
2	Endpoint Protection	We are deploying antivirus, anti-malware, and host-based intrusion prevention software on production devices and machines to safeguard against malware and unauthorized activities.
3	Industrial Control System (ICS) Security	It is securing the control systems used in the production process, such as SCADA (Supervisory Control and Data Acquisition) systems, PLCs (Programmable Logic Controllers), and DCS (Distributed Control Systems) to prevent cyberattacks that could disrupt operations or cause physical harm.
4	Security Monitoring and Incident Response	Implementing security information and event management (SIEM) solutions to monitor network and system activities, detect potential security incidents, and respond promptly to any breaches or anomalies.
5	Data Protection	They encrypt sensitive data in transit and at rest to prevent unauthorized access and breaches, ensuring that production-related data remains confidential and integral.

6	Access Control	We are implementing strong authentication and authorization mechanisms to control access to critical production systems and data, limiting privileges to only authorized personnel.
7	Security Awareness Training	We are conducting regular cybersecurity training for production industry staff to raise awareness about potential threats, social engineering attacks, and safe online practices.
8	Patch Management	We keep production systems and software up-to-date with the latest security patches to address known vulnerabilities and reduce the attack surface.
9	Secure Software Development	You follow secure coding practices and conduct security testing while developing production-related applications to prevent vulnerabilities.
10	Physical Security Integration	It integrates cybersecurity measures with physical security protocols to protect production facilities from unauthorized physical access that could lead to cyber breaches.
11	Supply Chain Security	They ensure that third-party vendors and suppliers adhere to robust cybersecurity standards to prevent supply chain attacks and protect the production process from external threats.
12	Incident Response Planning	Developing comprehensive incident response plans to handle cybersecurity incidents effectively, minimize potential damages, and recover operations quickly.
13	Security Audits and Compliance	We conduct regular security audits to identify vulnerabilities and ensure compliance with industry regulations and cybersecurity standards.
14	Threat Intelligence Sharing	We collaborate with other production industry stakeholders, government agencies, and cybersecurity communities to share threat intelligence and stay informed about emerging cyber threats.

By integrating these cybersecurity technologies and practices into the production industry, organizations can significantly reduce the risk of cyberattacks, protect critical assets, and maintain smooth and secure operations.

8.6 Integration of BA with Internet of Things (IoT) Technologies in Production Industry:

The Internet of Things (IoT) technology has the potential to revolutionize the production industry by connecting devices, machines, and sensors to the Internet, enabling data exchange, automation, and improved efficiency. Here are some possible applications of IoT technology in the production industry:

Table 19: Details of possible applications of Internet of Things (IoT) Technology for Production Industry

S. No.	Application of Integration	Description
1	Predictive Maintenance	IoT sensors can be deployed in production machinery and equipment to monitor their health in real time. By analyzing data on factors like temperature, vibration, and usage, predictive maintenance algorithms can predict when equipment is likely to fail. This allows proactive maintenance, reducing downtime and preventing costly breakdowns.
2	Asset Tracking and Management	IoT devices can be attached to assets, such as raw materials, finished goods, or equipment, to track their location and monitor their condition. This improves supply chain visibility, reduces inventory losses, and optimizes asset utilization.
3	Inventory Management	IoT technology can automate inventory tracking, enabling real-time updates on stock levels. This data can be integrated with production

		schedules, ensuring materials are available when needed and minimizing stockouts or overstocking.
4	Quality Control	IoT sensors can be employed in production to monitor and measure product quality parameters continuously. This data can be used for real-time quality control, ensuring products meet specified standards and reducing defects.
5	Energy Management	IoT-enabled intelligent meters and sensors can monitor energy consumption in the production facility. This data can be analyzed to identify areas of high energy usage and optimize energy efficiency, leading to cost savings and reduced environmental impact.
6	Remote Monitoring and Control	IoT allows production managers to monitor and control production processes and equipment remotely. This capability is particularly beneficial for managing multiple production sites or for limited on-site presence.
7	Workforce Safety	Wearable IoT devices can be used to monitor the health and safety of workers in hazardous production environments. These devices can detect and alert supervisors in case of potential accidents or unsafe conditions.
8	Supply Chain Optimization	IoT technology can improve supply chain visibility by tracking the movement of goods in real time. This data can help identify bottlenecks, optimize transportation routes, and improve supply chain efficiency.
9	Process Automation	IoT-enabled devices can automate routine tasks in the production process, streamlining operations and reducing the need for manual intervention.
10	Data Analytics and Optimization	IoT generates vast amounts of data, which can be analyzed using advanced analytics to gain insights into production processes. This data-driven approach enables continuous improvement and optimization of production operations.
11	Environmental Monitoring	IoT sensors can be deployed to monitor environmental factors such as temperature, humidity, and air quality within the production facility. This data can help ensure compliance with environmental regulations and create a safer and healthier work environment.
12	Product Personalization	IoT technology allows manufacturers to gather data on customer preferences and usage patterns, enabling the production of personalized products tailored to individual needs.

By embracing IoT technology, the production industry can enhance operational efficiency, reduce costs, improve product quality, and create new opportunities for innovation and growth. However, it's essential to implement robust cybersecurity measures to protect IoT devices and data from potential cyber threats.

8.7 Integration of BA with 3D Printing Technologies in Production Industry:

3D printing, also known as additive manufacturing, is a transformative technology that has the potential to revolutionize the production industry. It allows the creation of three-dimensional objects by adding material layer by layer, providing several benefits such as design flexibility, cost-effectiveness, reduced waste, and faster production. Here are some possible applications of 3D printing technology in the production industry:

Table 20: Details of possible applications of 3D Printing Technology for Production Industry

S. No.	Application of Integration	Description
1	Rapid Prototyping	3D printing enables quick and cost-effective prototyping of new products. Designers and engineers can create physical prototypes

		to test and validate their ideas before moving on to traditional manufacturing processes.
2	Customization and Personalization	3D printing allows for the production of highly customized and personalized products. Manufacturers can tailor products to meet specific customer requirements and preferences without incurring high setup costs.
3	Tooling and Fixtures	3D printing creates jigs, fixtures, and tooling for assembly and production processes. These custom tools enhance precision, reduce production time, and improve manufacturing workflow.
4	Spare Parts Manufacturing	With 3D printing, obsolete or hard-to-find spare parts can be produced on demand, reducing the need for extensive inventory storage and ensuring ongoing maintenance and repairs.
5	Lightweight and Complex Designs	3D printing allows for the creating of intricate and lightweight designs that are difficult or impossible to achieve using traditional manufacturing methods. This is especially valuable in the aerospace, automotive, and medical industries.
6	Low-Volume Production	3D printing is well-suited for low-volume production runs, eliminating the need for expensive molds or tooling. It is particularly beneficial for niche or custom products.
7	Bioprinting	3D printing technology creates tissues, implants, and organs in the medical and pharmaceutical industries. Bioprinting holds promise for personalized medicine and regenerative therapies.
8	Construction and Architecture	Large-scale 3D printers are being developed to construct buildings and architectural structures. This method can significantly reduce construction time and costs.
9	Food Printing	3D printers can create intricate designs with food materials, allowing chefs and manufacturers to experiment with unique presentations and personalized nutrition.
10	Jewelry and Fashion	3D printing creates intricate and customizable jewelry designs, fashion accessories, and even clothing with unique textures and patterns.
11	Education and Training	3D printing is becoming increasingly prevalent in educational settings, allowing students to bring their ideas to life and gain practical experience in product design and manufacturing.
12	Entertainment and Gaming	In the entertainment industry, 3D printing produces action figures, collectibles, and props for movies and video games.
13	Art and Sculpture	Artists and sculptors use 3D printing to bring their creative visions to life, allowing for the production of complex and unique artworks.

Thus, 3D printing technology offers numerous opportunities for innovation and creativity in the production industry, leading to more efficient and customized manufacturing processes across various sectors. As technology advances, it is likely to find even more diverse and ground-breaking applications in the future.

8.8 Integration of BA with Mobile Communication & Marketing Technologies in Production Industry:

Mobile communication and marketing technology can significantly benefit the production industry by improving communication, enhancing marketing efforts, optimizing processes, and increasing efficiency. Here are some possible applications of mobile communication and marketing technology in the production industry:

Table 21: Details of possible applications of Mobile Communication & Marketing Technology for Production Industry

S. No.	Application of Integration	Description
1	Mobile Collaboration	Production teams can use mobile communication apps to facilitate real-time communication and collaboration among team members. They can share updates, discuss production issues, and coordinate tasks, regardless of their physical location.
2	Remote Monitoring and Control	Mobile applications can be developed to monitor and control production processes remotely. This allows production managers to stay informed about the status of operations and make adjustments as needed, even when not on-site.
3	Mobile Dashboards and Reporting	Production managers can access real-time production data and performance metrics through mobile dashboards. These mobile analytics tools enable quick decision-making and provide insights into operational efficiency.
4	Inventory Management	Mobile apps can assist production teams in managing inventory levels, tracking stock movement, and issuing purchase orders. This helps ensure that materials are available when needed, reducing production delays.
5	Maintenance and Repairs	Mobile apps can streamline maintenance tasks by providing technicians with maintenance schedules, access to equipment manuals, and the ability to report issues and order replacement parts directly from their mobile devices.
6	Employee Training and Safety	Mobile communication technology can be used for employee training and safety programs. Employees can access training materials and safety guidelines on their mobile devices, improving knowledge retention and compliance.
7	Customer Support	Mobile communication technology enables production companies to provide timely and personalized customer support through messaging apps, chatbots, or dedicated customer support apps.
8	Marketing and Sales	Mobile marketing technology allows production companies to reach potential customers through targeted mobile advertising, SMS marketing, and mobile-friendly websites. It can also facilitate customer engagement through mobile apps and loyalty programs.
9	Field Sales Support	Mobile apps equipped with product catalogs, pricing information, and customer data can support sales representatives in the field, enabling them to provide accurate and up-to-date information to customers.
10	Augmented Reality (AR) and Virtual Reality (VR)	AR and VR technologies integrated into mobile apps can enhance production processes by providing interactive training, design visualization, and virtual walkthroughs of production facilities.
11	QR Code and NFC Technology	QR codes and near-field communication (NFC) tags can track and identify products throughout the production and supply chain process, providing valuable information to stakeholders.
12	Mobile Payments	Production companies can offer mobile payment options to streamline transactions, mainly when selling directly to end consumers.

By leveraging mobile communication and marketing technology, production companies can optimize their operations, improve customer engagement, and stay competitive in a rapidly evolving market. However, it's essential to prioritize data security and privacy when implementing these technologies to protect sensitive production-related information.

8.9 Integration of BA with Information Storage Technologies in Production Industry:

Information storage technology plays a crucial role in the production industry by efficiently managing, securing, and accessing vast amounts of data generated during production. Here are some possible applications of information storage technology in the production industry:

Table 22: Details of possible applications of Information Storage Technology for Production Industry

S. No.	Application of Integration	Description
1	Database Management	Information storage systems, such as relational databases, NoSQL databases, and data warehouses, store structured and unstructured data related to production processes, inventory, quality control, customer information, and more.
2	Historical Data Storage	Production companies often need to store historical data, including past production runs, quality metrics, and maintenance records. This data can be valuable for trend analysis, process optimization, and compliance.
3	Cloud Storage	Cloud-based storage solutions provide scalable and cost-effective options for storing production-related data, making it accessible from anywhere with an internet connection. Cloud storage also facilitates data backup and disaster recovery strategies.
4	Product Lifecycle Management (PLM)	PLM systems store and manage all product-related information, including design data, specifications, revisions, and change history. This ensures effective collaboration among design, engineering, and manufacturing teams.
5	Enterprise Resource Planning (ERP):	ERP systems serve as centralized databases for production-related information, integrating data from departments like sales, inventory, manufacturing, and finance.
6	Document Management	Information storage technology manages work instructions, standard operating procedures (SOPs), compliance documents, and safety protocols.
7	Sensor Data Storage	Production processes often involve using sensors and Internet of Things (IoT) devices to collect data. Information storage systems manage and analyze the data generated by these devices.
8	Supply Chain Management	Information storage technology is employed to manage data related to suppliers, procurement, logistics, and distribution, optimizing supply chain efficiency and reducing lead times.
9	Quality Assurance	Production companies store data related to quality inspections, non-conformance reports, corrective actions, and audits to maintain and improve product quality and compliance.
10	Big Data Analytics	Advanced information storage technologies and big data analytics allow production companies to process and analyze large datasets to gain insights into production performance, identify inefficiencies, and make data-driven decisions.
11	Simulation and Modeling	Complex simulations and models are used for design validation and process optimization in production industries like automotive or aerospace. Information storage technology is crucial in storing and retrieving these simulation results.
12	Intellectual Property Protection	Information storage systems help protect sensitive intellectual property and trade secrets related to new product designs and manufacturing processes.
13	Digital Twins	Information storage technology stores data from digital twin models, representing virtual replicas of physical assets. Digital twins facilitate predictive maintenance, performance monitoring, and optimization of production equipment.

8.10 Integration of BA with Ubiquitous Education Technologies in Production Industry:

Ubiquitous Education Technology integrates technology into various aspects of education, making learning accessible anytime and anywhere. When applied to the production industry, it can have several significant benefits. Here are some possible applications of Ubiquitous Education Technology for the production industry:

Table 23: Details of possible applications of Ubiquitous Education Technology for Production Industry

S. No.	Application of Integration	Description
1	Training and Skill Development	Ubiquitous Education Technology can provide employees with continuous training and skill development. Mobile learning applications, virtual reality (VR), and augmented reality (AR) simulations can offer hands-on training in a safe and controlled environment. This approach can be beneficial for training employees in operating complex machinery, ensuring safety protocols, and mastering new production techniques.
2	Performance Support	Employees can access real-time information, production guidelines, troubleshooting assistance, and best practices through mobile apps or wearable devices. This immediate resource access can enhance their problem-solving abilities and minimize downtime, increasing productivity.
3	Remote Learning	Ubiquitous Education Technology enables employees in the production industry to access learning materials and participate in training sessions remotely. Online courses, webinars, and virtual workshops can update employees on the latest industry trends, technologies, and regulations, even if they are not physically present at the production facility.
4	Data Visualization and Analytics	Technology can assist in presenting complex production data in a user-friendly and visual format. Interactive dashboards, data analytics tools, and performance tracking systems can help employees and managers monitor production metrics, identify trends, and make data-driven decisions to optimize processes.
5	Collaboration and Communication	Collaboration platforms and communication tools can be integrated to facilitate knowledge sharing and communication among production teams. Employees from different locations can collaborate in real time, share experiences, and exchange best practices, fostering a culture of continuous improvement.
6	Quality Control and Inspection	Ubiquitous Education Technology can improve quality control and inspection by leveraging AI-driven image recognition, IoT devices, and sensors. These technologies can help identify defects, ensure adherence to quality standards, and streamline the inspection process.
7	Onboarding and New Employee Training	When new employees join the production industry, ubiquitous education technology can provide comprehensive onboarding materials and training resources. This can accelerate their integration into the company and ensure they have the necessary knowledge to contribute effectively.
8	Continuous Learning and Upskilling	Through microlearning modules, gamification, and personalized learning pathways, employees can engage in continuous learning and upskilling. This approach empowers them to acquire new skills and adapt to changing production processes and technologies.
9	Safety Training	Safety is of utmost importance in the production industry. Ubiquitous Education Technology can deliver interactive safety training modules, conduct virtual safety drills, and reinforce

		safety protocols to ensure a safe working environment for all employees.
10	Performance Assessment and Feedback	Technology-driven assessments and feedback mechanisms can be used to evaluate employee performance. Managers can provide timely feedback, identify areas for improvement, and recognize exemplary performance, fostering a culture of accountability and motivation.

By leveraging Ubiquitous Education Technology in these ways, the production industry can enhance workforce capabilities, improve production efficiency, and adapt to the market's ever-changing demands.

8.11 Integration of BA with Virtual & Augmented Reality Technologies in Production Industry:

Virtual and Augmented Reality (VR/AR) technologies offer exciting possibilities for the production industry, revolutionizing various processes and enhancing overall efficiency. Here are some possible applications of VR/AR technology for the production industry:

Table 24: Details of possible applications of Virtual & Augmented Reality Technology for Production Industry

S. No.	Application of Integration	Description
1	Design and Prototyping	VR/AR can create immersive 3D models of products, machinery, and production layouts. Engineers and designers can visualize and interact with these virtual prototypes, enabling them to identify design flaws, make improvements, and optimize production processes before physical production begins.
2	Training and Simulation	VR/AR can provide realistic and safe training environments for employees to learn how to operate complex machinery and equipment. Workers can practice assembling, operating, and troubleshooting machinery in a virtual setting, reducing the risk of accidents and increasing their confidence and competence.
3	Remote Collaboration	VR/AR facilitates remote collaboration among production teams, suppliers, and experts from different locations. Participants can hold virtual meetings, visualize products or production processes, and make real-time decisions, saving time and travel costs.
4	Maintenance and Repair	AR technology can overlay digital information onto physical machinery or equipment, providing maintenance personnel with real-time instructions, schematics, and diagnostic data. This hands-free access to information can streamline maintenance and repair tasks, reducing downtime and increasing equipment uptime.
5	Quality Control and Inspection	AR can be used for real-time quality control and inspection. Workers equipped with AR headsets or intelligent glasses can compare physical products with digital models, identify defects, and ensure quality standards compliance.
6	Assembly Assistance	VR/AR can guide workers step-by-step during the assembly process. Digital instructions can be superimposed on physical parts, guiding workers through the correct assembly sequence and reducing the likelihood of errors.
7	Inventory Management	AR can help optimize inventory management by providing real-time information about stock levels, locations, and reordering points. Warehouse staff can visualize inventory data overlaid onto physical shelves, simplifying the picking and restocking processes.

8	Safety Training and Hazard Identification	VR/AR can simulate hazardous situations, enabling workers to undergo safety training in a controlled environment. Employees can learn to respond to emergencies, identify potential hazards, and practice safety procedures without risking their well-being.
9	Remote Support and Troubleshooting	AR can enable experts to provide remote support to on-site technicians. Using AR-enabled devices, on-site personnel can share a live video feed of the problem, and experts can annotate the video with instructions and guidance in real-time.
10	Data Visualization	VR/AR can display real-time production data and analytics visually compellingly. Managers can explore data in 3D, identifying trends, patterns, and areas for improvement more intuitively.

These VR/AR technology applications in the production industry can lead to increased productivity, reduced errors, improved safety, and enhanced collaboration among teams. As the technology evolves, its potential impact on the industry will grow even further.

8.12 Integration of BA with Quantum Computing Technologies in Production Industry:

Quantum computing technology is still in its early stages of development, but its potential applications in the production industry are vast and promising. Quantum computing relies on the principles of quantum mechanics to perform complex calculations and solve problems beyond classical computers' capabilities. Here are some possible applications of quantum computing technology for the production industry:

Table 25: Details of possible applications of Quantum Computing Technology for Production Industry

S. No.	Application of Integration	Description
1	Optimization of Supply Chain	Quantum computing can optimize supply chain operations by efficiently solving complex logistical problems. It can help determine the most cost-effective routes for transportation, minimize inventory carrying costs, and optimize production schedules to meet demand while minimizing costs.
2	Materials and Chemical Simulation	Quantum computing can simulate the behavior of materials and chemicals at the quantum level, leading to the discovery of new materials with unique properties or more efficient chemical processes. This could lead to advancements in manufacturing and production processes.
3	Drug Discovery and Development	Quantum computing can significantly speed up the drug discovery process by simulating molecular interactions and accurately predicting the effectiveness of potential drug compounds. This could lead to the developing of new and more effective pharmaceuticals for various medical conditions.
4	Process Optimization	Quantum computing can analyze vast amounts of data from production processes and supply chains to optimize various parameters. It can help identify the most efficient production processes, reduce waste, and improve productivity.
5	Cryptography and Data Security	Quantum computing has implications for data security. Quantum-resistant cryptography can be implemented to protect sensitive production and business data from potential threats posed by future quantum computers.
6	Computational Fluid Dynamics (CFD)	Quantum computing can enhance CFD simulations used in industries like aerospace and automotive. It can enable more accurate modeling and analysis of fluid flows, leading to better designs and improved efficiency.

7	Machine Learning and AI	Quantum computing can accelerate machine learning algorithms, enabling more advanced pattern recognition and optimization capabilities. This could be applied to the production industry's predictive maintenance, quality control, and demand forecasting.
8	Energy Optimization	Quantum computing can optimize energy consumption in production facilities, helping to reduce operational costs and environmental impact. It can analyze energy consumption patterns and suggest improvements to increase efficiency.
9	Portfolio Optimization	For manufacturing companies with diverse investments, quantum computing can optimize investment portfolios, ensuring the most efficient allocation of resources and maximizing returns.

It's essential to note that quantum computing technology is still in its early stages, and the practical applications mentioned above are mainly theoretical. The development of quantum computing is a complex and ongoing process, and it may take time before these applications become mainstream in the production industry. Quantum computing has immense potential to revolutionize various production and manufacturing processes.

9. ABCD ANALYSIS FRAMEWORK ON TECH-BUSINESS ANALYTICS IN SECONDARY INDUSTRY SECTOR FROM STAKEHOLDERS POINT OF VIEW :

9.1 ABCD ANALYSIS OF TBA AS FROM SUPPLIER POINT OF VIEW:

9.1.1 Advantages:

The TBA in the secondary industrial sector has a number of benefits:

Table 26: Advantages of TBA as stakeholder as supplier

S. No.	Aspects	Description
1.	Enhanced judgement	Business analytics powered by technology can give decision-makers insights into critical organizational data to help them make informed decisions.
2.	Efficiency gain	Tech-driven business analytics can help organizations identify operational inefficiencies to make the necessary modifications to increase productivity and reduce waste.
3.	More stringent quality assurance	Using tech-driven business analytics, organizations may monitor quality control systems and identify areas for improvement. Businesses can use this to ensure that their products are high caliber and conform to legal requirements, increasing consumer satisfaction.
4.	Improved inventory management	Business analytics powered by technology can aid organizations in managing inventories more effectively by providing real-time information on stock levels, demand patterns, and production capacity.
5.	Better supply chain management	Businesses can optimize their supply chains with tech-driven business analytics, ensuring that the right products and resources are always available when needed. Analyzing information on supplier performance, transportation costs, and other factors allow businesses to identify places where their supply chains can be streamlined and costs reduced.

To help businesses in the secondary industrial sector operate more effectively, reduce expenses, and improve the quality of their output, tech-driven business analytics is becoming increasingly popular. Businesses may use data to gain a competitive edge and position themselves for long-term success.

9.1.2 Benefits:

There are several ways that the secondary industrial sector might profit from using tech-driven business analytics.

Table 27: Benefits of TBA as stakeholder as supplier

S. No.	Aspects	Description
1.	Boosted profitability	By using tech-driven business analytics, businesses can find opportunities to cut expenses and streamline operations, which will enhance profitability.
2.	Customer happiness	The application of tech-driven business analytics has aided in this and may help organizations better understand the needs and preferences of their clients.
3.	Gaining a competitive edge	Businesses can compete in the market if they utilize data to the fullest extent possible. By using tech-driven business analytics to automate processes, reduce costs, and enhance product quality, businesses can become market leaders, attracting new customers and retaining those they already have.
4.	Efficiency gain	Technology-driven business analytics can help businesses reduce waste, increase efficiency, and streamline operations. Businesses may identify inefficiencies and make the necessary adjustments to boost productivity and save costs by accessing data on manufacturing processes, resource utilization, and supply chain management.
5.	Real-time insights	Businesses may receive real-time insights on their processes using tech-driven business analytics, enabling them to take prompt, logical action. With dashboards and data visualization tools, businesses can monitor key metrics and see trends in real-time, allowing them to make adjustments as needed.

9.1.3 Constraints:

Although there are many benefits to integrating tech-driven business analytics in the secondary industrial sector, organizations could encounter specific difficulties. Here are a few examples:

Table 28: Constraints of TBA as stakeholder as supplier

S. No.	Aspects	Description
1.	Data reliability and accessibility	If the data is faulty, incorrect, or outdated, its conclusions could not be trustworthy. Some businesses may not have access to the necessary data because of data silos or privacy issues.
2.	Cost	The price of continuous upkeep and training may also increase with time.
3.	Technical knowledge	Another hurdle for businesses may be a need for more technological expertise.
4.	Opposition to change	To present processes and workflows may be necessary to implement tech-driven business analytics. For some employees who may be wary of these changes, further training may be necessary to use new tools and technology.
5.	Adaptation to current systems	Incorporating new analytics tools with an organization’s current infrastructure might also provide challenges.

Therefore, even though tech-driven business analytics have many benefits for the secondary industrial sector, companies must consider potential drawbacks and challenges while implementing these solutions.

9.1.4 Drawbacks:

The secondary industrial sector's use of tech-driven business analytics has several drawbacks:

Table 29: Drawbacks of TBA as stakeholder as supplier

S. No.	Aspects	Description
1.	Reliance on data too much	Even though data can provide insightful information, a firm reliance on it may lead to a limited focus on quantitative measurements at the expense of other essential factors. Businesses must not recognize qualitative data since it can provide valuable insights into the human aspect of their operations. Employee feedback and customer reviews are two examples of such data.
2.	Security and privacy issues	When handling sensitive data, tech-driven business analytics might raise security and privacy concerns. Businesses must ensure they abide by all applicable data protection rules and regulations and have robust security measures in place to avoid data breaches.
3.	Complexity	It can be challenging and time-consuming to put tech-driven business analytics into practice. Businesses may need to spend money on new software, equipment, and specific skills to handle and evaluate data efficiently.
4.	Data bias	Analytics models can only produce results as accurate as the data they are based on. Data biases can produce inaccurate results. Businesses must use varied and representative data sets to avoid reinforcing existing stereotypes or creating new ones.
5.	Resistance to change	Tech-driven business analytics implementation may require significant changes to present processes and workflows. Some employees might have differing views on these changes or want further training to get used to cutting-edge tools and technologies.

Thus, even while tech-driven business analytics can provide beneficial information for businesses in the secondary industrial sector, several drawbacks must be considered.

9.2 ABCD ANALYSIS OF TBA AS PRODUCER POINT OF VIEW :

9.2.1 Advantages:

Being a producer offers numerous benefits to a stakeholder in tech business analytics (TBA). Several advantages are listed below:

Table 30: Advantages of TBA as stakeholder as producer

S. No.	Aspects	Description
1.	Insights and Decision-Making	As a TBA producer, you have access to a wealth of data and analytical tools that can offer insightful analysis of many business-related topics. You can utilize these insights to make knowledgeable decisions, streamline operations, spot patterns, and create growth and profitability strategies.
2.	Competitive Advantage	TBA producers can use data and analytics to obtain a competitive edge in the market. You can find patterns and trends to help you remain ahead of the competition by applying advanced analytics approaches, such as predictive modeling or machine learning algorithms.
3.	Improved Operational Efficiency	TBA can aid in streamlining processes and enhancing effectiveness across numerous company functions. You can pinpoint areas for improvement, better allocate resources, and cut costs by analyzing data on supply chains, inventory management, consumer behavior, or production processes.
4.	Targeted Marketing and Personalization	TBA makes it easier for you to comprehend demographics, consumer behavior, and preferences. You can better serve customers by customizing product offerings and marketing activities using this information. This focused strategy can result in increased customer happiness, greater brand loyalty, and higher sales and revenue.

5.	Risk Management and Fraud Detection	Utilizing real-time and historical data analysis, TBA enables you to spot possible dangers and catch fraudulent activity. You may proactively reduce risks, stop fraud, and guarantee regulatory compliance by utilizing anomaly detection methods and predictive analytics.
6.	Innovation and New Opportunities	The manufacturers of TBA are in an excellent position to recognize future markets, new trends, and innovative prospects. You can spot market gaps and create cutting-edge goods or services to fill those demands by analyzing data from multiple sources, including client feedback, market trends, and competition intelligence.
7.	Data-Driven Culture	A data-driven culture is promoted within an organization by being a TBA producer. This supports a systematic method of problem-solving and encourages evidence-based decision-making. Additionally, it encourages cooperation and knowledge exchange throughout the entire organization and aids in dismantling departmental silos.

Hence, you may use data and analytics as a producer and stakeholder in tech business analytics to guide strategic decision-making, boost operational effectiveness, acquire a competitive edge, and open up fresh possibilities for expansion and innovation.

9.2.2 Benefits:
It can benefit from several things as a producer and stakeholder in the field of tech business analytics (TBA):

Table 31: Benefits of TBA as stakeholder as producer

S. No.	Aspects	Description
1.	Enhanced Decision-Making	TBA offers you helpful information and insights to aid in decision-making. Making data-driven decisions reduces guesswork and increases the likelihood of good results by analyzing data and utilizing modern analytical tools.
2.	Competitive Advantage	It may allow obtaining a market advantage by using TBA. Using analytics, this can learn about client preferences, market trends, and rival plans. This may create unique items, create custom marketing strategies, and enhance overall business performance with the use of this information.
3,	Operational Efficiency	TBA makes business processes more efficient. It may locate bottlenecks, streamline procedures, and increase effectiveness by analyzing workflows, processes, and resource allocation data. As a result, expenses are reduced, productivity rises, and resources are used more effectively.
4.	Customer Insights and Personalization	TBA helps you better comprehend your customers. Analyzing their data may help you learn more about your customers' tastes, wants, and behavior. This information enables you to tailor marketing initiatives, develop targeted campaigns, and provide individualized experiences, improving client happiness and loyalty.
5.	Risk Management	TBA aids in risk identification and reduction. It can spot possible hazards, anticipate market changes, and take proactive measures to mitigate them by looking at past data and using predictive modeling. Your ability to manage risk is improved, as is your company's resilience.
6.	Improved Product Development	By offering knowledge about consumer preferences and market expectations, TBA helps with product creation. It can find chances for product innovation and enhancement by examining information

		on consumer feedback, product usage patterns, and market trends. Products that better satisfy consumer demands and preferences are subsequently developed.
7.	Business Growth and Revenue Generation	TBA can assist in boosting sales and business expansion. Effective growth strategies may be created by seeing market opportunities, streamlining processes, and utilizing customer data. It can use TBA to find underserved market niches, grow your clientele, and generate more money.
8.	Efficient Resource Allocation	Using TBA may allocate your resources. This may optimize resource allocation and ensure that resources are distributed to places where they provide the maximum value by analyzing data on resource utilization, demand patterns, and market dynamics. Saving money and managing resources more effectively result from this.
9.	Continuous Improvement	TBA encourages an environment of constant development inside the business. It may pinpoint areas for development, establish benchmarks, and measure advancement over time by routinely monitoring and analyzing performance indicators. This supports organizational learning and encourages an innovative and efficient culture.

Hence, as a stakeholder and producer in tech business analytics, it can gain advantages like improved decision-making, competitive advantage, operational efficiency, customer insights, risk management, business growth, and continuous improvement. In today's data-driven world, TBA equips you to use data and analytics to create corporate success.

9.2.3 Constraints:

Tech Business Analytics (TBA) has many benefits but has several limitations that stakeholders may encounter as creators. These typical restrictions should be taken into account:

Table 32: Constraints of TBA as stakeholder as producer

S. No.	Aspects	Description
1.	Data Quality and Availability	The availability and caliber of the data are crucial to TBA. Accessing pertinent and trustworthy data may provide difficulties for stakeholders. Data may impact analytics efforts' accuracy and efficacy.
2.	Security and Privacy of Data	This must manage delicate and private data as a TBA producer. To safeguard client information and adhere to rules, it is essential to guarantee data privacy and security. For stakeholders, managing data privacy issues, establishing strong security measures, and dealing with data breaches are constant difficulties.
3.	Technical Expertise and Resources	TBA needs qualified personnel with data analytics, statistics, and programming knowledge. Finding and keeping top talent can be challenging because there is a need for more qualified specialists. For some stakeholders, investing in the hardware, software, and other resources required for data analytics can also be expensive.
4.	Complexity and Interpretation	TBA uses sophisticated statistical models, machine learning methods, and complex algorithms. It could be challenging to interpret and comprehend the conclusions of these evaluations. Stakeholders must possess the knowledge and skills necessary to interpret the analysis results and turn them into insights that can be used.
5.	Change Management and	Changes to organizational procedures, structures, and cultures are frequently needed to implement TBA projects. Successful TBA implementation may be hindered by resistance to change, a lack of

	Organizational Alignment	stakeholder support, and difficulties coordinating organizational goals with analytics objectives.
6.	Ethical Considerations	TBA raises moral questions about data use, privacy, and bias. Stakeholders must deal with problems, including guaranteeing algorithmic decision-making is fair, preventing unintentional discrimination, and resolving potential biases in data gathering and analysis.
7.	Integration and Data Silos	The seamless data integration for analytics is hampered in many organizations by fragmented technologies and data silos. Stakeholders hoping to use TBA effectively may need more support to solve these integration problems and build a single data architecture.
8.	Scalability and Agility	Stakeholders find scalability a constraint as data volume and complexity increase quickly. Careful planning and resource allocation are necessary so TBA programs can manage growing data quantities and react to changing business needs.
9.	Legal and Regulatory Compliance	Stakeholders in TBA are subject to several legal and regulatory obligations around data security, privacy, and protection. Maintaining awareness of evolving legislation and ensuring compliance can be a considerable challenge, particularly in highly regulated businesses.
10.	Cultural Adoption and Change	The organization may need a cultural shift to implement TBA, where data-driven decision-making becomes the norm. Getting stakeholders to adopt analytics, improve their data literacy, and alter the way they make decisions might be difficult.

Despite these limitations, businesses can work to overcome them by investing in data governance, hiring skilled workers, adopting clear data policies, and promoting a data-driven culture. Stakeholders must overcome certain obstacles to utilize TBA and produce good results fully.

9.2.4 Drawbacks

There are many advantages to tech business analytics (TBA), but stakeholders may run into potential drawbacks and difficulties as producers. Consider these negative aspects:

Table 33: Drawbacks of TBA as stakeholder as producer

S. No.	Aspects	Description
1.	Overreliance on Data	TBA places a strong emphasis on data-driven decision-making, which could result in excessive dependence on statistics and a disregard for qualitative considerations like intuition and experience. There is a chance of ignoring crucial contextual data that cannot be obtained by data analysis alone.
2.	False Interpretation of Data	TBA strongly emphasizes data-driven decision-making, which could result in excessive dependence on statistics and a disregard for qualitative considerations like intuition and experience. There is a chance of ignoring crucial contextual data that cannot be obtained by data analysis alone.
3.	Data Bias and Inaccuracies	The accuracy of TBA results can be affected by biases and mistakes in the data utilized for analysis. To produce biased results and poor decision-making, data may reflect historical biases, inadequate information, or sampling errors. To address biases in data sources and analysis techniques, stakeholders must be careful.
4.	Implementation Challenges	TBA projects might be challenging to implement when integrating analytics tools into current company processes and systems. There must be extensive planning, coordination, and change management

		initiatives to embrace and implement the change across the organization successfully.
5.	Cost and Resource Intensiveness	TBA projects can be labor- and resource-intensive, necessitating substantial expenditures on IT infrastructure, analytical tools, and qualified employees. Particularly for smaller organizations with tighter resources, the expenses associated with data storage, processing, and analysis can be significant.
6.	Complexity and Technical Expertise	TBA uses sophisticated analytical methods, complicated algorithms, and statistical modeling. With the required technical know-how, stakeholders could successfully comprehend and use these strategies. Hiring and retaining qualified data scientists and analysts can take time and effort.
7.	Time Constraints and Timeliness of Insights	TBA procedures can take a while, especially when working with data. Finding insights into data and communicating them quickly can be difficult, especially when decision-making speed is crucial. Stakeholders must balance the urgency of decision-making and the requirement for thorough analysis.
8.	Resistance to Change	Employees who are hesitant to use TBA because they are averse to analytics or worried about how it will affect their jobs may be the ones to object. Change aversion can inhibit adoption, restrict the use of analytics capabilities, and prevent the integration of TBA into organizational procedures.
9.	Privacy and Ethical Concerns	Managing such a large amount of data by TBA raises security, privacy, and morality issues. Stakeholders must understand privacy laws, deal with possible biases in data, and guarantee that data is used ethically in analytical procedures.
10.	Constant Technological Advancements	New methods, devices, and technological advancements are often made in TBA, which is continually changing. To fully utilize TBA, stakeholders must keep up with recent developments and trends. Outdated analytics techniques could stem from a failure to keep up with technological advancements.

Stakeholders must be aware of these shortcomings and take proactive measures to overcome them through solid data governance, continual training and skill development, meticulous validation of outcomes, and ethical concerns. By controlling these difficulties, stakeholders can maximize TBA's advantages while reducing potential negatives.

9.3 ABCD ANALYSIS OF TBA FROM CONSUMER POINT OF VIEW :

9.3.1 Advantages:

There are various benefits this can enjoy as a stakeholder and user of tech business analytics (TBA).

Table 34: Advantages of TBA as stakeholder as consumer

S. No.	Aspects	Description
1.	Improved Decision-Making	TBA gives you, as a customer, the power to decide more wisely. You better understand your company's operations, market dynamics, customer behavior, and industry trends by utilizing analytics-driven insights and reports. Due to this knowledge, its decisions will be data-driven and in line with your company's goals.
2.	Competitive Intelligence	TBA offers you practical competitive intelligence. You can learn more about your industry's landscape and spot opportunities for differentiation by examining market statistics, customer trends, and competition plans. With the help of this intelligence, you may stay one step ahead of the competition and take calculated risks to seize business chances.

3.	Enhanced Customer Understanding	It can better comprehend your consumers, thanks to TBA. This may help you learn more about your customers' requirements, wants, and pain areas by studying their data, such as purchase history, preferences, and demographics. This may better satisfy consumer expectations and promote customer happiness by customizing your products, services, and marketing initiatives using this insight.
4.	Personalized Marketing and Customer Experience	The marketing and consumer experience can be tailored with TBA. It may deliver targeted marketing campaigns, individualized recommendations, and specialized experiences to specific clients by utilizing customer data and sophisticated segmentation techniques. Improved customer engagement and loyalty result from this personalization, increasing conversion rates.
5.	Operational Efficiency and Cost Savings	Your business operations can be optimized, and costs can be reduced with the aid of TBA. This can locate inefficiencies, restructuring processes, and improve resource allocation by analysing operational data. Profitability rises, costs are decreased, and operational effectiveness is enhanced.
6.	Risk Management and Fraud Detection	It can manage risks and spot fraudulent activity with the help of TBA. It can identify possible hazards, foresee market changes, and spot fraudulent behavior by analyzing data patterns, anomalies, and historical trends. This proactive approach to risk management safeguards your company and aids in developing more effective risk mitigation measures.
7.	Continuous Improvement	TBA actively supports a culture of ongoing development. Analyzing performance indicators lets you pinpoint problem areas, monitor development, and make data-driven changes to your operations and strategy. An iterative process promotes innovation, improves workflow, and maintains flexibility in shifting market conditions.
8.	Data-Driven Partnerships	TBA enables you to work with additional stakeholders who offer analytics services. By collaborating with analytics service providers, it can benefit from their knowledge and access to cutting-edge analytics tools and methods. Thanks to this relationship, it can obtain a competitive advantage, accelerate corporate growth, and extract valuable insights.

Hence, as a stakeholder and user of Tech Business Analytics, you can use data and analytics to learn important things, make wise choices, better understand your clients and markets, streamline processes, control risks, and promote business expansion. In the modern, data-driven corporate environment, TBA gives you the tools to stay competitive, flexible, and responsive.

9.3.2 Benefits:

There are various advantages it can enjoy as a stakeholder and user of tech business analytics (TBA):

Table 35: Benefits of TBA as stakeholder as consumer

S. No.	Aspects	Description
1.	Actionable Insights	TBA offers you data-driven insights that it can put into practice. TBA aids you in finding the obvious by utilizing advanced analytics approaches. These insights may help you make wise decisions and take specific measures to advance your business.
2.	Data-Driven Decision-Making	TBA allows you to base decisions on facts rather than feelings or speculation. You can rely on factual information to assist your decision-making by using analytics. This lowers the possibility of prejudice or subjective judgments and raises the possibility of making more precise and valuable decisions.

3.	Improved Customer Understanding	This can help you learn more about your clients, thanks to TBA. It may identify consumer categories, requirements, and pain points by analyzing data about them, such as demographics, buying behavior, and preferences. With this knowledge, you can better match their needs and improve their entire experience by customizing your offerings regarding goods, services, and marketing tactics.
4.	Targeted Marketing and Personalization	It may use TBA to apply tailored marketing tactics and customize consumer experiences. Customer data and segmentation strategies can give personalized messages, offers, and suggestions to particular consumer segments. This improves the relevance and efficacy of your marketing initiatives, which raises conversion rates and improves consumer engagement.
5.	Competitive Advantage	TBA gives you a market advantage. It may keep up with the competition by using analytics to track market trends, examine rival strategies, and find market opportunities. TBA enables you to make data-driven decisions that position your company for success and let you stand out in the industry.
6.	Risk Management and Fraud Detection	TBA assists in risk identification, risk mitigation, and fraud detection. It may proactively identify possible risks and implement effective risk management strategies by analyzing data patterns, anomalies, and historical trends. In addition, TBA helps you secure your organization and reduce financial losses by identifying fraudulent actions and behavior.
7.	Enhanced Operational Efficiency	It may streamline your business operations with TBA. It can find inefficiencies, bottlenecks, and places for improvement by examining operational data and performance measures. TBA aids in process streamlining, resource allocation, and operational efficiency enhancement, which results in cost savings and increased production.
8.	Continuous Improvement	TBA encourages your company's culture of continual improvement. This can find areas that need improvement, track your progress, and make data-driven changes to your strategy and operations by routinely analyzing and monitoring data. It can promote innovation, improve procedures, and maintain responsiveness to shifting market dynamics with this iterative methodology.
9.	Data-Driven Partnerships	TBA makes joint ventures with technology suppliers and analytics providers possible. It can get more valuable insights from your data by working with outside specialists and utilizing their specialized knowledge, resources, and technologies. Thanks to this relationship, your ability to make decisions will be improved, and you'll have access to cutting-edge analytical methods and business growth.

It may make data-driven decisions, improve customer understanding, gain a competitive advantage, manage risks, increase operational efficiency, and promote continuous improvement in your business operations by utilizing the advantages of Tech Business Analytics as a stakeholder or consumer. TBA gives you the tools to maximize the value of your data and create a competitive advantage.

9.3.3 Constraints:

As consumers, stakeholders can benefit significantly from tech business analytics (TBA), but several potential limitations exist. A few typical restrictions to think about are listed below:

Table 36: Constraints of TBA as stakeholder as consumer

S. No.	Aspects	Description
1.	Data Availability and Quality	Data that is pertinent and of high quality must be available for TBA. Constraints may result if the essential data is not readily available or

		of the proper caliber, completeness, or correctness. Inconsistent or inadequate data can hamper a decision-makers improved.
2.	Data Privacy and Security	When using TBA, consumer stakeholders must consider issues with privacy and security. Ensuring compliance with data protection laws is essential since handling sensitive consumer data has inherent dangers. A constant problem for stakeholders is ensuring data privacy and implementing effective security measures.
3.	Resource Constraints	It takes a lot of resources to implement and maintain TBA capabilities. Consumer stakeholders may experience budgetary, technological, and human resource restrictions. For TBA projects to be successful, adequate expenditures must be made on analytics tools, technologies, and expertise.
4.	Technical Expertise and Knowledge Gap	Effective use of TBA necessitates a certain amount of technical knowledge. They may have limitations if consumer stakeholders need to gain the knowledge and abilities to comprehend and analyze the analytics outputs. Getting the necessary expertise and filling the knowledge gap might take much work.
5.	Integration Challenges	It could be challenging to integrate TBA into current procedures and systems. To offer a complete view for analysis, data from different systems and sources must be merged. Compatibility problems, data silos, and outdated systems may make integrating TBA into organizational operations complex without any disruption.
6.	Ethical Considerations	The utilization of client data, privacy, and potential biases in algorithms are some of the ethical issues that TBA brings up. The use of data must be ethical and accountable, biases must be addressed, and analytics practices must remain transparent. It is essential to follow legal and ethical requirements.
7.	Change Management and Organizational Alignment	TBA might necessitate structural adjustments and a change in how people make decisions. The alignment of analytics activities with business goals may take time for stakeholders to achieve, or they may face employee opposition to change. Getting beyond barriers, cultivating cultures that value data, and connecting analytics to strategic objectives can be difficult.
8.	Complexity and Interpretation	TBA uses sophisticated statistical models, machine learning methods, and complex algorithms. In particular, consumer stakeholders may need more analytical knowledge to comprehend and evaluate the analytics data. It can be challenging to appropriately interpret the insights and turn them into practical solutions.
9.	Data Volume and Processing Speed	Managing massive amounts of data and ensuring timely analysis can be challenging for stakeholders in the consumer market. TBA has to handle real-time or nearly real-time analytics and has robust data processing capabilities. As data volume and velocity rise, scalability and processing speed may face difficulties.
10.	Return on Investment (ROI) Uncertainty	TBA has the potential to bring about a lot of advantages, but consumer stakeholders may need help calculating the ROI of their analytics projects. The immediate influence of analytics on corporate results can be challenging to measure, and evaluating the return on TBA investments can also be challenging.

To navigate these limitations, proactive steps must be taken, including investing in data governance, prioritizing data quality, upskilling personnel, resolving privacy and security concerns, and ensuring TBA projects align with organizational objectives. Stakeholders can use TBA successfully and realize its full potential by overcoming these obstacles.

9.3.4 Drawbacks

Despite the many advantages of tech business analytics (TBA), stakeholders may run through some disadvantages and difficulties as users. Consider these negative aspects:

Table 37: Drawbacks of TBA as stakeholder as consumer

S. No.	Aspects	Description
1.	Overreliance on Data	TBA strongly emphasizes data-driven decision-making, which could result in an overreliance on data and disregarding intuition, experience, and qualitative elements. There is a chance of missing crucial contextual information that cannot be obtained by data analysis alone.
2.	False Interpretation of Data	It takes skill and careful interpretation to analyze complicated data sets and get relevant insights. When statistics are interpreted or presented correctly, it can result in accurate conclusions and better decision-making. The outputs of the analytics must be accurate and consistent with the context of the business, according to stakeholders.
3.	Data Privacy and Security Risks	Since TBA depends on minimizing the risk of data breaches or unauthorized access, consumer stakeholders must ensure compliance with data protection laws, deploy strong security measures, and manage sensitive customer data responsibly.
4.	Complexity and Technical Expertise	Technical know-how in data analysis, statistics, and machine learning is necessary for using TBA efficiently. It could be difficult for consumer stakeholders to find or access the appropriate expertise within their organization. TBA capabilities implementation and upkeep may also necessitate spending on cutting-edge analytics tools and technology.
5.	Cost and Resource Intensiveness	TBA projects can be resource-intensive, requiring significant investments in technical infrastructure, analytics tools, and qualified employees. Particularly for smaller organizations with tighter resources, the expenses related to data storage, processing, and analysis can be significant.
6.	Change Management and Organizational Alignment	Organizational adjustments and a culture change could be necessary to integrate TBA into current workflows and decision-making processes. Aligning analytics activities with company goals, getting people to embrace change, and getting employees to use new technologies could be difficult for consumer stakeholders.
7.	Data Quality and Availability	TBA is dependent on reliable and pertinent data being accessible. The correct data sources may be difficult to access, and it may be challenging to manage data consistency across many platforms and systems and to ensure data accuracy and completeness.
8.	Limited Scope and Scalability	There can be restrictions on TBA's scalability and scope. TBA's applicability in some situations may be constrained because some data or business processes aren't well-suited for analysis. When data amount and complexity rise, processing times lengthen, and potential performance problems may arise. This raises questions about scalability.
9.	Ethical Considerations and Bias	TBA may raise moral issues relating to algorithmic biases, data privacy, and other unforeseen consequences. Stakeholders are responsible for ensuring the ethical use of data, addressing biases in algorithms and analysis techniques, and considering how their decisions may affect other stakeholders.
10.	Lack of Human Judgment and Creativity	TBA relies on numerical analysis and might need to fully capture the nuances and intricacies that human judgment and creativity can offer. Stakeholders need to create a balance between data-driven insights and the insightful ideas that only human knowledge and intuition can provide.

Stakeholders must be aware of these shortcomings and take proactive measures to solve them through data governance practices, ongoing training and skill development, ethical considerations, and a comprehensive approach to decision-making that blends data-driven insights and human judgment. Stakeholders can maximize the advantages of TBA while reducing any potential negatives by controlling these difficulties.

10. ABCD ANALYSIS OF INTEGRATION OF BA WITH ICCT UT :

10.1 ABCD of Integrating Business Analytics with AI & Robotics in Manufacturing Industry:

Table 38: ABCD Analysis of Integration of BA with AI & Robotics:

S. No.	Aspects	Description
Advantages:		
1	Enhanced Process Efficiency	By combining Business Analytics with AI and robotics, manufacturers can analyze real-time production data, identify inefficiencies, and optimize manufacturing processes for increased productivity.
2	Predictive Maintenance	The integration enables predictive maintenance, where AI algorithms can proactively anticipate equipment failures and schedule maintenance, reducing downtime and optimizing maintenance costs.
3	Improved Quality Control	Business Analytics coupled with AI-powered robotics can monitor production quality in real-time, enabling early detection of defects and reducing the number of faulty products.
4	Data-Driven Decision Making	The combination empowers manufacturers with valuable insights from data analysis, allowing them to make informed decisions for inventory management, resource allocation, and production planning.
5	Flexible and Adaptive Manufacturing	The combination empowers manufacturers with valuable insights from data analysis, allowing them to make informed decisions for inventory management, resource allocation, and production planning.
Benefits:		
1	Increased Productivity	The synergy between Business Analytics, AI, and robotics streamlines production workflows, leading to higher output rates and overall operational efficiency.
2	Cost Reduction	By optimizing processes, predicting maintenance needs, and reducing defects, the integration helps minimize production costs and waste, resulting in improved profitability.
3	Enhanced Safety	AI-powered robots can handle hazardous tasks, while Business Analytics ensures that safety data is closely monitored and used to improve worker safety.
4	Competitive Advantage	Manufacturers who leverage the integration gain a competitive edge by offering high-quality products at reduced costs, enabling them to meet market demands effectively.
Constraints:		
1	High Initial Investment	Implementing AI-driven robotics and Business Analytics systems requires substantial upfront investments in technology, training, and infrastructure.
2	Technical Expertise	Integrating these technologies demands specialized skills and expertise, which might pose challenges in finding qualified personnel.
3	Data Privacy and Security	As sensitive production data is involved, ensuring data privacy and protecting against cyber threats becomes critical when integrating AI and robotics with Business Analytics.
Disadvantages :		
1	Complexity and Integration Issues	Combining Business Analytics, AI, and robotics may lead to technical complexities and integration challenges, potentially causing delays and operational disruptions.
2	Dependency on Technology	Manufacturers become reliant on technology for decision-making, which could pose risks if systems encounter failures or malfunctions.

3	Workforce Concerns	Automation through AI and robotics might raise concerns among the workforce regarding job displacement and require careful transition management.

Hence, despite the constraints and disadvantages, the advantages and benefits of integrating Business Analytics with AI and robotics in the manufacturing industry hold immense potential for revolutionizing production processes, achieving higher efficiency, and staying competitive in an increasingly technology-driven market. It is essential for manufacturers to carefully plan and execute the integration while addressing the associated challenges to maximize its benefits.

10.2 ABCD of Integrating Business Analytics with Blockchain in Manufacturing Industry:

Integrating Business Analytics technology with blockchain technology in the Manufacturing Industry can offer various advantages, benefits, constraints, and disadvantages. Here’s a comprehensive list:

Table 39: ABCD Analysis of Integration of BA with Blockchain Technology:

S. No.	Aspects	Description
Advantages:		
1	Enhanced Data Security	Blockchain’s decentralized and immutable nature ensures that data remains secure, preventing unauthorized access and tampering.
2	Increased Transparency	Blockchain’s distributed ledger provides a transparent view of the supply chain, allowing stakeholders to trace the flow of goods and raw materials, thereby improving accountability.
3	Streamlined Supply Chain	Blockchain integration can optimize supply chain processes, reducing delays and eliminating inefficiencies by enabling real-time tracking of goods and assets.
4	Smart Contracts Automation	The combination of analytics and blockchain allows for automating intelligent contracts, streamlining payment processes and other contractual obligations.
5	Data Integrity	The combination of blockchain’s immutability and analytics ensures that data is accurate and reliable, reducing the chances of errors and discrepancies.
6	Real-time Data Analysis	Business analytics can process data from blockchain in real time, providing manufacturers with valuable insights for better decision-making and performance optimization.
7	Improved Quality Control	By utilizing blockchain and analytics, manufacturers can track and verify the quality of raw materials, components, and finished products throughout the supply chain.
8	Reduced Counterfeiting	Blockchain’s transparency helps detect and prevent counterfeit products, protecting the manufacturer’s brand reputation.
Benefits:		
1	Efficient Inventory Management	Integrating analytics with blockchain can lead to better inventory management, reducing excess inventory and optimizing stock levels based on demand and supply data.
2	Predictive Maintenance	Business analytics can analyze data from blockchain-enabled sensors in manufacturing equipment, enabling predictive maintenance to minimize downtime and increase productivity.
3	Enhanced Product Lifecycle Management	Blockchain combined with analytics can provide insights into the entire product lifecycle, enabling manufacturers to identify potential bottlenecks and opportunities for improvement.
4	Data-driven Decision Making	Combining both technologies empowers manufacturers to make data-driven decisions, leading to better resource allocation and operational efficiency.

5	Improved Collaboration	Blockchain's shared and secure database and analytics facilitate better collaboration between manufacturers, suppliers, and other stakeholders.
Constraints:		
1	Integration Complexity	Integrating two complex technologies, blockchain and business analytics, might present implementation challenges and require skilled expertise.
2	Costs	Implementing and maintaining both technologies may involve high upfront costs and ongoing expenses.
3	Data Privacy Concerns	Blockchain's transparency might raise privacy concerns, especially if sensitive business information is exposed to all network participants.
4	Scalability	As the volume of data grows, the blockchain network's scalability might become a concern for handling large datasets required for analytics.
Disadvantages :		
1	Learning Curve	Employees may need time to adapt to the new technologies, potentially leading to a temporary decrease in productivity during the transition.
2	Potential Security Vulnerabilities	While blockchain is known for its security, integrating analytics applications could introduce potential vulnerabilities that need careful consideration.
3	Dependency on Internet Connectivity	Real-time analytics on blockchain require constant internet connectivity, which might be an issue in specific regions or during network disruptions.
4	Regulatory Challenges	The legal and regulatory landscape around blockchain and analytics may need to be more well-defined in some jurisdictions, posing compliance challenges.

Before implementing such integration, businesses in the Manufacturing Industry should thoroughly assess their specific needs, conduct a cost-benefit analysis, and ensure they have the technical expertise to overcome potential challenges.

10.3 ABCD of Integrating Business Analytics with Cloud Computing in Manufacturing Industry:

Integrating Business Analytics technology with cloud computing in the Manufacturing Industry can bring numerous advantages, benefits, constraints, and disadvantages. Table 40 depicts a comprehensive list.

Table 40: ABCD Analysis of Integration of BA with cloud computing Technology

S. No.	Aspects	Description
Advantages:		
1	Scalability	Cloud computing allows businesses to scale their analytics infrastructure based on demand, ensuring the system can handle large datasets and growing analytical requirements.
2	Cost Efficiency	Cloud-based analytics eliminates the need for expensive on-premises hardware and software, reducing capital expenses and allowing manufacturers to pay for resources as they use them.
3	Real-time Data Analysis	Cloud computing provides the processing power to analyze vast amounts of data quickly, enabling real-time insights that can lead to faster and more informed decision-making.
4	Flexibility and Accessibility	Cloud-based analytics can be accessed from anywhere with an internet connection, allowing key stakeholders to access and act upon critical data regardless of physical location.

5	Data Collaboration	Cloud platforms facilitate data sharing and collaboration among teams, departments, and external partners, enhancing communication and fostering data-driven decision-making.
6	Integration with IoT Devices	Cloud computing seamlessly integrates with Internet of Things (IoT) devices on the manufacturing floor, enabling real-time monitoring of equipment and processes and enhancing predictive maintenance capabilities.
7	Automatic Updates	Cloud analytics platforms often receive regular updates and improvements, ensuring manufacturers benefit from the latest features and advancements without manual intervention.
Benefits:		
1	Predictive Maintenance	Cloud-based analytics can process data from IoT sensors in real time, allowing manufacturers to predict equipment failures and perform preventive maintenance, reducing downtime and increasing productivity.
2	Supply Chain Optimization	By analyzing data across the supply chain, manufacturers can identify inefficiencies, reduce lead times, optimize inventory levels, and enhance overall supply chain performance.
3	Enhanced Product Quality	Cloud analytics can help manufacturers monitor and analyze product quality data, identifying defects or deviations early in production for improved quality control.
4	Improved Resource Management	Manufacturers can leverage cloud analytics to optimize resource allocation, such as raw materials, energy consumption, and labor, leading to cost savings and efficiency gains.
Constraints:		
1	Data Security Concerns	Storing and analyzing sensitive manufacturing data in the cloud raises security considerations, necessitating robust encryption and access controls to safeguard information.
2	Internet Dependency	Real-time analytics on the cloud require stable internet connectivity, and any disruptions may impact access to critical data and analytics applications.
3	Data Compliance and Regulations	The Manufacturing Industry may be subject to specific data regulations and compliance requirements, and using cloud services must align with these regulations to avoid legal issues.
Disadvantages :		
1	Latency Issues	For specific analytics tasks that require immediate response, the latency introduced by cloud computing may be a limitation.
2	Potential Downtime	Cloud services are not immune to outages, and any unplanned downtime could temporarily disrupt analytics processes and decision-making.
3	Data Transfer Costs	Large volumes of data transferred to and from the cloud can incur additional costs, particularly for businesses with limited bandwidth or high data usage.

Manufacturers considering integrating Business Analytics with cloud computing should thoroughly analyze their specific needs, evaluate the security measures of cloud service providers, and assess potential risks to make informed decisions about adopting this technology.

10.4 ABCD of Integrating Business Analytics with Cyber Security in Manufacturing Industry:

Integrating business analytics technology with cybersecurity technology in the manufacturing industry can have various advantages, benefits, constraints, and disadvantages. Here's a comprehensive list:

Table 41: ABCD Analysis of Integration of BA with Cyber Security:

S. No.	Aspects	Description
Advantages:		

1	Improved Threat Detection	By combining business analytics and cybersecurity, manufacturers can detect potential threats and cyber-attacks more effectively, enabling them to respond proactively and mitigate risks promptly.
2	Real-time Monitoring	Integrating analytics and cybersecurity allows manufacturers to monitor their systems in real time, identifying anomalies and potential breaches as they occur, leading to quicker response times.
3	Data-driven Decision Making	Business analytics provides valuable insights into manufacturing operations, enabling data-driven decision-making for enhancing security protocols and processes.
4	Predictive Maintenance	Manufacturers can predict potential security risks and system vulnerabilities by analyzing data from business operations and security systems, reducing the likelihood of unplanned downtime.
5	Resource Optimization	Integration of analytics and cybersecurity helps manufacturers optimize resource allocation by identifying areas where security investments are most needed.
Benefits:		
1	Compliance and Risk Management	Manufacturers can better adhere to industry regulations and compliance standards with the help of analytics, reducing the risk of penalties and legal consequences.
2	Enhanced Incident Response	The combination of analytics and cybersecurity streamlines incident response procedures, enabling faster identification, containment, and resolution of security incidents.
3	Business Continuity	Improved cybersecurity through analytics integration can minimize disruptions to manufacturing processes, ensuring business continuity and reducing financial losses.
4	Supply Chain Security	By analyzing data across the supply chain, manufacturers can identify potential security weak points and strengthen the overall security of the supply chain network.
5	Competitive Advantage	Companies that effectively integrate business analytics and cybersecurity can gain a competitive edge by demonstrating higher security and reliability to customers and partners.
Constraints:		
1	Complexity	Integrating two technologies can be complex and time-consuming, requiring skilled personnel and specialized knowledge.
2	Cost	Implementing and maintaining integrated systems may involve high upfront costs and ongoing training, software, and hardware upgrade expenses.
3	Data Privacy Concerns	Combining business analytics and cybersecurity technologies may raise privacy concerns, mainly if sensitive data is used for analysis or shared between systems.
4	Skill Gap	Finding and retaining professionals with expertise in business analytics and cybersecurity can be challenging due to the specialized nature of these fields.
5	Interoperability Issues	Integrating existing analytics and cybersecurity solutions might lead to compatibility issues, potentially causing disruptions or data loss during integration.
Disadvantages :		
1	False Positives/Negatives	More reliance on analytics can lead to false positives (raising unnecessary alarms) or false negatives (missing actual threats), impacting the effectiveness of security measures.
2	Overwhelming Data Volume	Integrating both technologies can generate a large volume of data, making extracting meaningful insights and identifying genuine security threats challenging.

3	Training and Adoption	Constraints and Employees may require extensive training to utilize integrated systems effectively, and some may resist change, affecting the overall adoption of the technology.
4	Overemphasis on Data	Integrating too much data from various sources can lead to information overload, making prioritizing and acting on critical security alerts difficult.
5	Technology Risks	As with any technology integration, there is a risk of technical failures or vulnerabilities in the integrated system, potentially exposing new attack vectors.

When considering integrating business analytics technology with cybersecurity technology, manufacturers should carefully weigh the advantages and benefits against the constraints and disadvantages to make informed decisions that align with their business goals and security requirements.

10.5 ABCD of Integrating Business Analytics with Internet of Things (IoT) in Manufacturing Industry:

Integrating business analytics technology with the manufacturing industry's Internet of Things (IoT) technology offers several advantages, benefits, constraints, and disadvantages. Here's a comprehensive list:

Table 42: ABCD Analysis of Integration of BA with Internet of Things (IoT):

S. No.	Aspects	Description
Advantages:		
1	Predictive Maintenance	Combining business analytics and IoT allows manufacturers to analyze real-time data from connected devices and machinery, enabling predictive maintenance. This helps identify equipment failures and maintenance needs, reducing downtime and increasing operational efficiency.
2	Enhanced Data Insights	IoT devices generate vast amounts of data, and when combined with business analytics, manufacturers can gain deeper insights into various aspects of their operations. This includes production performance, supply chain optimization, and customer behavior.
3	Optimized Resource Management	With the help of integrated analytics and IoT, manufacturers can optimize resource allocation, including energy usage, raw materials, and workforce, leading to cost savings and environmental benefits.
4	Real-time Monitoring and Control	IoT technology provides real-time data from sensors and devices across the manufacturing process. Integrating business analytics enables manufacturers to monitor operations, detect anomalies, and make timely adjustments for optimal productivity.
5	Improved Quality Control	By analyzing data from IoT sensors and devices, manufacturers can implement better quality control measures and detect defects or deviations from standards more efficiently.
Benefits:		
1	Inventory Management	Business analytics combined with IoT data enables manufacturers to track inventory levels accurately, identify demand patterns, and optimize inventory management processes.
2	Supply Chain Visibility	Integrating IoT and business analytics provides end-to-end supply chain visibility, helping manufacturers monitor shipments, predict delays, and enhance overall supply chain efficiency.
3	Data-Driven Decision Making	The combination of IoT and business analytics empowers manufacturers to make informed, data-driven decisions based on real-time insights and historical trends.

4	Process Optimization	By analyzing IoT data, manufacturers can identify bottlenecks, streamline workflows, and optimize production processes, increasing productivity and reducing waste.
5	Competitive Advantage	Companies that successfully integrate IoT and business analytics gain a competitive edge by leveraging data-driven insights to improve operational efficiency, product quality, and customer satisfaction.
Constraints:		
1	Data Security Risks	Integrating IoT devices with business analytics introduces new security risks as more data points become accessible, potentially increasing the attack surface for cyber threats.
2	Data Privacy Concerns	Combining data from various IoT devices and business analytics may raise privacy concerns, especially when dealing with sensitive information about production processes or customer data.
3	Complexity	Integrating and managing a vast network of IoT devices and analytics infrastructure can be complex and require specialized expertise.
4	Cost	Implementing and maintaining IoT devices and business analytics systems can involve high upfront costs and ongoing expenses.
5	Interoperability Issues	Integrating diverse IoT devices from manufacturers with business analytics platforms may challenge interoperability.
Disadvantages :		
1	Data Volume and Processing	Integrating IoT devices can lead to overwhelming data processing, requiring powerful analytics tools and infrastructure.
2	Scalability	As the number of IoT devices and data sources grows, scalability can become a concern, requiring regular updates to accommodate increased data processing needs.
3	Reliability and Downtime	If IoT devices or analytics systems experience downtime, it can disrupt manufacturing operations and lead to losses in productivity.
4	Training and Adoption	Employees may require training to use the integrated IoT and analytics systems effectively, and some may need help adopting new technologies.
5	Energy Consumption	Integrating IoT devices may increase energy consumption, potentially offsetting some sustainability benefits achieved through optimized resource management.

Before integrating business analytics technology with IoT in the manufacturing industry, organizations must carefully assess the advantages and benefits against the constraints and disadvantages to ensure a successful and secure implementation. Robust security measures, data privacy policies, and scalable infrastructure are crucial to the success of such integration.

10.6 ABCD of Integrating Business Analytics with 3D Printing in Manufacturing Industry:

Integrating business analytics with 3D printing technology in the manufacturing industry can lead to various advantages, benefits, constraints, and disadvantages. Table 43 depicts a comprehensive list.

Table 43: ABCD Analysis of Integration of BA with 3D Printing:

S. No.	Aspects	Description
Advantages:		
1	Enhanced Design Optimization	By combining business analytics with 3D printing, manufacturers can analyze design data, identify patterns, and optimize product designs for improved performance and efficiency.
2	Cost Savings	Business analytics can help identify cost-saving opportunities in the 3D printing process, such as material usage optimization and reducing printing errors.

3	Customization and Personalization	Integrating analytics with 3D printing enables manufacturers to analyze customer preferences and create personalized products more effectively, addressing specific market demands.
4	Reduced Time-to-Market	Analytics-driven insights can streamline the 3D printing process, reducing production lead times and enabling faster product launches.
5	Inventory Reduction	With on-demand 3D printing driven by analytics, manufacturers can produce items as needed, reducing the need for extensive inventory storage.
Benefits:		
1	Waste Minimization	Business analytics can aid in optimizing 3D printing parameters, minimizing material wastage, and contributing to a more sustainable manufacturing process.
2	Quality Control	Integration of analytics with 3D printing allows manufacturers to monitor the quality of printed products in real time, identifying defects and ensuring higher quality standards.
3	Design Validation	Business analytics can help validate 3D-printed designs by comparing them against simulations and real-world performance data, leading to more reliable products.
4	Rapid Prototyping	Manufacturers can rapidly iterate prototypes by using analytics to refine 3D printing settings, accelerating the product development cycle.
5	Better Resource Allocation	With analytics, manufacturers can assess the utilization of 3D printing resources, ensuring efficient allocation for maximum productivity.
Constraints:		
1	Data Privacy and Security	Integrating business analytics with 3D printing systems may introduce security risks if sensitive design or manufacturing data is involved.
2	Initial Investment	Implementing 3D printing and analytics technologies can involve substantial upfront equipment, software, and training costs.
3	Skill Gap	Utilizing both technologies effectively requires skilled personnel with 3D printing, data analytics, and integration expertise.
4	Data Overload	Integrating analytics with 3D printing can generate a vast amount of data, potentially overwhelming the system and making it challenging to extract valuable insights.
5	Complexity	Integrating two distinct technologies can introduce complexities in managing and maintaining the integrated system.
Disadvantages :		
1	Interoperability Issues	Ensuring compatibility and seamless communication between 3D printing and analytics platforms may be challenging, especially with diverse software solutions.
2	Scalability	As data and printing volumes grow, the integrated system must be scalable to handle increased demands.
3	Accuracy and Calibration	Precise calibration and accurate data input are critical for achieving optimal results in the integrated process, and errors could lead to faulty products.
4	Regulatory Compliance	Manufacturers must ensure that integrating analytics with 3D printing complies with industry regulations and standards.
5	Adoption and Change Management	Employees may require training and support to adapt to the integrated system, potentially leading to resistance or initial productivity dips.

Employees may require training and support to adapt to the integration. Before integrating business analytics technology with 3D printing in the manufacturing industry, organizations must carefully consider the advantages and benefits against the constraints and disadvantages. They should also focus on data security, scalability, and ensuring proper training and skill development to make the most of this integration and achieve business goals effectively.

10.7 ABCD of Integrating Business Analytics with Mobile Communication in Manufacturing Industry:

Integrating business analytics technology with mobile communication technology in the manufacturing industry can offer several advantages, benefits, constraints, and disadvantages. Table 44 depicts a comprehensive list.

Table 44: ABCD Analysis of Integration of BA with Mobile Communication:

S. No.	Aspects	Description
Advantages:		
1	Real-time Data Access	By integrating business analytics with mobile communication technology, manufacturing personnel can access critical data and insights in real-time, regardless of location, enabling faster decision-making.
2	Enhanced Collaboration	Mobile communication facilitates seamless communication and collaboration between different teams and departments, allowing for better coordination and problem-solving.
3	Remote Monitoring	Business analytics combined with mobile technology enables remote monitoring of manufacturing processes, equipment, and performance, improving efficiency and reducing the need for on-site presence.
4	Improved Productivity	Mobile access to analytics data empowers employees to stay informed and make informed decisions on the go, leading to increased productivity and agility.
5	Faster Issue Resolution	Mobile communication with analytics integration allows for swift identification and resolution of production issues and anomalies, minimizing downtime and disruptions.
Benefits:		
1	Supply Chain Visibility	Integrating analytics with mobile technology gives stakeholders real-time visibility into the supply chain, helping track shipments, inventory levels, and demand patterns.
2	Customer Insights	Mobile analytics can give manufacturing companies valuable insights into customer preferences, feedback, and buying behavior, facilitating better customer engagement and product development.
3	Asset Management	Mobile access to business analytics data aids in efficient asset management, helping track and maintain manufacturing equipment and infrastructure.
4	Data Visualization	Mobile communication technology allows for interactive and visually appealing data visualization, making it easier for users to grasp complex analytics insights.
5	Competitive Advantage	Manufacturers who effectively utilize analytics through mobile communication gain a competitive edge by responding quickly to market changes and customer demands.
Constraints:		
1	Data Security Risks	Integrating business analytics with mobile technology may expose sensitive manufacturing data to security risks, especially if not adequately protected.
2	Device Compatibility	Different mobile devices and platforms may require customizations to ensure smooth integration and consistent user experiences.
3	Bandwidth and Connectivity	Mobile analytics require reliable and high-speed internet connectivity to deliver real-time data, which can be a constraint in remote or low-bandwidth areas.
4	User Training	Employees may require training to effectively use mobile analytics tools and interpret data on mobile devices.
5	Privacy Concerns	Using mobile devices for analytics access raises privacy concerns, mainly if personal or sensitive data is accessed through these devices.

Disadvantages :		
1	Screen Size Limitations	Mobile devices have smaller screens than desktops, which can limit the amount of data displayed at once and potentially reduce data comprehensibility.
2	Data Consumption	Real-time access to analytics on mobile devices can lead to increased data consumption, potentially resulting in higher mobile data costs.
3	Technical Support	Manufacturers must ensure adequate technical support for mobile analytics users to address any technical issues promptly.
4	Integration Complexity	Integrating analytics with mobile communication technology can be complex, requiring seamless integration between various systems and databases.
5	Resistance to Change	Some employees may resist using mobile devices for analytics, preferring traditional desktop setups.

Manufacturers should carefully evaluate the advantages and benefits against the constraints and disadvantages to determine the feasibility and effectiveness of integrating business analytics technology with mobile communication technology. Addressing security, connectivity, and user training issues will be crucial to successful implementation and maximizing the benefits of this integration.

10.8 ABCD of Integrating Business Analytics with Information Storage Technology in Manufacturing Industry:

Integrating business analytics technology with information storage technology in the manufacturing industry can offer several advantages, benefits, constraints, and disadvantages. Table 45 depicts a comprehensive list:

Table 45: ABCD Analysis of Integration of BA with Information Storage Technology:

S. No.	Aspects	Description
Advantages:		
1	Data Centralization	Integrating business analytics with information storage technology allows manufacturers to centralize and organize their data, making accessing and analyzing critical information from various sources easier.
2	Enhanced Data Analysis	With centralized data storage, manufacturers can perform in-depth data analysis and gain valuable insights into production processes, supply chains, customer behavior, and other critical aspects of their operations.
3	Real-time Reporting	The integration enables real-time reporting and data visualization, empowering decision-makers to monitor performance and make informed decisions promptly.
4	Predictive Analytics	By combining business analytics with historical data stored in the information storage system, manufacturers can employ predictive analytics to forecast demand, optimize production schedules, and plan inventory levels more effectively.
5	Improved Efficiency and Productivity	Access to timely and relevant data through integrated analytics and information storage technology enables process optimization, increasing efficiency and productivity.
Benefits:		
1	Data-Driven Decision Making	The integration empowers manufacturing leaders to make data-driven decisions based on accurate and up-to-date information, reducing guesswork and enhancing overall decision-making processes.
2	Quality Control and Compliance	Manufacturers can use integrated analytics to monitor product quality, identify defects, and ensure compliance with industry standards and regulations.

3	Supply Chain Optimization	The combination of analytics and information storage technology allows manufacturers to optimize their supply chain by tracking inventory levels, monitoring supplier performance, and improving logistics.
4	Cost Reduction	Data-driven insights from the integrated system can help identify cost-saving opportunities, such as streamlining operations, reducing waste, and optimizing resource allocation.
5	Competitive Advantage	Companies that effectively integrate business analytics with information storage technology can gain a competitive edge by being more agile, responsive, and efficient in their manufacturing processes.
Constraints:		
1	Data Security Risks	Integrating business analytics with information storage technology may introduce security risks as sensitive manufacturing data becomes accessible from a centralized location.
2	Data Privacy Concerns	Manufacturers must address data privacy concerns and ensure compliance with relevant data protection regulations when centralizing and analyzing sensitive information.
3	Technical Compatibility	Integrating different information storage systems with analytics platforms may require technical adjustments to ensure compatibility and smooth data flow.
4	Initial Investment	Implementing the integrated system may involve significant upfront software, hardware, and training costs.
5	Data Volume and Processing	Large volumes of data stored in the information storage system can pose challenges in data processing and analytics, requiring robust infrastructure.
Disadvantages :		
1	Skill Gap	Utilizing the integrated system effectively requires skilled personnel with business analytics and information storage technologies expertise.
2	Data Integration Challenges	Integrating data from diverse sources can be complex and time-consuming, requiring careful data mapping and integration strategies.
3	Data Redundancy	Data duplication across different storage systems can lead to redundancy and increased storage costs.
4	Scalability	As data and manufacturing processes grow, the integrated system must be scalable to accommodate increased demands.
5	Resistance to Change	Employees may require training and support to adapt to the integrated system, potentially leading to resistance or initial productivity dips.

Manufacturers must carefully assess the advantages and benefits against the constraints and disadvantages when integrating business analytics technology with information storage technology. Addressing data security, privacy concerns, technical compatibility, and employee training will be critical to successful implementation and achieving the desired outcomes.

10.9 ABCD of Integrating Business Analytics with Ubiquitous Education Technology in Manufacturing Industry:

Integrating business analytics technology with ubiquitous education technology in the manufacturing industry can offer various advantages, benefits, constraints, and disadvantages. Table 46 depicts a comprehensive list.

Table 46: ABCD Analysis of Integration of BA with Ubiquitous Education Technology:

S. No.	Aspects	Description
Advantages:		
1	Enhanced Workforce Training	Ubiquitous education technology enables manufacturers to provide continuous and personalized training to their workforce, improving their skills and knowledge.

2	Data-Driven Skill Development	By integrating business analytics, manufacturers can analyze employee training data to identify skill gaps and tailor training programs accordingly.
3	Improved Onboarding	Ubiquitous education technology combined with analytics can streamline the onboarding process, ensuring new hires receive the necessary training and resources to become productive quickly.
4	Enhanced Safety Training	With integrated technology, manufacturers can deliver real-time safety training, reducing workplace accidents and improving overall safety measures.
5	Performance Monitoring	Business analytics can track employee progress and performance in training programs, enabling management to assess the effectiveness of educational initiatives.
Benefits:		
1	Continuous Learning Culture	Integrating education technology with analytics promotes a culture of continuous learning, encouraging employees to stay updated with the latest industry trends and technologies.
2	Reduced Training Costs	Ubiquitous education technology can offer cost-effective training solutions, and analytics help optimize training investments by focusing on areas that yield the most significant impact.
3	Employee Engagement	Interactive education technology can enhance employee engagement and motivation, increasing retention rates and job satisfaction.
4	Knowledge Retention	The integration allows for the assessment of knowledge retention, enabling manufacturers to reinforce learning where necessary and ensure long-term knowledge retention.
5	Improved Decision-Making	With a well-trained and knowledgeable workforce, manufacturers can make better-informed decisions, leading to improved operational efficiency and competitiveness.
Constraints:		
1	Initial Investment	Implementing and integrating education technology with business analytics can involve significant upfront software, hardware, and training costs.
2	Technical Compatibility	Ensuring seamless integration between education technology platforms and analytics systems may require technical adjustments and customizations.
3	Data Privacy and Security	Integrating education technology with analytics may raise data privacy concerns, especially involving employee training records and performance data.
4	Skill Gap	Manufacturers need skilled personnel who can effectively utilize education technology and analytics to maximize the benefits of integration.
5	Content Quality	The effectiveness of education technology relies on the quality of content and training materials. Ensuring high-quality and relevant content can be challenging.
Disadvantages :		
1	User Adoption	Employees may need training and support to adapt to the integrated system, and some may resist using new technologies for training purposes.
2	Overwhelming Information	Ubiquitous education technology may provide abundant training resources, potentially overwhelming employees and reducing training effectiveness.
3	Reliability and Downtime	Technical issues or connectivity problems with education technology can disrupt training programs and affect employee productivity.
4	Content Customization	Tailoring training content to meet specific manufacturing industry needs may require additional effort and resources.

5	Tracking and Assessment	Measuring the direct impact of education technology and analytics integration on employee performance can be challenging, requiring comprehensive tracking and assessment mechanisms.

Manufacturers must carefully assess the advantages and benefits against the constraints and disadvantages when integrating business analytics technology with ubiquitous education technology. Addressing data privacy, content quality, user adoption, and technical compatibility will be crucial to successful implementation and achieving the desired outcomes in workforce development and productivity.

10.10 ABCD of Integrating Business Analytics with Virtual and Augmented Reality Technology in Manufacturing Industry:

Integrating business analytics technology with virtual and augmented reality technology in the manufacturing industry can offer several advantages, benefits, constraints, and disadvantages. Table 47 depicts a comprehensive list.

Table 47: ABCD Analysis of Integration of BA with Virtual and Augmented Reality Technology:

S. No.	Aspects	Description
Advantages:		
1	Enhanced Data Visualization	Business analytics combined with virtual and augmented reality allows manufacturers to visualize complex data and analytics insights more immersive and interactively, making it easier to comprehend and analyze trends and patterns.
2	Real-time Monitoring	Virtual and augmented reality technology enables real-time monitoring of manufacturing processes, and by integrating analytics, manufacturers can gain immediate insights into performance metrics and identify potential issues as they occur.
3	Remote Collaboration	Integrating analytics with virtual and augmented reality facilitates remote collaboration, allowing teams from different locations to work together, conduct virtual meetings, and analyze data collectively.
4	Improved Training and Simulation	Manufacturers can use virtual and augmented reality for training employees on complex tasks and scenarios. Integrating analytics helps assess employee performance during training and identify areas for improvement.
5	Predictive Maintenance	By combining business analytics with virtual and augmented reality, manufacturers can predict equipment maintenance needs more accurately, reducing downtime and optimizing maintenance schedules.
Benefits:		
1	Design Visualization and Prototyping	Virtual and augmented reality technology enables manufacturers to visualize product designs and prototypes in a realistic 3D environment. Integrating analytics helps refine designs based on user feedback and performance data.
2	Quality Control	Virtual and augmented reality can be used for quality control inspections. Integrating analytics allows manufacturers to analyze inspection data and identify defects more effectively.
3	Safety Enhancement	Integrating analytics with virtual and augmented reality can improve safety training and provide real-time safety information to workers, reducing workplace accidents.
4	Enhanced Customer Engagement	Manufacturers can use virtual and augmented reality to showcase products to customers. By integrating analytics, they can gather customer feedback and preferences for product improvement.
5	Competitive Advantage	Companies that effectively integrate business analytics with virtual and augmented reality gain a competitive edge by leveraging data-driven insights and innovative visualization techniques.

Constraints:		
1	Technical Complexity	Integrating multiple technologies, including virtual and augmented reality business analytics, can be technically challenging and require specialized expertise.
2	Initial Investment	Implementing and integrating these technologies can involve high upfront hardware, software, and employee training costs.
3	Data Security and Privacy	Integrating business analytics with virtual and augmented reality may expose sensitive manufacturing and customer data to security risks if not adequately protected.
4	Device Compatibility	Different virtual and augmented reality devices may require customizations to ensure compatibility with the analytics platform.
5	Skill Gap	Utilizing analytics and virtual/augmented reality technologies effectively requires skilled personnel with expertise in these areas.
Disadvantages :		
1	User Adoption	Employees may require training and support to adapt to using virtual and augmented reality technologies for analytics purposes.
2	Data Overload	Integrating analytics with virtual and augmented reality can generate vast amounts of data, potentially overwhelming the system and making it challenging to extract valuable insights.
3	Content Quality	The effectiveness of virtual and augmented reality experiences relies on the quality of content and data visualization.
4	Regulation and Compliance	Integrating these technologies may raise regulatory and compliance concerns related to data usage and privacy.
5	Maintenance and Support	Ensuring the reliable and smooth operation of integrated virtual and augmented reality systems may require ongoing maintenance and technical support.

Manufacturers must carefully assess the advantages and benefits against the constraints and disadvantages when integrating business analytics technology with virtual and augmented reality technology. Addressing data security, technical complexity, user adoption, and content quality will be crucial to successful implementation and maximizing the potential benefits in the manufacturing industry.

10.11 ABCD of Integrating Business Analytics with Quantum Computing Technology in Manufacturing Industry:

Integrating business analytics with quantum computing technology in the manufacturing industry can offer various advantages, benefits, constraints, and disadvantages. Table 48 depicts a comprehensive list.

Table 48: ABCD Analysis of Integration of BA with Quantum Computing Technology:

S. No.	Aspects	Description
Advantages:		
1	Faster Data Processing	Quantum computing can handle complex calculations and data processing significantly faster than traditional computing, allowing manufacturers to analyze vast amounts of data in real time.
2	Advanced Data Analysis	Quantum computing enables more sophisticated and in-depth data analysis, uncovering patterns and insights that might be difficult or impossible to identify using classical computing methods.
3	Optimized Supply Chain	Integrating business analytics with quantum computing allows manufacturers to optimize their supply chain by simultaneously considering multiple variables and constraints, leading to more efficient inventory management and logistics.

4	Improved Predictive Analytics	Quantum computing can enhance predictive analytics models, allowing manufacturers to forecast demand, maintenance needs, and quality control more accurately.
5	Enhanced Optimization	Quantum computing's ability to handle complex optimization problems can help manufacturers optimize production schedules, resource allocation, and process efficiency.
Benefits:		
1	Accelerated Research and Development	Quantum computing can speed up research and development processes, enabling manufacturers to explore innovative materials, designs, and manufacturing techniques rapidly.
2	Improved Machine Learning	Quantum computing can enhance machine learning algorithms, leading to better predictive models and decision-making systems.
3	Energy Efficiency	Quantum computing can reduce energy consumption in computing processes, contributing to overall sustainability in manufacturing operations.
4	Competitive Advantage	Manufacturers that adopt quantum computing technology for business analytics gain a competitive edge by leveraging advanced data analysis capabilities to make more informed and strategic decisions.
5	Drug Discovery and Material Design	Quantum computing can accelerate drug discovery and material design processes, allowing manufacturers to develop new products with enhanced properties and functionalities.
Constraints:		
1	Limited Availability	Quantum computing technology is still in its early stages, and commercially available quantum computers are currently limited in capacity and accessibility.
2	Cost	Quantum computing technology is expensive to develop and implement, and its current cost may be prohibitive for some manufacturers.
3	Skill Gap	Quantum computing requires specialized expertise, and there is a need for more professionals with the necessary knowledge to operate and utilize quantum computing in manufacturing.
4	Hardware Complexity	Quantum computing hardware is intricate and sensitive to external influences, requiring specialized maintenance and environment control.
5	Quantum Error Correction	Quantum computers are susceptible to errors due to quantum decoherence, requiring sophisticated error-correction techniques to maintain accuracy.
Disadvantages :		
1	Data Integration	Integrating business analytics with quantum computing may require data storage and processing methods adjustments, given the differences in computing paradigms.
2	Quantum Algorithms	Developing quantum algorithms for specific manufacturing tasks can be challenging and may require extensive research and testing.
3	Scalability	Scaling quantum computing systems to handle larger datasets and more complex manufacturing problems remains a significant challenge.
4	Security Concerns	Quantum computing poses security risks, as it can break existing cryptographic protocols, requiring manufacturers to adopt quantum-resistant encryption methods.
5	Regulatory Compliance	Integrating quantum computing into manufacturing may raise regulatory and compliance concerns about data handling and security.

Manufacturers must carefully assess the advantages and benefits against the constraints and disadvantages when considering integrating business analytics technology with quantum computing technology. While quantum computing holds promise for advanced data analysis, its limitations and complexities must be considered for successful implementation in the manufacturing industry.

11. IMPLEMENTATION, AND IMPACT OF TECH -BUSINESS ANALYTICS ON PRODUCTIVITY OF SECONDARY INDUSTRY SECTOR :

11.1 Implementation:

Secondary industrial enterprises can considerably boost their efficiency by utilizing tech-driven business analytics. Table 49 contains some examples of how:

Table 49: Implementation of TBA on productivity of secondary industry sector

S. No.	Key Aspects	Description on Implementation
1.	Process optimisation in manufacturing	Tech-driven business analytics can help businesses optimize their production processes by finding opportunities to reduce waste, reorganize workflows, and increase efficiency. Businesses can increase productivity by employing data analysis to assess the efficiency with which resources are being used, the performance of the machines, and the volume of output being generated.
2.	Using technology to generate business analytics	By providing them with real-time access to data on inventory levels, shipping schedules, and demand estimates, businesses can help them streamline their supply chains. By examining this data, businesses can make their supply chains more effective by ensuring that the right products are accessible at the right time, reducing delays, and boosting productivity.
3.	TBA can help organisations cut downtime.	TBA can help by anticipating potential issues. By studying data about the performance of their equipment, businesses can identify failure trends and set up preventative maintenance programs to reduce the chance of unplanned downtime.
4.	Real-time observation	Businesses can monitor essential performance measures in real-time thanks to tech-driven business analytics, which enables them to identify and fix issues that might be stifling production quickly. Utilizing dashboards and data visualization tools, businesses can keep tabs on factors such as manufacturing output, equipment utilization, and inventory levels. This allows them to make informed decisions in real time.
5.	Commercial predictive analytics	Predictive analytics, which enables businesses to anticipate future trends and issues before they materialize, can also be provided via tech-driven business analytics for businesses. Market trends, consumer behavior, and production output data can be analyzed to help businesses make decisions that will position them for long-term success.

The efficiency of companies in the secondary industrial sector can be significantly increased by employing tech-driven business analytics. Businesses may boost output and profits by leveraging data to streamline processes, cut downtime, and make wise decisions.

11.2 Impact:

Business analytics powered by technology may significantly impact the secondary industry sector's productivity. Using tech-driven business analytics, the following techniques (Table 50) can help one to work for more productively:

Table 50: Impact of TBA on productivity of secondary industry sector

S. No.	Key Aspects	Description on Impact
1.	Using data to inform decisions	Businesses now have access to real-time data and insights through technology-enabled business analytics. Processes will be

		streamlined, output effectiveness will be improved, and problem areas will be identified using this data.
2.	Improved efficiency Businesses	Using tech-driven business analytics can identify inefficiencies in processes and operations. Analyzing data to identify bottlenecks, areas of waste reduction, and process simplification opportunities can help businesses increase efficiency.
3.	Preventing future problems	Utilizing technology-driven business analytics to anticipate when machinery or equipment may need maintenance, businesses may lower the chance of unplanned downtime. Businesses can foresee problems before they arise and take preventative action by analyzing equipment performance data.
4.	TBA can help businesses optimise their inventories.	Businesses can optimize their inventory using technology-driven business analytics so that the correct products are always available at the right time. Businesses can alter their inventory levels to avoid stockouts and reduce waste by accessing data on customer demand and production output.
5.	TBA can assist businesses with supply chain optimisation.	Technology-driven business analytics can help companies optimize their supply chains to have the assets and raw materials needed to generate their goods. Businesses may boost efficiency and eliminate supply chain bottlenecks by obtaining data on shipment schedules, inventory levels, and demand projections.

Hence, tech-driven business analytics can significantly affect the secondary industry's sector productivity. Businesses may increase productivity and profitability by using data to streamline processes, reduce waste, and make informed decisions.

12. SUGGESTIONS ON HOW TO USE TBA IN PRODUCTION INDUSTRY :

Efficiency, productivity, and decision-making may increase significantly in the production industry using technology and business analytics. Here are some suggestions for utilizing digital business analytics in the manufacturing sector:

(1) Establish a reliable method for gathering data to capture pertinent information during production. Data on equipment efficiency, stock levels, production rates, quality indicators, and other information may be included. Create an extensive library by combining data from numerous sources, including sensors, machinery, and ERP systems.

(2) Use cutting-edge analytics methods to monitor the production process continuously. This can assist in locating possible bottlenecks, equipment problems, or quality problems before they become more serious. Demand forecasting, manufacturing schedule optimization, and predicting maintenance needs are further predictive analytics applications.

(3) To find areas for improvement and compare key performance indicators (KPIs) between various manufacturing lines, shifts, or facilities. Use analytics to set performance goals, monitor development, and draw attention to outliers. This supports efforts for continual improvement and data-driven decision-making.

(4) Analytics should examine high-quality data and find trends or anomalies that might point to errors or poor quality. This may entail employing machine learning strategies to find relationships between process variables and quality outcomes, enabling proactive quality management measures.

(5) The supply chain, comprising procurement, inventory control, and logistics, can be made more efficient using business analytics. Demand forecasting, inventory optimization, and supplier relationships can all be streamlined by using predictive models. In addition to lowering lead times and reducing stockouts, this can boost the effectiveness of the entire supply chain.

(6) Utilise analytics to monitor and improve the production process's use of resources, waste management, and energy. Determine opportunities for energy savings, examine usage trends, and put plans in place to lessen waste and increase sustainability.

(7) Create interactive reporting tools and dashboards that offer in-the-moment insights into performance trends and KPIs. Enable managers and operators to immediately spot areas that need attention or areas where improvements may be made by presenting data user-friendly.

(8) Optimise maintenance schedules using predictive analytics to find needed maintenance. It can proactively schedule maintenance activities, minimize downtime, and increase the lifespan of crucial assets by analyzing equipment data and seeing early warning signals of future breakdowns.
(9) Analytics should support continuous improvement programs and decision-making processes. Perform a root cause analysis to pinpoint inefficient processes and produce insights that may be put to use for process improvement and cost-cutting.
(10) Optimise workforce planning, resource allocation, and skill development in the production sector using analytics. Analyse employee performance, training needs, and skill gaps to find chances for skill upgrading or retraining. This could increase staff effectiveness overall, increase productivity, and decrease turnover.
As a result, adopting tech business analytics in the manufacturing industry necessitates a multidisciplinary strategy involving data gathering, analytics skills, IT infrastructure, and change management. To guarantee maximum value and effect, it's critical to coordinate technological projects with specific business goals. You should also regularly evaluate and fine-tune your analytics strategy.

13. CONCLUSION :

Therefore, applying TBA may result in considerable gains in productivity for businesses in the secondary industrial sector. Businesses may increase efficiency, reduce procedures, and make lucrative decisions by leveraging the power of data. TBA offers businesses real-time data and insights that can help them identify inefficiencies in their operations and procedures, anticipate maintenance needs, increase inventory levels, and improve supply chain management. The result is a rise in output, a decline in downtime, and a competitive edge for the company. But before using tech-driven business analytics, it's essential to carefully assess potential limitations and drawbacks, including the need for qualified people, worries about data privacy and security, and the cost of setting up and maintaining such systems. As a result, businesses in the secondary industrial sector can significantly benefit from using tech-driven business analytics. However, weighing the benefits and drawbacks carefully is crucial and ensuring that the technology maximizes the benefits while minimizing potential drawbacks.

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Revolutionizing Agriculture: A Case Study of IBM's AI Innovations

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Subject Area: Information Technology.
Type of the Paper: Research Case Study.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10070895
Google Scholar Citation: IJAEML

How to Cite this Paper:
Swathi Kumari, H., & Veeramanju, K. T. (2023). Revolutionizing Agriculture: A Case Study of IBM's AI Innovations. *International Journal of Applied Engineering and Management Letters (IJAEML), 7*(4), 95-114. DOI: https://doi.org/10.5281/zenodo.10070895

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0195

Received on: 25/08/2023
Published on: 04/11/2023

Revolutionizing Agriculture: A Case Study of IBM's AI Innovations

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ABSTRACT

Background / Purpose: *The development of computer systems that can carry out tasks that traditionally require human intelligence is referred to as artificial intelligence (AI). It entails the development of intelligent machines that can reason, learn, solve issues, and make judgements. A fast-developing topic, AI has enormous ramifications for many different businesses and facets of society. By leveraging advanced algorithms and data analysis techniques, AI systems can process and interpret large amounts of information in real-time, enabling them to extract valuable insights and patterns that may be difficult for humans to perceive.AI technologies have a wide range of applications across multiple domains, including healthcare, finance, transportation, manufacturing, education, entertainment, including agriculture. When referring to AI in the context of agriculture, we mean the use of advanced analytics and computational algorithms to analyse massive volumes of agricultural data, anticipate the future, and give farmers and stakeholders useful information. The main goal of using AI to agriculture is to increase efficiency, sustainability, and productivity across a range of farming operations, also to create smart and efficient systems that can monitor, analyze, and control water resources in real-time, leading to improved water management and sustainable agricultural practices, thereby addressing the challenges faced by the agricultural sector.AI offers significant potential to optimize water usage, enhance crop productivity, and mitigate environmental impact. In this paper, IBM, a significant provider of services in the sector of agriculture in recent years, is examined.*

Objective: *In this case study, artificial intelligence is the main topic with particular emphasis on IBM's agricultural technology.*

Design/Methodology/Approach: *Academic works published in a variety of peer-reviewed journals, conferences, and business websites provided the necessary information and specifics for this case study on IBM.*

Findings/Result: *This study is primarily concerned with the usefulness and significance of AI in the modern world. The demand for and necessity of the numerous resources provided by IBM, discussion topics include the company's business plan, varied results, top clientele, and numerous service types.*

Originality/Value: *The analysis gives a concise description of IBM, the types of data collected and managed, information on artificial intelligence (AI), and the numerous AI services offered by IBM.*

Paper Type: *Case study on the importance of storage and computing requirements for AI services offered by different service providers, with a focus on IBM.*

Keywords: Artificial Intelligence, Internet of Things, Machine Learning, Expert Systems, Agriculture, Irrigation, IBM.

1. INTRODUCTION :

The foundation of AI can be traced back to the work of mathematician and logician Alan Turing, who proposed the concept of a "universal machine" capable of mimicking any other machine.
In 1950, Turing published the influential paper "Computing Machinery and Intelligence," which introduced the idea of the Turing Test to determine a machine's ability to exhibit intelligent behaviour. The Dartmouth Conference, held in the summer of 1956, is considered the birth of AI as a formal discipline. It brought together researchers from various fields to discuss the possibility of creating artificial intelligence (Haenlein, M. et.al. (2019). [1]).
Early AI researchers focused on symbolic or "good old-fashioned AI" (GOFAI) approaches, aiming to develop systems that could reason and manipulate symbolic representations of knowledge. In 1956, John McCarthy coined the term "artificial intelligence" and proposed the development of a program called the Logic Theorist, which aimed to prove mathematical theorems. In the 1960s, researchers like Allen Newell and Herbert Simon developed the General Problem Solver (GPS), a program that could solve a wide range of problems using heuristics. The 1970s saw the rise of expert systems, which used knowledge and rules to solve complex problems in specific domains.
In 1974, the MYCIN system, developed at Stanford University, demonstrated the potential of expert systems in diagnosing bacterial infections. During this period, AI research faced significant setbacks and funding cuts due to unfulfilled promises and unrealistic expectations. In the 1980s, research shifted towards knowledge-based systems that represented and manipulated explicit knowledge about the world.
Machine learning techniques gained prominence, allowing systems to learn from data and improve their performance over time. Expert systems (Liao, S. H. (2005). [2]) were commercialized and applied in various industries, such as finance and healthcare.
In 1986, Geoffrey Hinton and colleagues developed the back propagation algorithm, a key advancement in training neural networks. The late 1980s and early 1990s witnessed an "AI winter" characterized by waning interest and funding in AI research.
However, AI experienced a resurgence in the late 1990s, driven by advancements in computing power, availability of large datasets, and breakthroughs in machine learning techniques. In 1997, IBM's Deep Blue defeated world chess champion Garry Kasparov, showcasing the potential of AI in complex tasks. The mid-2000s marked a significant shift towards deep learning, a subfield of machine learning that employs neural networks with multiple layers.
Deep learning models, such as convolution neural networks (CNNs) (Nielsen, M. A. (2015). [3]) and recurrent neural networks (RNNs), achieved groundbreaking results in areas like image recognition and natural language processing.AI applications have become increasingly prevalent in various domains, including autonomous vehicles, virtual assistants, healthcare, finance, and more. Recent advancements in AI have also raised ethical concerns regarding bias, privacy, and the impact of automation on jobs.
Artificial Intelligence (AI) has emerged as a powerful tool in agriculture (Eli-Chukwu, N. C. (2019). [4]), revolutionizing various aspects of the industry. It offers numerous benefits and has the potential to address key challenges faced by farmers, increase productivity, and promote sustainable practices. Agriculture has always been a data-intensive industry, relying on various factors such as weather patterns, soil conditions, crop diseases, and market demands. Traditionally, farmers have relied on their experience and intuition to make decisions. However, with the advent of AI technologies (Allen, G. (2020). [5]), farmers can now leverage large volumes of data to make informed and optimized decisions.
Precision farming techniques, which use sensors, drones, and satellite photography to gather information about the health of crops, moisture in the soil levels, and nutrient content, are made possible by AI. This data is then analyzed using AI algorithms to provide farmers with precise recommendations on irrigation, fertilization, and pesticide usage, leading to optimized resource allocation and increased yields.

2. RELATED WORKS :

The following table Table-1 lists literature reviews for the scholarly publications that are currently available.

Table 1: An analysis of literature on Artificial Intelligence and Machine Learning.

S. No.	Research Field	Focal Point	Result	Reference
1	Artificial intelligence and the legal profession	The methods businesses use to recruit using AI	Organisations can save money and time by having better access and accuracy throughout the whole hiring process.	Ben-Ari, D. et al. (2016). [6]
2	Machine learning methods and their use in the manufacturing industry.	Analyses uses where various machine learning techniques have been successfully used and rates them.	Obtain interpretable ensemble classifiers.	Pham, D. T. et al. (2005). [7]
3.	A review of the literature on artificial intelligence in agriculture.	Presents a comprehensive assessment of the literature on the application of artificial intelligence techniques in agriculture.	AI enables real-time, more automated, and more accurate systems.	Bannerjee, G. et al. (2018). [8]
4.	IoT, big data, and AI in the food and agricultural industries.	A description of the Internet of Things (IoT), big data, and artificial intelligence (AI), as well as how they are reshaping the way agri-food systems are created.	The benefits of blockchain technology with next-generation genome sequencing for food safety and traceability in the event of pathogen outbreaks	Misra, N. N. et al. (2020). [9]
5.	Model for recommending agriculture using AI and sensors to determine the suitability of the land.	Combines artificial intelligence and sensor networks to suggest an expert system. such as multi-layer perceptron (MLP) and neural networks for assessing the suitability of agricultural land	Using MLP with four hidden layers to manage the information obtained from numerous sensors has ensured greater efficiency.	Vincent, D. R. et al. (2019). [10]
6.	Agriculture and artificial intelligence: a new area of study.	It offers a glimpse of how artificial intelligence (AI) might support agriculture's many sectors.	The farmers are able to increase their average production per hectare and have better control over food grain prices, guaranteeing that they continue to make a profit.	Khandelwal, P. M. et.al. (2019). [11]

3. RESEARCH AGENDA :

(1) What is the importance of AI Concepts?
(2) How can artificial intelligence and machine learning be used to manage irrigation requirements in agriculture?
(3) What are the various algorithms employed in different irrigation techniques?

4. STUDY OBJECTIVES :

(1) To research and comprehend the idea of AI.
(2) To assess the value of the AI concept and the various AI methods applied in the agricultural sector.

(3) To evaluate the function and significance of AI services in managing client needs.
(4) To present an overview of IBM Enterprises (P) Limited.
(5) To conduct a SWOC analysis of IBM Enterprises (P) Limited.

5. METHODOLOGY :

The study's foundation is data that came from numerous sources. Common reference book on AI concepts, a wide range of articles and websites, and literature evaluations on AI and AI services are all included in the contents.

5.1 Database searches:

Google Scholar, IEEE Explore, and Research Gate are a few of the online and World Wide Web services that are archives of several conference publications and peer-reviewed journals that are widely utilised to obtain information.

6. AI CONCEPTS :

The study of artificial intelligence is concerned with developing computer programmes that can do mental tasks that previously could only be performed by people. In recent years, AI has developed swiftly, altering people's lifestyles. The advancement of AI has turned out to be a critical development strategy for countries all over the world in order to maintain security and increase national competitiveness. Preferential policies have been widely implemented, and critical deployment has been accelerated (Zhang, C. et al. (2021). [12]).

Based on the relatively mature development of technical conditions, such as data, algorithms, and processing capabilities, AI has begun to successfully solve problems and provide economic benefits. Financial services, healthcare, the automotive industry (Longo, L. et. al. (2020). [13]), and retail are a few examples of industries with a substantial data base and somewhat advanced AI application scenarios.

According to Luger and Stubblefield, artificial intelligence is "the branch of computer science that is concerned with the automation of intelligent behaviour" (Geetha, R. (2018). [14]). The intelligent agent method is believed to be involved. The concept of Artificial Intelligence Systems (Geetha, R. (2018). [14]) represented in Fig.1. A system that perceives and takes action is an agent. In terms of resolving genuine issues, it actually matters. As a result, behaviour is prioritised, and behaviour may be tested scientifically more than thought. More generally, try employing an intelligent machine to tackle difficult problems rather than trying to use the human brain to do it.

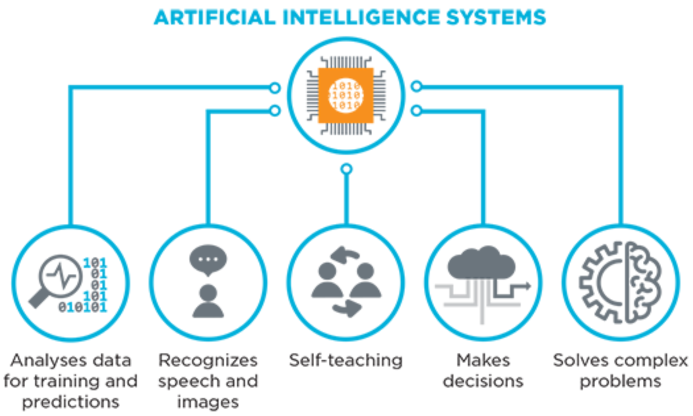

Fig.1: Artificial Intelligence System [14]

Artificial intelligence (AI) has two subfields: machine learning and deep learning (Janiesch, C. et.al. (2021). [15]), which teach computers to learn from data and make deft predictions or judgements.

The creation of algorithms and models that can recognise patterns and correlations in data without explicit programming is the focus of the AI subfield of machine learning. It makes use of statistical approaches to provide computers the ability to autonomously learn from experience. Deep learning is a branch of machine learning that focuses on deep neural networks, which are neural networks with

several layers. By creating intricate computational models known as artificial neural networks (ANNs), deep learning algorithms seek to replicate the composition and operation of the human brain. Each neuron in these networks consists of interconnected nodes (neurons) that are arranged in layers and performs a straightforward computation.
A model is created using machine learning, an area of artificial intelligence that focuses on prediction based on known attributes obtained from training data, to learn the trends. A technology that focuses on understanding the representations and features of the data is deep learning (Salehi, H. et.al. (2018). [16]), a subset of machine learning. The many intelligent strategies mentioned above are schematically shown in Fig 2.

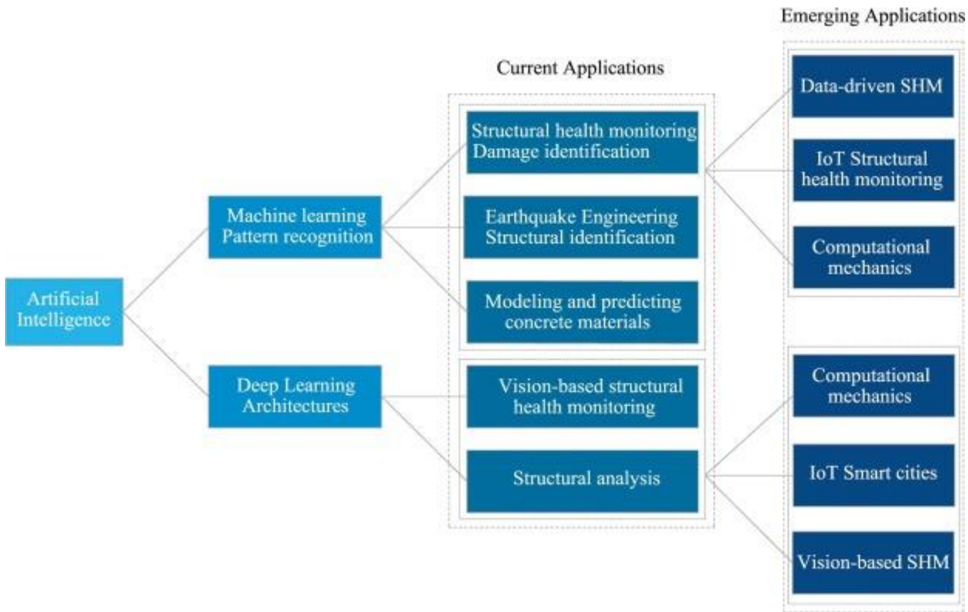

Fig. 2: Branches of Artificial Intelligence [17]

By enabling computers to learn from data and make wise decisions, machine learning and deep learning are potent techniques that have revolutionised numerous professions. They are widely used and keep becoming better as academics create new algorithms, designs, and methods to address ever-more complicated issues.

7. AI IN AGRICULTURE :

Agriculture is the foundation of any sustainable economy (Eli-Chukwu, N. C. (2019). [18]). According to it makes a major contribution to structural transformation and long-term economic growth (Ryan, M. et al. (2023), [19]). Growing crops and producing food were the only concerns of agriculture in the past. But during the last 20 years, it has evolved to encompass the processing, production, marketing, and distribution of agricultural and livestock goods. Given the exponential increase in world population, it is critical that agricultural practises be examined in order to offer creative ways for preserving and enhancing agricultural activity.

Applying AI to agriculture will be made possible by other technological developments, including big data analytics, robotics (Garcia, E. et al. (2007). [20]), the internet of things, the availability of inexpensive sensors and cameras, drone technology, and even widespread internet connectivity on geographically separated fields. AI systems will be able to forecast which crop to plant in a certain year and when the best dates to sow and harvest are in a particular location by looking at soil management data sources such as temperature, weather, soil analysis, moisture, and previous crop performance. Crop yields will increase as a result, and less water, fertiliser, and pesticide will be used.

8. AI IN IRRIGATION :

Artificial intelligence (AI) in irrigation refers to the use of artificial intelligence methods and tools for enhancing and automating irrigation systems. It entails utilising sensors, data analysis, and machine learning algorithms to enhance agricultural water management procedures. The techniques of

Artificial intelligence is utilised in irrigation to enhance water management in agriculture. In the field, sensors are set up to track vital metrics like soil moisture, temperature, humidity, and meteorological conditions. Continuous data is gathered by these sensors and sent for analysis to a centralised system.

Irrigation is the farming method that requires the most labour (Dharmaraj, V. et al. (2018). [21]). Automation of irrigation can increase productivity. This is made possible by AI-trained equipment that are educated about historical weather patterns, the state of the soil, and the kind of crops that should be grown. Around 70% of the fresh water supply in the world is used for irrigation; automation can assist farmers manage their water issues while also saving water.

Information about soil moisture levels, plant water content, atmospheric humidity, temperature, etc. must be gathered in order to perform smart irrigation (Krishnan, S. R. et al. (2022). [22]).
AI in irrigation entails the fusion of numerous technologies to improve agricultural water management. Field sensors (Tumanski, S. (2013). [23]) are used to keep tabs on important variables like soil moisture, temperature, humidity, and meteorological conditions. These sensors continuously gather data, which is subsequently sent to a centralised system for evaluation.
In order to find patterns, correlations, and trends, the AI system uses machine learning algorithms to analyse the obtained data. The AI system may make predictions (El Bilali, A. et al. (2020). [24]) and produce useful insights by comprehending the correlations between various variables. For instance, based on the crop type, development stage, soil conditions, and weather forecasts, it can determine the best timing and amount of water needed for irrigation.
Sensors for measuring humidity, temperature, and soil moisture can all be used to collect this data. These sensors are linked to inexpensive Arduino-based devices (Ga, S. et al. (2021). [25]) to store the collected data and run analysis algorithms to forecast the crop's water needs at a specific moment.
In order to find patterns, correlations, and trends, the AI system analyses the gathered data using machine learning techniques. The AI system can forecast outcomes and produce actionable insights by comprehending the connections between various variables. For instance, it can calculate the ideal irrigation schedule and volume based on the crop type, growth stage, soil characteristics, and weather predictions (Hamill, T. M. et al. (2006). [26]).

The ability of AI in irrigation to adapt to and learn from its surroundings is one of its main benefits. Based on input from the field, the AI system can improve its models and algorithms over time. This makes it possible to continuously improve irrigation plans and techniques to fit the unique requirements of the crops, save water, and increase yields. Aside from providing real-time monitoring (Syu, W. J. et al. (2020). [27]) and control capabilities, AI-based irrigation systems do so. Through mobile applications or web interfaces, farmers can remotely use the system to keep an eye on the irrigation process, get notifications, and make any adjustments. This makes it easier and more flexible to manage irrigation operations, even from a distance.

9. THE GROWTH OF AI :

Artificial intelligence (AI) has grown at an unparalleled rate in recent years, revolutionising (Makridakis, S. (2017). [28]) a number of industries and playing a significant role in our daily lives. This tremendous expansion has been facilitated by a number of important elements. First off, the development of AI has been greatly aided by improvements in computer capacity and the accessibility of vast amounts of data. The creation of robust technology, such as GPUs and dedicated AI chips, has boosted the processing capacity of AI systems, allowing them to execute complicated tasks with astounding quickness and effectiveness. The growth of the internet and linked gadgets has also generated a volume of data, giving AI algorithms the knowledge, they need to operate more accurately and efficiently.
Recent developments in AI research (Schank, R. C. (1987). [29]) and the emergence of deep learning have been crucial to the field's expansion. Deep learning algorithms, which are modelled after the structure of the human brain, have proven to have outstanding aptitudes for comprehending patterns, processing unstructured data, and carrying out challenging tasks like speech synthesis, image identification, and natural language processing. These developments have made AI systems more

practical and adaptable for a variety of applications, allowing them to achieve previously unheard-of levels of accuracy and dependability.

The rise of AI has been significantly influenced by the rising attention and funding from the public and private sectors. Companies from a variety of industries have made significant investments in AI research, development, and deployment because they understand how it can improve decision-making (Jarrahi, M. H. (2018). [30]), expedite operations, and improve consumer experiences. The strategic value of AI for boosting economic growth and competitiveness is also acknowledged by governments, which has resulted in favourable legislation, funding for research projects, and partnerships between academics and industry. The growth and use of AI technologies have been further accelerated by this collaborative effort, which has set off a positive innovation cycle.

Recent developments in high power computational capability processors and with the accessibility of enormous amounts of data, scientific advances in AI, the introduction of deep learning, and greater attention from the public and corporate sectors are all factors that have contributed to AI's astounding growth. These elements work together to catapult AI to new heights and promise even more revolutionary uses in the future in industries like healthcare, finance, transportation, and more. To fully realise AI's potential for the good of society, it is crucial to address ethical questions, privacy problems, and assure responsible development. Artificial intelligence (AI) startup funding worldwide from 2011 to 2023 (in billion U.S. dollars), by quarter explained with the help of chart in the Fig.3.

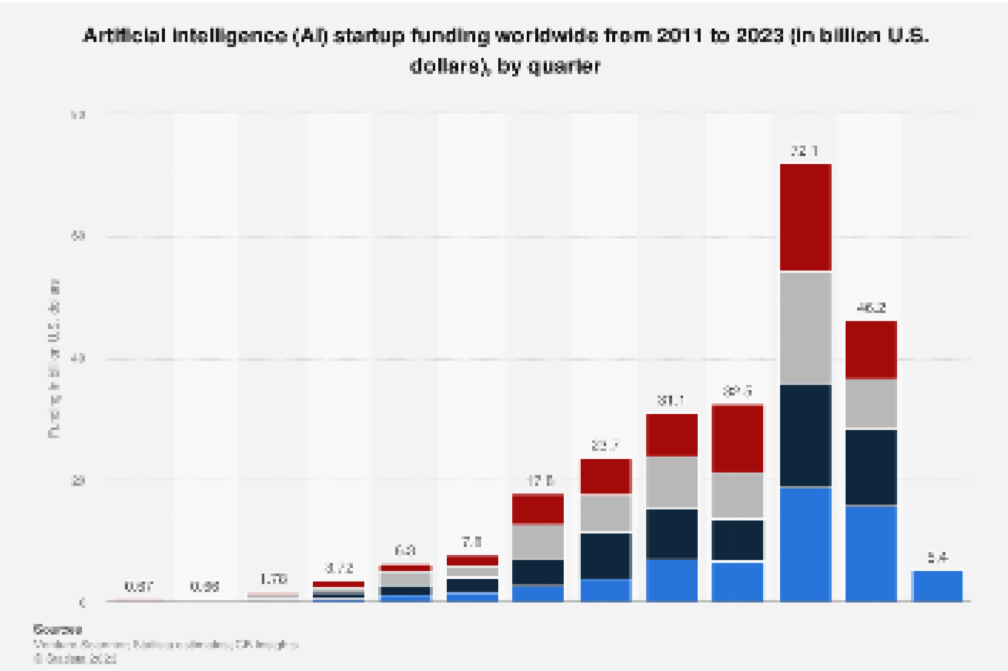

Fig. 3: AI funding worldwide 2011-2023, by quarter [31]

10. ALGORITHMS USED IN ARTIFICIAL INTELLIGENCE :

(1) Linear Regression: Linear regression (Poola, I. (2017). [32]) is a supervised learning approach used for predicting a continuous output variable based on one or more input features. It fits a linear relationship between the input and output variables to make predictions.

(2) Logistic Regression: Logistic regression (Poola, I. (2017). [32]) is a classification algorithm used for binary classification problems. It predicts the probability that an instance belongs to a certain class by fitting a logistic curve to the input data.

(3) Decision Trees: Decision trees (Hajjej, F. et al. (2022). [33]) are a non-linear, supervised learning algorithm used for both classification and regression tasks. They split the data into branches based on different features and create a tree-like model for making predictions.

(4) Random Forest: Multiple decision trees are combined in Random Forest, an ensemble learning technique, to increase accuracy and decrease overfitting. To reach a conclusion, it builds several trees and integrates their forecasts. (D. Rajkovi et al. (2023). [34]).

(5) Support Vector Machines (SVM): SVM is a potent supervised learning technique that is utilised for regression and classification tasks. In order to maximise the margin between the classes, it determines the optimal hyperplane for classifying the data (Mijwil, M. M. et al. (2021). [35]).
(6) k-Nearest Neighbours (KNN): According to (Mijwil, M. M. et al. (2021). [35]) KNN is a straightforward and understandable classification method that predicts the class of a data point based on the classes of its k nearest neighbours in the feature space.
(7) Naive Bayes: Based on Bayes' theorem, Naive Bayes is a probabilistic classification algorithm. It makes text classification and spam filtering computationally efficient and successful by assuming that the features are independent of one another (Ratha, A. K. et al. (2018). [36]).
(8) K-Means: Data is split into K clusters based on similarity using the unsupervised clustering algorithm K-Means. The cluster centroids are updated and data points are iteratively assigned to clusters up until convergence (Ratha, A. K. et al. (2018). [36]).
(9) Artificial Neural Networks (ANN): ANNs are modelled after how the human brain works and is organised. An input layer, one or more hidden layers, and an output layer are only a few of the layers made up of interconnected nodes (neurons) that make up these structures. Deep learning algorithms are built on ANNs, according to (Bobadilla, J. et al. (2020). [37]).
(10) Convolutional Neural Networks (CNN): CNN is a type of deep learning neural network primarily used for image recognition and computer vision tasks. It uses convolutional layers to automatically learn hierarchical patterns and features from the input data (Bobadilla, J. et al. (2020). [37]).
(11) Recurrent Neural Networks (RNN): RNN is a type of deep learning neural network well-suited for sequential data, such as time series or natural language. It uses feedback loops to pass information from previous time steps to the current one (Bobadilla, J. et al. (2020). [37]).
(12) Genetic Algorithms: A class of optimisation algorithms called genetic algorithms was developed as a result of the natural selection process. According to (J. Bobadilla. et al. (2020). [37]) they employ strategies like mutation, crossover, and selection to create answers to issues.
(13) Particle Swarm Optimization (PSO): is an optimisation algorithm that draws its inspiration from the social behaviour of fish schools and flocks of birds. The swarm's particles travel about the search area in pursuit of the best answer (Chen, Y. P. et al. (2009). [38]).
(14) Q-Learning: Q-Learning is a popular reinforcement learning algorithm used for making decisions in an environment with rewards and penalties. It learns the optimal action-value function through trial and error (Sabry, M. et al. (2019). [39]).
(15) Deep Q Networks (DQNA deep neural network is used by DQN, a deep learning-based extension of Q-Learning, to approximate the action-value function in reinforcement learning tasks (Sabry, M. et al. (2019). [39]).

These are only a few of the numerous artificial intelligence algorithms that are employed. The choice of method relies on the particular situation and available data. Each algorithm has strengths and limitations.

11. COMPANIES USING AI IN AGRICULTURE :

Several companies [40] are using AI in agriculture to improve efficiency, productivity, and sustainability. Here are some prominent companies:
(1) John Deere: A well-known agriculture machinery manufacturer, John Deere, has been incorporating AI and machine learning into their equipment. They use AI for precision farming, crop monitoring, and data-driven decision-making for farmers.
(2) IBM: Agriculture has used IBM's Watson platform to analyse information from a variety of sources, including weather, soil, and crop conditions. It aids farmers in decision-making and resource efficiency.
(3) Trimble: Trimble provides precision agriculture solutions that use AI and data analytics to assist farmers in optimizing field operations, managing water resources, and monitoring crop health.
(4) Prospera Technologies: Prospera offers AI-driven solutions for agriculture that use computer vision and machine learning to monitor crops, detect diseases, and optimize irrigation practices.
(5) The Climate Corporation (Bayer): This company uses AI to analyze weather data and field conditions to provide personalized insights and recommendations for farmers, helping them make data-driven decisions.

12. OVERVIEW OF COMPANY :

The international technology business IBM (International Business Machines Corporation) has a lengthy history in the sector. It was established in 1911 and through the years has developed into one of the top technology and consulting organisations in the world. With its involvement in a number of areas, including hardware, software, cloud computing, artificial intelligence, and enterprise solutions, IBM has significantly shaped the computer industry.

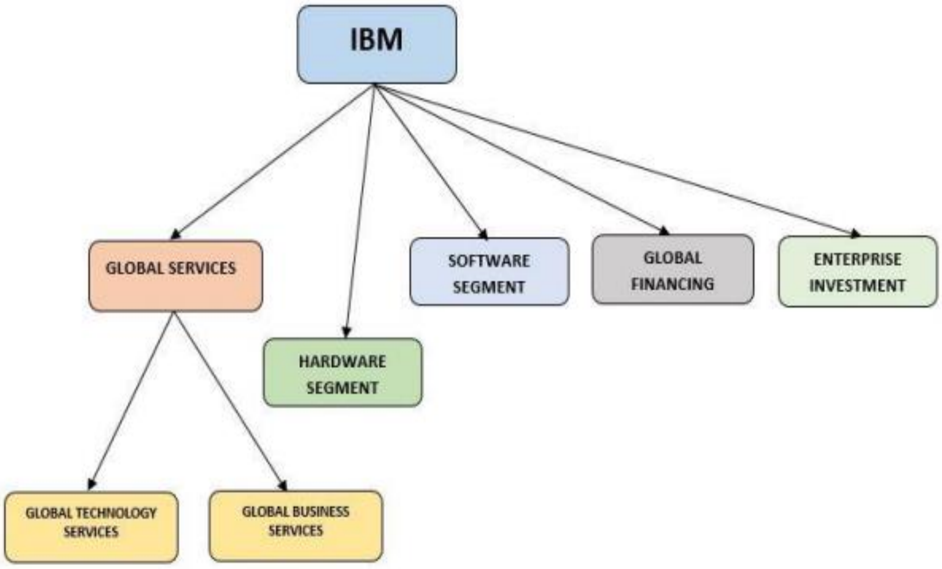

Fig. 4: Services provided by IBM [41]

IBM performs a wide range of tasks that generate and provide value as depicted in Fig.4. The global trade landscape has witnessed significant transformations, allowing consumer electronic goods companies to explore new markets worldwide. The introduction of open markets and trade regulations has facilitated the launch and sale of products across different countries, benefiting overseas companies. Moreover, the flexibility in pricing due to exchange rate fluctuations has enabled these companies to offer their products at reasonable prices in various regions. Furthermore, the trend of outsourcing has emerged as a major cost-cutting measure, particularly in the IT industry. Many businesses now prefer to outsource their software development projects, leading to reduced expenses on taxes, benefits, and employee insurance.

This shift towards outsourcing has also spurred the concept of economies of scale, as fixed capital is replaced by contract staffing, resulting in increased production capacity. Additionally, labor laws have become more lenient, fostering a friendlier work culture where employees are actively engaged in various forms of work. Leadership and managerial skills are honed through these programs, driving productivity and efficiency. Moreover, immigration reforms have made it easier for companies to recruit talent from different backgrounds and skill sets, bolstering the workforce in the IT industry. Governments of various countries have also extended political support to the booming IT sector by providing tax incentives and infrastructure assistance.

The rise of new technology, fuelled by cost-saving measures and automation (Al Rashdan, A. Y. et al. (2018). [42]), has led to an increased demand for sophisticated software to support these advancements. Sustainability has become a central focus in the corporate world, leading to the development of applications that promote energy conservation and paperless operations. This has made it possible for new businesses to release creative applications that support these objectives. Embracing diversity in the workforce, with employees from various cultural backgrounds, has proven to enhance operational efficiency and service delivery. With improvements in education standards and an increasing number of enrolments in STEM programs, there is a substantial pool of skilled individuals available to meet the industry's demands, driving technological advancements and achieving complex targets.

The changing demographics, such as an aging population, have contributed to the growing market for personal computers and laptops, which are now essential tools for both work and personal use. The rise of remote work and home-based businesses has further amplified the demand for personal computers and software applications. In the international arena, the global market has become more accessible, allowing IT consulting and software development companies to launch products in multiple languages and explore complex regions. For businesses looking to increase their presence and profit from various markets, this globalisation has created new opportunities (Muzumdar, P. (2013). [43]).

13. FINANCIAL GROWTH DETAILS OF IBM :

IBM's annual revenue has experienced fluctuations over the years from 2010 to 2023. In 2019, the company had a revenue of $55.179 billion, which decreased by 4.39% compared to the previous year. However, there was a 3.93% gain in sales from 2020, or $57.35 billion, which indicated a minor recovery. When IBM's yearly revenue reached $60.53 billion in 2022, up 5.54% from the year before, the upward trend persisted. According to the quarterly figures, IBM's revenue for the quarter ending March 31, 2023 was $14.252 billion, an increase of just 0.39% over the previous year. The twelve months revenue ending on March 31, 2023, was $60.585 billion, indicating a 3.81% increase compared to the same period last year. Despite facing some challenges, IBM demonstrated overall growth during this period, reflecting the dynamic nature of the technology industry and the company's strategies to adapt to changing market conditions [44]. Fig. 5 gives the details about the annual revenue generation.

IBM Annual Revenue (Millions of US $)		IBM Quarterly Revenue (Millions of US $)	
2022	$60,530	2023-03-31	$14,252
2021	$57,350	2022-12-31	$16,691
2020	$55,179	2022-09-30	$14,107
2019	$57,714	2022-06-30	$15,535
2018	$79,591	2022-03-31	$14,197
2017	$79,139	2021-12-31	$16,694
2016	$79,919	2021-09-30	$13,251
2015	$81,741	2021-06-30	$14,218
2014	$92,793	2021-03-31	$13,187
2013	$98,367	2020-12-31	$1,925
2012	$102,874	2020-09-30	$17,560
2011	$106,916	2020-06-30	$18,123
2010	$99,870	2020-03-31	$17,571

Fig. 5: IBM Revenue 2010-2023 [44]

Over the next three years, IBM is expected to experience significant earnings growth. However, it is projected that IBM's revenue will grow at a slower rate (3.5% per year) compared to the broader US market (forecasted at 7.5% per year). Additionally, IBM's high growth revenue is anticipated to grow at a rate lower than 20% per year. During Q1 2022, IBM brought in $14.19 billion in sales. Revenue by business segment of IBM depicted in Fig. 6 [45]:

Segment	Revenue in Q1 2022	Contribution in Q1 2022
Consulting	4829	34.0%
Financing	154	1.1%
Infrastructure	3219	22.7%
Other	224	1.6%
Software	5772	40.7%
Total	14198	100.0%

Fig. 6: IBM's Revenue by business segment [45].

14. ORGANIZATION DETAILS :

Any organisation needs an organisational structure (Ashton, D. N. (2004). [46]) because it offers a clear framework for defining roles, responsibilities, and reporting relationships. It guarantees effective workflow, accountability, and reduces effort duplication. A clearly defined framework encourages improved teamwork and communication among staff, which boosts output. It makes job and decision delegation easier, maximising the utilisation of resources and encouraging specialisation.
Inefficiencies, bottlenecks, and disputes can also be found and resolved with the use of a clear organisational structure, which boosts overall operational effectiveness. It makes it possible for workers to comprehend their career trajectories and prospects for progress inside the organisation, which boosts motivation and retention. A solid framework also links individual goals to the company's goals, creating a sense of belonging and shared vision among staff members.
A professionally run organisation presents a credible external image to stakeholders including clients, investors, and shareholders. It enables flexibility and reactivity to shifting market circumstances and enables the business to scale and expand sustainably. Last but not least, a well-organized structure helps with regulatory compliance, ensuring that laws and industry standards are followed. In general, a company needs a strong organisational structure to survive and prosper in a cutthroat industry.

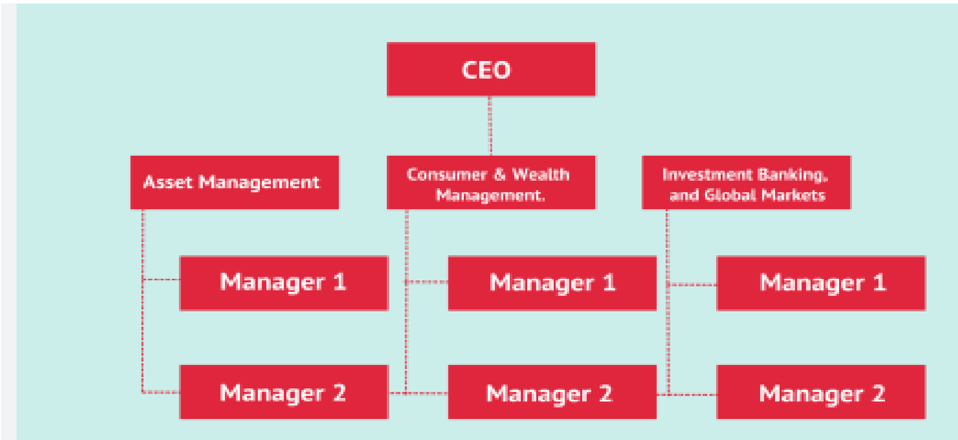

Fig. 7: IBM Organization Structure [47]

Details about the key players in the organisational structure are given in figure 7 [47].
(1) **President and CEO:** Arvind Krishna (Wikipedia. [48]), a business executive and the chairman and CEO of IBM, is Indian-American. As of April 2020, he has been the CEO of IBM. He became the company's chairman in January 2021. In 1990, Krishna began working at IBM's Thomas J. Watson Research Centre. After being elevated to Senior Vice President in 2015, he was given the chance to

oversee the IBM Cloud & Cognitive Software and IBM Research businesses. He played a significant part in the purchase of Red Hat, the largest acquisition in the company's history.

(2) **Senior Vice President and Chief Financial Officer:** James J. Kavanaugh is in charge of managing IBM's global finance operations. In his function as CFO, he is in charge of accounting and controllership, tax, internal audit, investor relations, corporate strategy, and corporate development. Additionally, he oversees IBM Financing. Mr. Kavanaugh was chosen for this position in January 2018 [49].

15. CLIENTS OF IBM SERVICES :

To numerous clients in diverse industries, IBM offers a broad range of services. These include things like technology solutions (Lasher, D. R. et al. (1991). [50]), cloud computing, artificial intelligence, and consultancy. Here are a few well-known customers of IBM services (Lasher, D. R. et al. (1991). [50]), along with brief summaries of their partnerships [51].
(1) Walmart: IBM and Walmart worked together to create a blockchain-based solution for enhancing the supply chain traceability of food items. By enabling quick tracking and product authentication, this ground-breaking system contributes to improving food safety and lowering potential health hazards [51].
(2) Maersk: To develop a blockchain platform called TradeLens, IBM teamed up with the international shipping firm Maersk [51]. This platform intends to increase efficiency, security, and transparency in the shipping and logistics sector in order to streamline and digitize global trade processes.
(3) Caesars Entertainment: Caesars Entertainment has improved client experiences in its resorts and casinos by utilizing IBM's AI technology, Watson. Watson helps to personalize customer encounters, make suggestions, and raise the standard of services as a whole [51].
(4) Coca-Cola European Partners: To improve maintenance and asset management throughout its bottling and distribution operations, Coca-Cola European Partners has implemented IBM's Maximo Asset Management solution [51]. This lessens downtime and increases operational effectiveness.
(5) AT&T: IBM and AT&T have worked together to improve AT&T's network capabilities by utilizing IBM's cloud infrastructure and services. This alliance seeks to offer cutting-edge solutions, like as 5G and edge computing, to enable the digital transformation of diverse industries [51].
(6) IBM has collaborated with Delta Airlines to create a predictive maintenance system that makes use of IoT and AI technology [51]. This system helps anticipate repair requirements, cut down on delays, and enhance overall flight operations by analyzing data from aircraft sensors.
(7) Banco Bradesco: One of the biggest banks in Brazil, Banco Bradesco, has received technology and consulting services from IBM (Lasher, D. R. et.al. (1991). [52]). The modernization of the bank's IT infrastructure, improvement of customer experiences, and expansion of digital banking capabilities have been the main goals of this collaboration.
(8) American Cancer Society: The American Cancer Society has used IBM's Watson AI technology to support cancer research and treatment decision-making. In order to offer insights and suggestions for individualized treatment approaches, Watson assists in the analysis of enormous volumes of medical literature and patient data (Lasher, D. R. et.al. (1991). [52]).
(9) The Weather Company: After being purchased by IBM, The Weather Company now uses its sophisticated weather forecasting capabilities to give reliable and fast weather information to people, organizations, and governments all around the world, assisting in disaster preparation and resource allocation [53].
(10) IBM and KONE have partnered to use IoT and AI technology for preventive equipment maintenance [53]. KONE is a leader in the world of elevator and escalator systems. This partnership contributes to the effective and safe operation of escalators and elevators in diverse buildings.
These instances demonstrate how IBM's various services and technologies are used in a variety of industries to address particular problems and spur innovation for its clients.

16. TYPES OF AI SERVICES BY IBM USED IN AGRICULTURE :

To increase production, sustainability, and efficiency in agriculture, IBM has created a number of AI services. By compiling and evaluating data from a variety of sources using AI technologies, these services help farmers make better decisions. Here are a few IBM services that apply artificial intelligence in agriculture [54].

(1) The Watson Decision Platform for Agriculture is an AI-powered platform (Freeman, D. et.al. (2017). [55]) that combines a variety of data sources, including crop data, satellite imaging, and IoT devices. It offers advice and suggestions to farmers on how to manage crops more effectively in terms of irrigation, pest control, planting times, and other areas. The tool helps farmers make data-driven decisions by using machine learning algorithms to forecast crop diseases, weather trends, and yield potential.

(2) IoT and Precision Agriculture: IBM's IoT technologies [56] are applied to agriculture to gather information from sensors placed in equipment, livestock, and fields. These sensors track the temperature, humidity, and other external variables as well as the moisture content of the soil. This data is processed by AI algorithms to produce accurate field maps, which farmers can use to analyze changes in soil conditions and adopt tailored planting, fertilizing, and irrigation methods. This results in higher crop yields and optimal resource utilization.

(3) Plant Disease Detection: IBM has created artificial intelligence (AI) algorithms (Kumar, R. et.al. (2020). [57]) that can examine photos of crops to look for disease and pest indicators. These models can recognize minute alterations in plant appearance that can point to the presence of illnesses by applying machine learning and image recognition techniques. Early identification enables farmers to respond quickly, stopping the spread of illnesses and reducing crop losses.

(4) Weather forecasting and climate analysis: IBM's AI services (Kumar, R. et.al. (2020). [57]) provide cutting-edge weather forecasting and climate analysis capabilities that aid farmers in preparing for severe weather conditions like heavy rain or droughts. These systems offer precise predictions by combining historical weather data and the most recent conditions, enabling farmers to modify their plans and safeguard crops from unfavorable weather effects.

(5) Crop Yield Prediction: To assess crop production potential, AI-driven crop yield prediction models use data from satellites, drones, and field sensors (Mostaco, G. M. et.al. (2018).[58]). These models offer insights into possible yields by examining elements including weather patterns, soil quality, and planting methods. This knowledge can be used by farmers to plan harvests, allocate resources, and improve marketing tactics.

(6) Supply Chain Optimization: By examining data pertaining to transportation, storage, and distribution, IBM's AI solutions help to optimize the agricultural supply chain (Manopiniwes, W. et.al. (2014). [59]). These services aid in minimizing waste, lowering transportation costs, and ensuring prompt delivery of fresh products to markets by anticipating demand trends and enhancing routes.

(7) IBM's AI services (Kumar, R. et.al. (2020). [60]) can evaluate historical and current market data to provide insights into industry patterns, consumer preferences, and price movements. These insights can help farmers decide which crops to grow, when to harvest them, and when to put them on the market in order to optimize profits.

In conclusion, IBM's AI services (Kumar, R. et.al. (2020). [60]) for agriculture provide a wide range of functions, including data analysis, prediction, and decision support. With the help of these technologies, farmers can streamline their processes, better utilize their resources, and efficiently address problems brought on by varying weather patterns and market circumstances.

17. SWOC ANALYSIS :

Strength, Weakness, Opportunities, and Challenges is abbreviated as SWOC (Rajeshwari, M. et.al. (2020). [61]). It is frequently used to evaluate an organization's internal capabilities. Scientific studies employ SWOC analysis to understand PESTLE analysis as outer institutionalism, ABCD analysis as internal organizational analysis, and SWOC analysis (Rajeshwari, M. et.al. (2020). [61]) as a conceptual framework. SWOC evaluations from numerous businesses in a range of market segments have been released as academic studies (Madhushree, R. R. et.al, (2018). [62]. & Aithal, P. S. (2017). [63]). SWOC evaluations from numerous businesses in a range of market segments have been released as academic studies (Sathyan, S. et.al, (2021). [64]. & Netravathi, P. S. et al. (2021). [65]). Here is the SWOC analysis of IBM:

Strengths:

(1) Legacy and Reputation: IBM has a long history of being a leader in computing innovation and technology. The corporation has remained a dominant force in the sector thanks to its well-known brand and rich history [66].
(2) Diversified Portfolio: IBM offers a large selection of goods and services to both businesses and private customers. Due to its diversified portfolio, the company is able to handle numerous markets and adjust to shifting market trends.
(3) Enterprise Solutions: IBM is a major player in the market for enterprise solutions, offering solutions in fields including blockchain, cloud computing, data analytics, and cybersecurity. The company's revenue stream has depended on these services [67].
(4) Research and growth: IBM makes significant investments in this area, enabling it to stay on the cutting edge of technological growth. The company has been able to provide innovative goods and solutions thanks to its dedication to innovation.

Weaknesses:

(1) Challenges in the transition: IBM encountered difficulties when switching its business strategy from traditional hardware and software sales to cloud-based solutions and services.
(2) Decline in Some Business areas: In recent years, some of IBM's established business areas, including hardware, have seen reductions, which has had an effect on overall revenue [67].
(3) Complex Organizational Structure: The company's enormous size and complex organizational structure may make decisions take longer to make and make it more difficult to adjust to changes in the market.
(4) Competition is fierce: IBM competes against both established technological behemoths and up-and-coming entrepreneurs in highly competitive markets.
(5) Aging Workforce: IBM has a sizable number of long-term employees, which could make it difficult to keep up with the quickly evolving technological trends [68].

Opportunities:

(1) Growing Demand for Flexible and Scalable IT Infrastructure: IBM's focus on cloud computing and hybrid cloud solutions is in line with this demand.
(2) Artificial intelligence and machine learning: IBM's experience in these fields opens doors for businesses in the manufacturing, healthcare, and financial sectors.
(3) Quantum computing: IBM is in a strong position to take use of the promise of quantum computing for a variety of applications thanks to its expertise in the field [68].
(4) Data Security and Privacy: Growing worries about data security and privacy present opportunities for IBM to design and provide cutting-edge cybersecurity solutions.
(5) Partnerships in the Industry: Innovative products and services can result through partnerships with other technological firms, start-ups, and industries [69].

Challenges:

(1) Market Competition: A large number of businesses compete for market share in the technology sector. IBM is up against competition from major tech behemoths like Microsoft, Amazon, Google, and Oracle as well as more niche, smaller businesses [70].
(2) Moving to the cloud: Despite considerable advancements in cloud computing achieved by IBM with its IBM Cloud platform, it struggled to catch up to competitors like Amazon Web Services (AWS) and Microsoft Azure.
(3) Legacy Hardware Business: As more businesses switch to cloud-based solutions and software-defined infrastructure, demand for IBM's conventional hardware business has been dropping in recent years [69].
(4) Leadership and Strategic Shifts: Like any large enterprise, IBM has gone through leadership transitions and strategic changes that may have an effect on the performance and direction of the business [70].

Despite certain difficulties, IBM is still a significant force in the technology and consulting sectors. The company's future success in a constantly changing market will depend on its capacity to leverage its strengths, capitalize on emerging technology, and handle its obstacles.

18. CONCLUSION :

IBM has revealed to be a strong and significant technology company with a global presence. With its broad range of services, IBM can meet the needs of a wide range of customers, demonstrating its flexibility and knowledge. The organization of the company, which is well-structured, supports effective service delivery and has experienced years of excellent financial growth. Despite its advantages, IBM nonetheless faces difficulties like escalating competition and shifting market dynamics. However, IBM is well-positioned to overcome these challenges and maintain its trajectory of development and innovation in the fast-moving technology sector by capitalizing on its strong brand reputation, technological innovation, and strategic relationships.

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A Study of Employee Engagement in the Higher Education Institutions

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Subject Area: Business Management.
Type of the Paper: Empirical Study.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10143197
Google Scholar Citation: IJAEML

How to Cite this Paper:
Mishra, N., & Aithal, P. S., (2023). A Study of Employee Engagement in the Higher Education Institutions. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 115-129. DOI: https://doi.org/10.5281/zenodo.10143197

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0196

Received on: 05/09/2023
Published on: 18/11/2023

A Study of Employee Engagement in the Higher Education Institutions

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ABSTRACT

Purpose: *After liberalization of the Indian economy, the impact of privatisation, economic changes, and international markets put pressure on all functions of the organizations (Bhatnagar, 2007; Budhwar, et al, 2026) There is a requirement amongst the managers to build capacities, competencies, and capabilities. With the overall competition, retaining and attracting good talent has become a challenge. Employee engagement is key to the retention of talent in an organization. During the last decade, several studies related to talent management have been conducted, but mostly in developed countries and in a corporate context. Even within the employee engagement framework, very little has been done on teaching faculty and staff in colleges and universities.*

Methodology: *There is a strong need to study employee/ faculty engagement in the education sector. The literature study on employee engagement shows very little study on faculty engagement and motivation. Faculty engagement and motivation are possible if organizations, i.e., colleges and institutes provide the teachers with a passion for work and an engaging ambience which their performances and give them a continuous satisfying work experience.*

Result/Analysis: *The research titled, "A Study of Employee Engagement in the Higher Education Institutions", is carried out as there is an immense need to study faculty engagement in the education sector. The previous studies on employee engagement have very little emphasis on faculty engagement and motivation. The study is a descriptive study and is based on primary data. Primary data from 72 teachers/ faculty members were collected from colleges and institutes of higher education across India. A structured questionnaire was adopted for collecting primary data through the questionnaire method and in few cases, wherever possible through the interview method, to collect in-depth information about the education system.*

Originality/Value: *This paper discusses a very important observation of the research study, i.e., the reason for the change in the engagement pattern of faculty members/teachers in the HEI. What has been discussed and seen during the research interview is that the faculty has expressed the support of the senior management and academic leaders in their meaningful contribution.*

Paper Type: *Empirical study.*

Keywords: Employee Engagement, Higher Education, Dedication, Vigour, Absorption

1. INTRODUCTION :

During the 1980s and 199s the working conditions of the employees was very different. The employees earlier were strictly led by the principles of loyalty and commitment to the organization. Highly dedicated employees endowed loyalty to the organization, and in reciprocation for that commitment, they were offered lifetime employment in their workplace. In the 1980s, with increased global competition, employers were demanded to be more flexible in their deployment of employees. Factories went for lockouts, due to economic conditions, unrest and political motives, and then again reopened in countries or places where wages were lower. As business became global, leaders looked-

for more regulation by the government, regarding wages, salaries, and benefits to employees so that they could compete effectively. With changes in the global scenario and working conditions, loyalty towards organization was fleeting. Many jo opportunities were available to the skilled workforce, giving rise to high attrition. Thus, the employee engagement movement reached as a tactic to resolve this problem. Employees should be more engaged to have better productivity at workplace. What started as a movement, became a culture and practice in the world of human resource management.
After liberalization of the Indian economy, the impact of privatisation, economic changes and international markets had put pressure on all functions of the organizations (Bhatnagar, 2007 [1]; Budhwar, et al. 2026 [2]) There is a requirement amongst the managers to build capacities, competencies, and capabilities. With the overall competition, retaining and attracting good talent has become a challenge. Employee engagement is key to the retention of talent in an organization. Over the last few years, several studies related to the management of talent have been conducted, but mostly in developed countries and in a corporate context. Even within the employee engagement framework, very little has been done on teaching faculty and staff in colleges and universities [3].
The literature study on employee engagement shows very little study on faculty engagement and motivation. Faculty engagement and motivation are possible if organizations, i.e., colleges and institutes provide the teachers with a passion for work and an engaging ambience with a continuous satisfying work experience.
The selection and recruitment of teachers also play a significant role in employee engagement and work satisfaction. It is therefore very important to have proper selection and recruitment of faculty members, fitting the job requirement, experience, and knowledge. Engaged teachers in a college or university will provide better learning outcomes for students and demonstrate better self-efficacy.
A study by Bailey et al 2015 [4]; suggests that high work engagement leads to lower voluntary turnover Having engaged employees results in better faculty and student feedback and better stakeholder satisfaction. Another very important aspect of employee engagement is on-the-job training. The recent concept of inductee teachers helps in providing teachers with training opportunities for learning, research, and self-development, thereby contributing more towards work productivity and employee engagement [5].
The questions that arise are:
(1) What is the organizational responsibility to attract and groom the best talent?
(2) What motivates employees to be engaged, to work with commitment, to take risks to do something more and different, and to withstand difficult situations?
There has been a considerable change in the learning organizational structure. The traditional learning organizational structures greatly relied on direct control of the management and to cost reduction. In the new structure, efficiency, and revenue flow are more important, where the major focus is on the smooth and judicious management of human capital, i.e., the teachers in this case. Currently, learning organizations expect their employees to be proactive and exhibit initiative, collaborate smoothly with their peers, take responsibility for their own professional development, and to be committed to teaching and research.

2. OBJECTIVES OF THE STUDY :

(1) To measure the engagement level of faculty in Higher Education Institutions.
(2) To study the demographic variables along with Vigour, Dedication, and Absorption of faculty in HEIs.
(3) To find out the engagement level between men and women faculty members.
(4) To analyze the effect of work experience on the level of employee engagement.
(5) To analyze the effect of monthly salary on the level of vigour, dedication, and absorption of faculty members.

3. LITERATURE REVIEW :

Employee Engagement is the effort to understand and describe, both qualitatively and quantitatively, the nature of the relationship between an organization and its employees. An "engaged employee" is defined as one who is fully absorbed by and enthusiastic about their work and so takes positive action to further the organization's reputation and interests.

3.1 Conceptual Background:

Burnout Antithesis Approach (2011) by Shuck's, identified four main approaches to defining engagement, which can also be utilized when exploring measures of engagement [16, 21]

The Needs-Satisfying Approach:

According to the Needs satisfying approach, engagement is the expression of one's preferred self in task behaviours. The first formal definition was provided by William Kahn (1990). He defined personnel engagement as "the harnessing of organization members' to their work roles; where, people employ and express themselves physically, cognitively, and emotionally during role performance [3, 4, 5].

Burnout antithesis approach, on the other hand describes employee engagement as energy, involvement and efficacy, and are exactly the opposites of established "burnout" constructs, like exhaustion, cynicism and lack of accomplishment.

The Satisfaction Engagement Approach:

Satisfaction-engagement approach, in which engagement is a more technical version of job satisfaction, evidenced by The Gallup Company's own Q12 engagement survey [6].

The Multidimensional Approach:

This approach makes a clear distinction between job and organizational engagement, usually with the primary focus on antecedents and consequents to role performance rather than organizational identification.

Four Approaches

Fig. 1: Four Approaches to Employee Engagement

3.2 Description of the Scale: Rich et al's (2010) -JES:

The scale of employee (Job) engagement has 17 items based on three dimensions. Dimension Physical Attribute is represented by five questions. Dimensions Emotional and Cognitive have six questions each. Making the questionnaire based on 17 Items. Participants rated their levels of employee engagement on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) [7]. Questionnaire 1, is given in annexure

Expected Findings:

After using above scale the analysis may reveal the physical, cognitive, and emotional level of employee engagement with the concerned job role. The findings may indicate the varying of the engagement level due to demographic profiles. So, these items were compared with the UWES and further research was conducted.

3.3 Burnout Antithesis Approach:

Schaufeli et al. (2002) conceptualizes "work engagement" as the positive opposite of psychological burn out. They defined engagement as "a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption" (pg. 74). This perspective refers to feelings of vigour (e.g. energy), dedication (e.g. enthusiasm), and absorption (e.g. feeling immersed).
The **Utrecht Work Engagement Scale** was developed by Schaufeli et al. (2002) [5] assesses three dimensions: vigor, dedication, and absorption. There are six questions for vigor and absorption and five questions for dedication, creating a total of 17 questions. Participants rate their levels of employee engagement on a 7-point Likert scale (0 = Never to 6 = Always/Every day). Questionnaire 2, is attached in the anexure

Expected Findings:

After using above scale, the analysis may reveal the state of mind of respondents in terms of energy, enthusiasm and feeling of immersion. The findings may indicate the varying of the engagement level due to demographic profiles.

3.4 Determinants of Employee Engagement:

Employee engagement is appositive fulfilling work related state of mind that is characterized by vigour, dedication and absorption.
(1) Vigour- Vigour indicates high levels of energy at work, resilience both physical and mental, time and strategy invested in actual work and high level of perseverance even during difficult times. Vigour has a positive influence on employee performance. An individual with vigour will do good things for the organization that would contribute towards bigger success.
(2) Dedication- Dedication at work refers to the disciplined behavior of an employee at work. A dedicated employee will always follow rules, comply with the policies, work hard to meet goals and take initiatives to initiate new things. This individual takes pride in his or her responsibilities, duties and feels important and meaningful in the organization. In the role efficacy scale the individual goes from role entering to role centering.
(3) Absorption- Absorption happens in employee engagement when an individual has perseverance and can absorb the instructions, roles and job descriptions better. The individual is more concentrated on work and escapes surrounding disturbances. The individual is not a clock watcher and stays focused in fulfilling his job obligations.

4. METHODOLOGY :

4.1 Research Methodology:

The present study is a descriptive study and is based on primary data. Primary data has been collected from colleges and institutes of higher education in Maharashtra, Chennai, Kolkata & Delhi. A structured questionnaire was adopted for collecting primary data through questionnaire method and in few cases, wherever possible through interview method, to collect in- depth information of the education system. Secondary data and literature study is taken from published articles, journals, periodicals, and research papers.

4.2 Hypotheses of the Study:

(1) Null Hypothesis: There is no significant difference in the mean scores of 'Vigour' with reference to Gender.
(2) Null Hypothesis: There is no significant difference in the mean scores of 'Dedication' with reference to Gender.
(3) Null Hypothesis: There is no significant difference in the mean scores of 'Absorption' with reference to Gender.
(4) Null Hypothesis: There is no significant difference in the mean scores of 'Vigour' with reference to Teaching Experience.
(5) Null Hypothesis: There is no significant difference in the mean scores of 'Dedication' with reference to Teaching Experience.

(6) Null Hypothesis: There is no significant difference in the mean scores of 'Absorption' with reference to Teaching Experience.
(7) Null Hypothesis: There is no significant difference in the mean scores of 'Vigour' with reference to Monthly Salary.
(8) Null Hypothesis: There is no significant difference in the mean scores of 'Dedication' with reference to Monthly Salary.
(9) Null Hypothesis: There is no significant difference in the mean scores of 'Absorption' with reference to Monthly Salary.

4.3 Research Design:

The philosophical foundation of this quantitative study builds upon the theory of knowledge regarding validity, scope, and method. The study adopted a positivism approach. The study focuses on theory testing in the context of teaching fraternity. The descriptive design was adopted with the use of demographic variables.

4.4 Sampling Framework:

The Stratified Random technique was adopted to select the sample from the universe. All the teachers were considered as the 'Universe' of study. The study was undertaken only for higher education college teachers. The college teachers from all specializations of Management, Interdisciplinary Education, were included while considering the importance of NEP 2020 in near future. Teachers from social sciences were included in the study to focus on interdisciplinary education. Moreover, the age group of samples were kept 30 years and above. Around 100 questionnaires were shared with respondents through google form and some personal interviews were also held to get in-depth understanding. Around 72 questionnaires complete in all aspects were considered for further analysis. However, sufficient care was taken by the researcher to avoid chance error, sample frame errors, non-response errors and misinterpretation errors.

4.5 Tool Description:

Construct of Employee Engagement:

An "engaged employee" is one who is enthusiastic about their work and is completely committed to the work, hence takes positive action to further the organization's reputation and interests.

Employee Engagement Measures:

The tool used for the present study was **Utrecht Work Engagement Scale (UWES)** developed by Schaufeli et al. (2002). The17 items used a five- point rating scale was chosen, ranging from 1= Strongly disagree, 2= Disagree, 3= Can't say, 4= Agree and 5= Strongly agree. A comparison of the questionnaire of UWES and Physical, emotional and cognitive scale was done, as stated above, the questionnaire used for the study, shows the factors and attributes that contributes to faculty engagement in Interdisciplinary Higher Education.
Question 1, 4, 8, 12, 15 and 17 -----------------Vigour Scale
Question 16, 14, 3, 6, 9 and 11-------------------Absorption Scale
Question 2, 5, 7, 10 and 13 ---------------------- Dedication Scale
The five items of Physical Dimension Attribute match the six items of Vigour Dimension Attribute. The Emotional and Cognitive dimensions also have much similarity with Dedication and Absorptions.

The tool consists of -

1. Personal information of respondents on age, gender, salary levels, and years of experience.
2. Other factors contributing to the engagement level of the faculty members, such as vigour, dedication, absorption.

Reliability of the Tool

Table 1: Cronbach Alpha Score

S. No.	Sub-Variable	Number of Statements	Cronbach Alpha
1	VIGOUR	6	0.872
2	DEDICATION	5	0.892
3	ABSORPTION	6	0.852

Cronbach's alpha is a measure of the extent to which the group of questions are related to one another. The measurement accuracy of the tool is good as Cronbach Alpha is above 0.8.

Data Interpretation

The following range will be used for the data interpretation to indicate the level of engagement (Objective 1).

Table 2: Range of Level of Engagement

S. No.	Sub-Variables	No of Items	Five-Point Scale	Range	Interpretation of Mean value
1	Vigour	6	1 - Strongly Disagree To 5 – Strongly Agree	6.00 to 14.00	Low Level Vigour
				14.01 to 22.00	Moderate Level Vigour
				22.01 to 30.00	High Level Vigour
2	Dedication	5		5.00 to 11.66	Low Level Dedication
				11.67 to 18.33	Moderate Level Dedication
				18.34 to 25.00	High Level Dedication
3	Absorption	6		6.00 to 14.00	Low Level Absorption
				14.01 to 22.00	Moderate Level Absorption
				22.01 to 30.00	High Level Absorption

5. ANALYSIS OF DATA :

The first part of this section was indicated by Frequency table for demographic details of the respondents. Further, Mean and standard deviation was shown to designate the level of sub-variables of engagement. Inferential Statistics used for the testing of hypotheses.

5.1 Demographic Profile of the Respondents:

Table 3: Age of the Respondents

Categories	Coding	Frequency	Percent
30-40	1	24	33.3
40-50	2	17	23.6
50-60	3	27	37.5
60 and above	4	4	5.6

N= 72

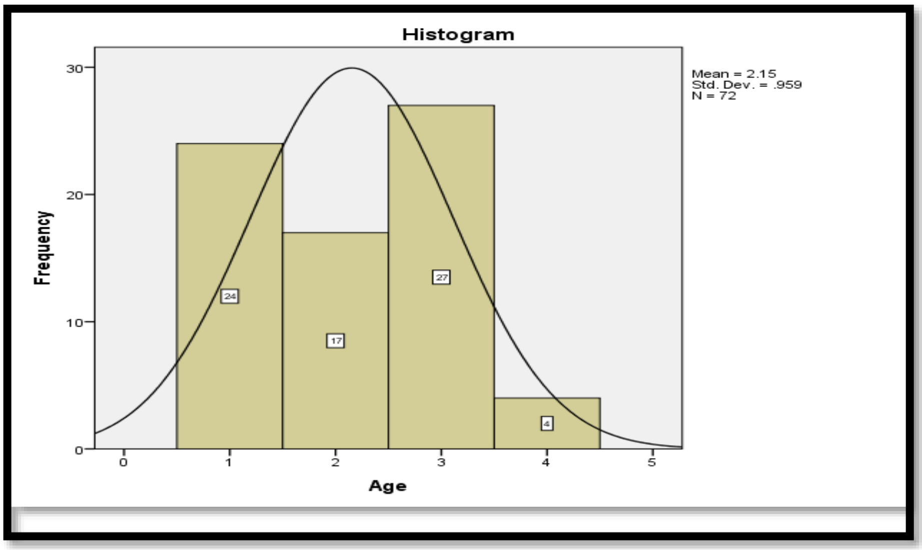

Fig. 2: Histogram; Age of Respondents

The respondents were in the Age group of 30 to 65 years and minimum age was considered as 30 years for the study as maturity and understanding of career goals is more focused for employees above 30. 65 years was taken as the maximum age limit as that is the retirement age for teachers/professors in higher education. The total number of respondents were divided according to the class interval of 30-40, 40-50, 50-60 and 60-70 years. The class interval is continuous, where the upper limit of the previous class is counted in the next class, as shown in Table 3 The maximum number of respondents was in the age group 50-60 year, i. e., 27 respondents, followed by 24 respondents in the age group of 30-40 year, 17 respondents in the age group of 40-50 and only 4 respondents in the age group of 60 and above. It is understood therefore that most faculty members in the age group of 50-60 year has taken the survey as they are interested in knowing better the employee engagement process and be effective in guiding the junior faculty.

Table 4: Teaching Experience of the Respondents

Categories	Coding	Frequency	Percent
Less than 5 years	1	15	20.83
5 to 10 years	2	11	15.28
10 to 15 years	3	16	22.22
15 to 20 years	4	16	22.22
20 and above	5	14	19.44

N = 72

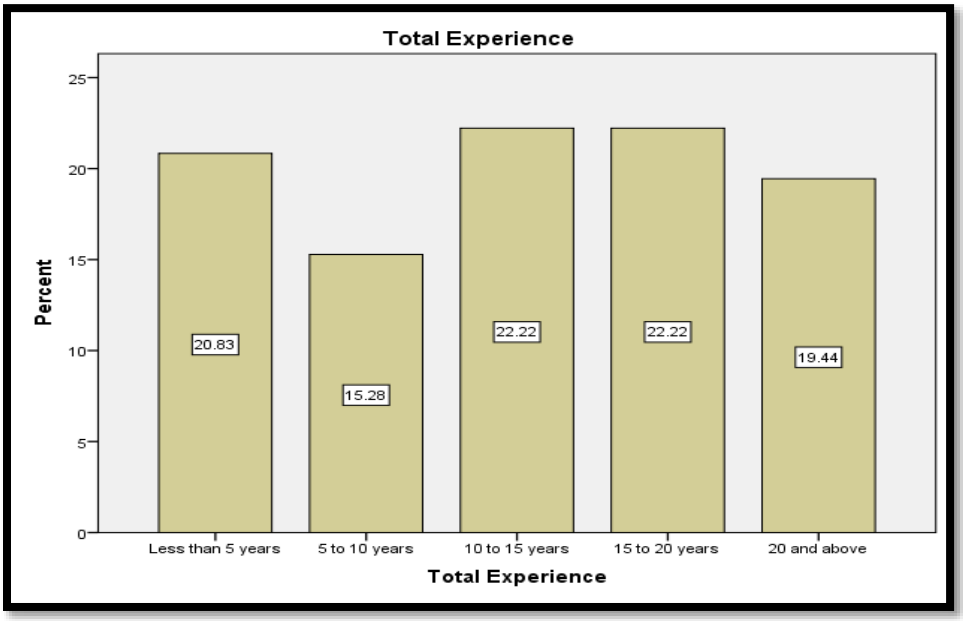

Fig. 3: Total Experience

The number of years for teaching experience is considered from below 5 years to 20 years and above. The class interval is taken as 5 years and is continuous in nature. Since the maximum number of respondents were in the age group of 50 -60 year, the class 10 years to 15, 15 years to 20 and 20 years and above has the maximum frequency, i.e., most respondents are in that experience group.

Table 5: Gender Profile

Categories	Coding	Frequency	Percent
Male	1	45	62.5
Female	2	27	37.5

N =72

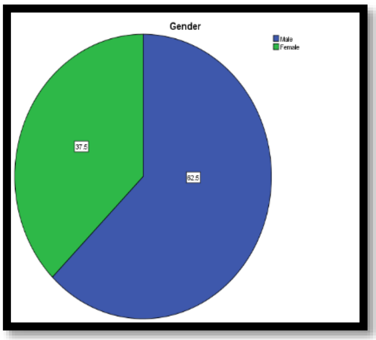

Fig. 4: Gender Profile

Of the total respondents, 45 were men and 27 were women teachers.

Table 6: Monthly Salary of the Respondents

Categories	Coding	Frequency	Percent
Less than 1 lakh	1	14	19.4
1 lakh to 1.5 lakhs	2	19	26.4
1.5 lakhs to 2 lakhs	3	22	30.6
Above 2 lakhs	4	17	23.6

N = 72

At the beginning of the study, it was mentioned that due to the increase in faculty pay packages and implementation of sixth and seventh pay commission, the salary levels are high. When organizations pay higher salaries the expectations from the faculty members are also high. The maximum number of respondents are seen in the salary bracket between Rs 1 Lakh to 2 lakhs.

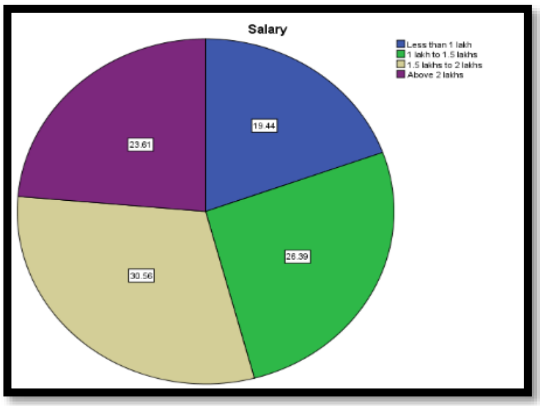

Fig. 5: Salary Statistics

5.2 Descriptive Statistics:

The total sum score, mean and the standard deviation has been worked out for all statements and sub-variables - ‘Vigour’, ‘Absorption’ and ‘Dedication’ presented below-

Table 7: Sum, Mean and Standard Deviation of Items

S. No.	Statements	Sum	Mean	SD	Interpretation
1	At my work, I feel bursting with energy. (vigor)	293	4.07	.924	High Level

2	I find the work that I do full of meaning and purpose. (dedication)	297	4.13	.963	High Level
3	Time flies when I'm working. (absorption)	289	4.01	.942	High Level
4	At my job, I feel strong and vigorous. (vigor)	296	4.11	.972	High Level
5	I am enthusiastic about my job. (dedication)	283	3.93	1.012	High Level
6	When I am working, I forget everything else around me. (absorption)	296	4.11	1.001	High Level
7	My job inspires me. (dedication)	286	3.97	1.007	High Level
8	When I get up in the morning, I feel like going to work. (vigor)	295	4.10	1.009	High Level
9	I feel happy when I am working intensely. (absorption)	307	4.26	.993	High Level
10	I am proud of the work that I do. (dedication)	288	4.00	.888	High Level
11	I am immersed in my work. (absorption)	274	3.81	.959	High Level
12	I can continue working for very long periods at a time. (vigor)	275	3.82	.983	High Level
13	To me, my job is challenging. (dedication)	267	3.71	.971	High Level
14	I get carried away when I'm working. (absorption)	274	3.81	.882	High Level
15	At my job, I am very resilient, mentally. (vigor)	268	3.72	1.051	High Level
16	It is difficult to detach myself from my job. (absorption)	272	3.78	.996	High Level
17	At my work I always persevere, even when things do not go well. (vigor)	293	4.07	.924	High Level

Source- prepared

Table 8: Sum, Mean and Standard Deviation of Variables

S. No.	Variable	Sum	Mean	SD	Interpretation
1	Vigor (6 Items)	1679.00	23.3194	4.41134	High Level
2	Dedication (5 Item)	1467.00	20.3750	4.07479	High Level
3	Absorption (6 Items)	1698.00	23.5833	4.47450	High Level

N =72

From the above table, it is observed that respondents indicated higher level mean for all three variables of employee engagement.

5.3 Inferential Statistics:

(A) Gender and Vigour, Dedication & Absorption:

Null Hypothesis: There is no significant difference in the mean Vigour, Dedication, and Absorption level scores with reference to Gender.

For testing the hypothesis, the Independent 't' test was computed for men and women

Table 9: Sum, Mean and Standard Deviation of Variables Gender Wise

Variables	Gender	N	Mean	Std. Deviation
Vigour	Male	45	24.0889	4.49152

	Female	27	22.0370	4.03334
Dedication	Male	45	21.0222	3.95135
	Female	27	19.2963	4.12138
Absorption	Male	45	24.3333	4.41588
	Female	27	22.3333	4.36771

Table 10: Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	**t**	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VIGOUR	Equal variances assumed	.941	.335	**1.948**	70	**.055**	2.05185	1.05333	-.04895	4.15266
DEDICATION	Equal variances assumed	.001	.979	**1.766**	70	**.082**	1.72593	.97746	-.22356	3.67542
ABSORPTION	Equal variances assumed	.104	.748	**1.868**	70	**.066**	2.00000	1.07063	-.13530	4.13530

5.4 Analysis of the Findings:

Three variables of employee engagement were computed by using ‘Independent t’ test wrt men and women. The sig. value was more than 0.05 for all three sub-variables. Therefore, there was no significant difference between men and women in terms of their vigor, dedication and absorption for their organization and work profile. Hence, the null hypothesis can be retained. It can be concluded that all HEI teachers of Management from Maharashtra have **similar level** of engagement for their organization as well as profession.

Table 11: Hypotheses

S. No.	**Hypotheses**	**Significant or No-significant Difference**
1	There is no significant difference in the mean **Vigour level** scores with reference to Gender.	**No-significant Difference**
2	There is no significant difference in the mean **Dedication level** scores with reference to Gender.	**No-significant Difference**
3	There is no significant difference in the mean **Absorption level** scores with reference to Gender.	**No-significant Difference**

Table 12: Hypotheses Testing

S. No.	**Hypotheses**	**Significant/ No-significant Difference**
1	There is no significant difference in the mean **Vigour level** scores with reference to Work Experience.	**No-significant Difference**
2	There is no significant difference in the mean **Dedication level** scores with reference to Work Experience	**No-significant Difference**
3	There is no significant difference in the mean **Absorption level** scores with reference to Work Experience	**No-significant Difference**

A) Teaching Experience and Vigour, Dedication & Absorption

Null Hypothesis: There is no significant difference in the mean scores of 'Vigour', 'Dedication' and 'Absorption' level with reference to Teaching Experience.

Table 13: Sum, Mean and Standard Deviation of Variables Teaching Experience Wise

Variables	Teaching Experience	N	Mean	Std. Deviation
Vigour	Less Than 15 Years	42	23.2143	4.52384
	More Than 15 Years	30	23.4667	4.32103
Dedication	Less Than 15 Years	42	20.0714	4.08682
	More Than 15 Years	30	20.8000	4.08867
Absorption	Less Than 15 Years	42	23.2381	4.45470

Table 14: Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VIGOUR	Equal variances assumed	.366	.547	**-.238**	70	**.813**	-.25238	1.06159	-2.36965	1.86489
DEDICATION	Equal variances assumed	.022	.883	**-.746**	70	**.458**	-.72857	.97712	-2.67738	1.22023
ABSORPTION	Equal variances assumed	.155	.695	**-.772**	70	**.442**	-.82857	1.07266	-2.96793	1.31078

Table 15: Hypotheses Testing

S. No.	Hypotheses	Significant/ No-significant Difference
1	There is no significant difference in the mean scores of **'Vigour' level** with reference to monthly salary.	**No-significant Difference**
2	There is no significant difference in the mean scores of **'Dedication' level** with reference to monthly salary	**No-significant Difference**
3	There is no significant difference in the mean scores of **'Absorption' level** with reference to monthly salary.	**No-significant Difference**

6. CONCLUSION :

What has been observed in the study is that faculty members are not individual workers, working in silos, they are integrated into a system that has students, management, institutions, and other stakeholders. Faculty engagement is required to realize higher levels of student learning attainment. What had happened earlier was the decoupling of teaching role and research role of faculty, more because remuneration for faculty was low. So, it was not expected of faculty to accomplish both the roles. But in the new career prospects under Sixth and Seventh pay commission, teaching, research, and institution building has been integrated. With increased faculty engagement, there are strategic collaborations between faculty and support professionals, thereby bringing more faculty engagement

in academic institutions. The positivity of faculty engagement is transmitted to the students, thus making learning more student-oriented.
A very important observation of the study was the reason for the change in the engagement pattern of faculty members/teachers in the HEI. What has been discussed and seen during the research interview is that the faculty have expressed the support of the senior management and academic leaders in their meaningful contribution. Teachers mentioned that they expect respectful treatment and two- way communication for better engagement and performance. Hence HODs, Principals, Directors, and Deans, along with the Management have a big role to play in effective employee engagement. High-quality leadership, proper governance and ethical practices in academic institutions can contribute towards better employee engagement. During the in-depth interview, many faculty members mentioned that the behavior of the senior academic leaders have impact on faculty engagement. Due to the increased role of technology in teaching, young faculty /teachers are adept in it and reverse mentoring is on the rise. While senior academic leaders share knowledge and research skills with young faculty members, they in turn teach the senior members technology-based learning. This has improved the faculty engagement in HEIs. The academic environment is more civil and there is less rudeness as compared to earlier times.

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****

ANNEXURE

Questionnaire 1. Rich et al- Job Engagement Measure:

1. I work with intensity on my job. (physical)
2. I exert my full effort to my job. (physical)
3. I devote a lot of energy to my job. (physical)
4. I try my hardest to perform well on my job. (physical)
5. I strive as hard as I can to complete my job. (physical)
6. I am enthusiastic about my job. (emotional)
7. I feel energetic about my job. (emotional)
8. I am interested in my job. (emotional)
9. I am proud of my job. (emotional)
10. I feel positive about my job. (emotional)
11. I am excited about my job. (emotional)
12. At work, my mind is focused on my job. (cognitive)
13. At work, I pay a lot of attention to my job. (cognitive)
14. At work, I concentrate on my job. (cognitive)
15. At work, I focus a great deal of attention on my job. (cognitive)
16. At work, I am absorbed in my job. (cognitive)
17. At work, I devote a lot of attention to my job. (cognitive)

Questionnaire 2. Utrecht Work Engagement Scale:

1. At my work, I feel bursting with energy. (vigor)
2. I find the work that I do full of meaning and purpose. (dedication)
3. Time flies when I'm working. (absorption)
4. At my job, I feel strong and vigorous. (vigor)
5. I am enthusiastic about my job. (dedication)
6. When I am working, I forget everything else around me. (absorption)
7. My job inspires me. (dedication)
8. When I get up in the morning, I feel like going to work. (vigor)
9. I feel happy when I am working intensely. (absorption)
10. I am proud of the work that I do. (dedication)
11. I am immersed in my work. (absorption)
12. I can continue working for very long periods at a time. (vigor)
13. To me, my job is challenging. (dedication)
14. I get carried away when I'm working. (absorption)
15. At my job, I am very resilient, mentally. (vigor)
16. It is difficult to detach myself from my job. (absorption)
17. At my work I always persevere, even when things do not go well. (vigor)

CRUD Operation on WordPress Database Using C# And REST API

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Subject Area: Computer Science.
Type of the Paper: Experimental Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10197134
Google Scholar Citation: IJAEML

How to Cite this Paper:
Chakraborty, S., & Aithal, P. S., (2023). CRUD Operation On WordPress Database Using C# And REST API. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 130-138. DOI: https://doi.org/10.5281/zenodo.10197134

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0197

Received on: 15/10/2023
Published on: 23/11/2023

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ABSTRACT

Purpose: *IoT is famous for research with sensor data. The standard way is to keep sensor data inside IoT platforms like AWS, Google, and Microsoft Azure cloud. We must pay to keep or exchange the data among different systems. Here, we provide a different approach to keep our research data inside the cloud. We created a communication channel using the C# application and WordPress website database over REST API, which is now widespread. Our data format is JSON, which is the industry standard. Upload data to the website database using an HTTP client from the C# application. The uploaded data can be accessible from anywhere among the various systems. Our website runs round the clock, so our data is always available. This procedure might be cheaper than the available solution due to the use of our existing website database. Through the practical approach, we demonstrate how to do that. This procedure can be helpful for the researcher trying to keep their research data at a cheap cost inside the cloud. The complete project code is available to download, and the value addition to this work.*

Design/Methodology/Approach: *We first install "Local" software inside our system. On that, we installed a WordPress website. Then, we create a custom route for our experiment to differentiate from existing website content inside the server using PHP. Then, we added our module, which provides CURD operation. This module receives JSON-structured content, which is converted by the WordPress engine. The module parses the command and processes it accordingly. The response is returned to the client application. We created a C# application with a couple of GUI elements to interact with the user. We added a couple of modules using the Nuget package manager for REST API. After the application opens, the first action is to connect with the database. Once the database is available, CRUD operation can be executed.*

Findings/Result: *We tested the entire project using practical deployment. The performance is pretty good. A small quantity of network latency is present in our observation. The content updation time depends on website bandwidth, network traffic, the system's specification, and the number of running applications.*

Originality/Value: *Over the net, there is some practical documentation on C# REST API on the WordPress Website. Sometimes, researchers working on WordPress websites want to use database operation over REST API. Here, we demonstrate this through practical examples. So, it is a slightly different approach for quickly understanding the communication flow.*

Paper Type: *Experimental-based Research.*

Keywords: REST API in WordPress and C#, REST API Demonstration, CRUD Operation in WordPress Website. Database operation using REST API.

1. INTRODUCTION :

We research in various fields. In all research projects, we process data. Some research must store processed and unprocessed data inside the cloud to access other team members or provide global data. In this scenario, The general trend is to subscribe to the cloud space from well-known cloud providers like AWS, Microsoft, Google, etc., which are efficient and easy to deploy. The only thing is to pay for the cloud server. Generally, the cost varies due to data traffic and storage space. Sometimes, this cost becomes overhead for the researcher. They keenly search for an alternate way to do the task or execute the research work. There is another way to do the same job without paying money. We can use that website database to store our data if we have our website.

Here, we demonstrate how to store our research data inside the WordPress website database. It is simpler than other available procedures, and we have complete control over the database and communication flow. The same procedure can also be applied to another website with little change. Most research institutes maintain a website that displays the various institutional research content. In the same database, we can use to store our data—the real-time data we can store without issues. The benefit of this process is to minimize the research cost. The deployment is also easy. The recurring fee is nill. Deployment and maintenance is also easy. We use local software for basic testing and code development. It is free and easy to use. Once the product development phase is over, we can deploy it inside the online website.

We create a data table inside the database programmatically from our application. We can also do a direct Admin panel provided by the website. Then, we communicate with the server from our C# REST client application. We need to provide server credentials like ID and Password When the client tries to communicate with the server. Once the connection is successful, we can operate several operations, Like CRUD operation, which are CRETE, READ, UPDATE, and DELETE.

2. RELATED WORKS :

Walker, C. et. Al. introduces the concept of a "Personal Data Lake," which serves as a unified storage facility for storing, analyzing, and querying personal data. It emphasizes the importance of data gravity pulling in data lakes to prevent them from becoming data swamps [1]. Kornienko D. et al. discuss the Single Page Application (SPA) architecture in the context of developing secure web services [2]. Luo, Y. et al. present insights into low-code development from a practitioner's perspective. It delves into the characteristics and challenges of low-code software engineering development [3]. Al Mahruqi, R. S., et. Al. presents a semi-automated framework for migrating web applications from SQL databases to document-oriented NoSQL databases [4]. Resceanu, I. C. et al. discuss the development of a framework for websites intended for an international audience [5]. Ferry E. et al. comprehensively evaluate the security aspects of the OAuth 2.0 framework [6]. Lemos, A. L. et al. surveyed techniques and tools used in web service composition [7]. Kaewprathum, T. P.'s paper analyzes the architectural aspects of retail omnichannel systems and the integration of cash IT point-of-sale software with e-commerce platforms [8]. Gagliardi, V. introduces the concept of decoupled Django architectures for building web applications with separate front-end and back-end components. It explains the principles and advantages of decoupled web development [9]. Gibbons K. et al. evaluate the security aspects of the OAuth 2.0 framework, focusing on its role in managing access and identity. It assesses the framework's security features and potential vulnerabilities [10]. Prstačić, S. explores the concept of web application frameworks as reusable components [11].

3. OBJECTIVES :

This research work aims to provide reference information on the WordPress website database used for data storage for our research work. Several documents are available over the net. Here, we provide practical examples so the researcher can integrate the WordPress database easily with little effort.

4. APPROACH AND METHODOLOGY :

Figure 1 depicts the complete block diagram of the projects. The central part of the architecture is the C# application. It coordinates the different functional blocks. The four module is connected to the main module. "**WordPress_REST.cs**" is used to communicate with the WordPress database. Inside the module, there are Separate functions for each activity. CREATE, READ, UPDATE, and DELETE. The "**project_BP.cs**" module is for the project-specific JSON object builder module. This module only varies from project to project. The rest of the module is the same for most of the projects. The "**Global. cs**" module is used to store the variable which is used across the different modules. The **GUI element** is used to interact with different commands. We use Datagrid to display fetched data in tabular format. It is also used to edit the data. The list box is used to display the status of different messages. The button is used to execute the command. The textbox is used to receive input from the user.

WordPress website: We worked with the default theme. However, we will use the existing website theme in a real website, which might not be an issue. The main point is registering a custom route with WordPress by adding a callback function. When our website gets a request, it triggers the callback function. Inside the callback function, we write our code, which handles the request of various database handling functions.

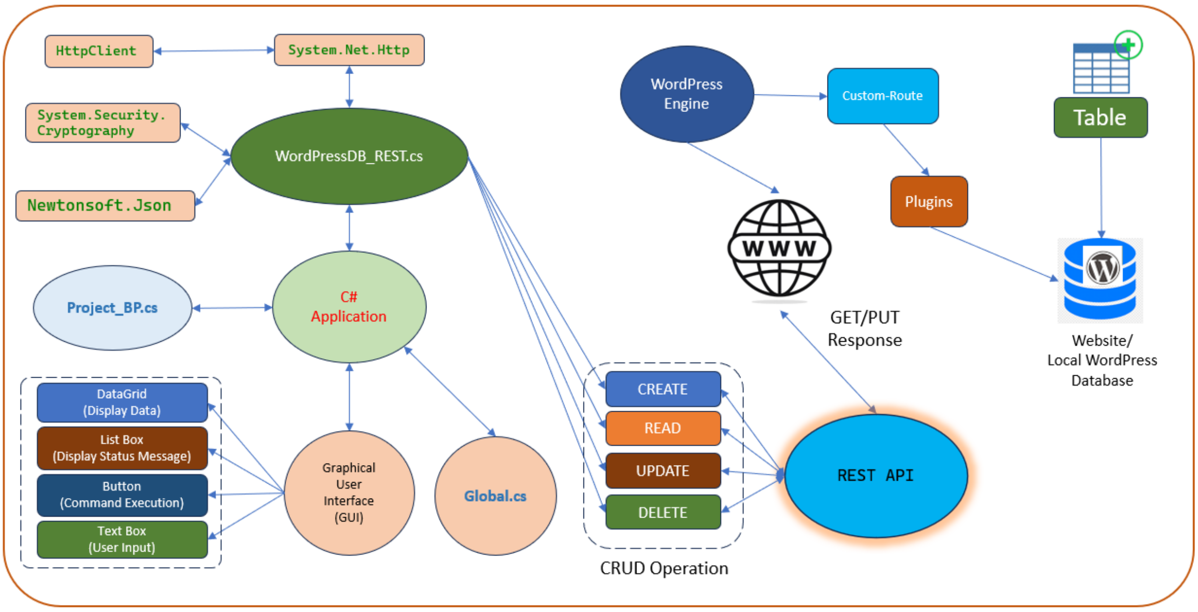

Fig. 1: Project block diagram

Table: The database table stores the data for our research work. We can create the table in different ways. The most common forms are either statically or programmatically. Statically means using the WordPress Adminer panel to create a table using variables from GUI control. Another good way is to create a table from the program. It is also called dynamic table creation. It has advantages, like changing table structure or variable type without logging into the website. We can delete or drop the table at any time.
The complete experiment we will do in local software. Everything development can be done using a local WordPress database. Once the experiment is finalized, we can take the website backup and restore it to the remote website. Several free plugins are available to create database backup and restore quickly without any issues. When the C# client requests some data. The query reaches the callback functions, and according to the function, the server replies to the client using JSON format.

5. EXPERIMENT :

Now, we will do some experiments for our experience. We need to follow the following steps:
Install WordPress: Open the link https://localwp.com/ in a browser. Click on the "**Download for free**" button. Select the platform, complete the form, and click "**GET IT NOW!**". One file will download; it looks like ***local-8.0.1-windows***. Double-click on the setup file and install the software.
Once the installation is finished, Click the "**WP Admin**" button from the local dashboard. From the left side menu, under the "**Appearance**," click on "**Themes**." We work with the 2023 theme. So make sure to "**Active: Twenty Twenty-Three.**"(Another theme is also pretty fine).
Create a file "***functions.php***" inside the C:\Users\..\LocalSites\xxxx\app\public\wp-content\themes\twentytwentythree\. Add the below code inside the "**functions.php,**" which is depicted in Figure 2.

```
C: > Users > sudip > Local Sites > simulab > app > public > wp-content > themes > twentytwentythree > functions.php
<?php
    require get_theme_file_path('/inc/custom-route.php');
```

Fig. 2: Code example for functions.php

Create a folder “**inc**” inside the path: C: \Users \xxxx\ Local Sites\ xxxxx \ app \ public \ wp-content \themes\ twentytwentythree: Inside the “**inc**” folder, create a file “**custom.php**” add the code depicted in Figure 3: Figure 3 depicts the execution code.

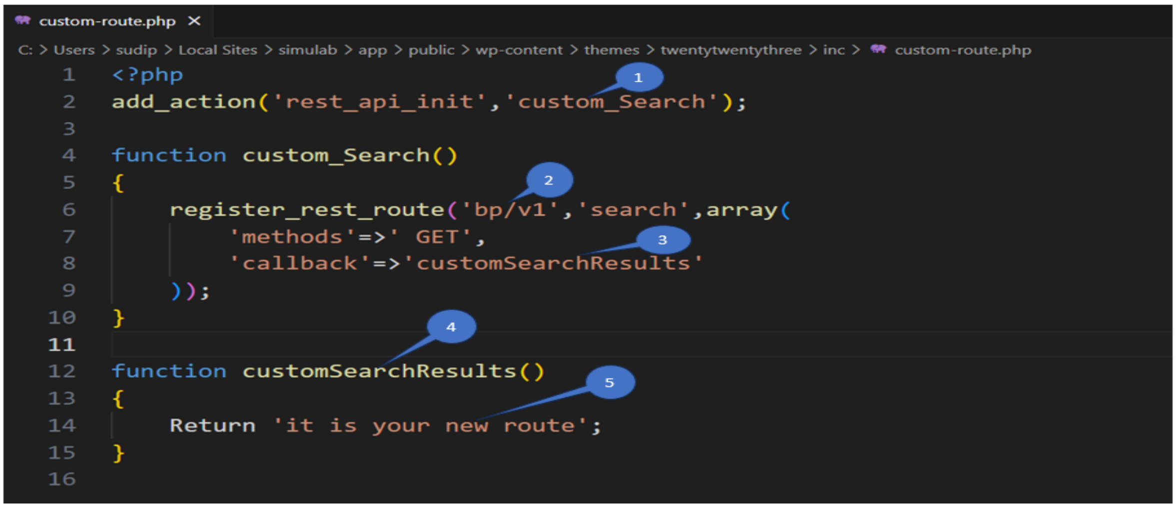

Fig. 3: Code example for custom-route.php

Now, we see the meaning of the code, which is marked in Figure 3.

1) This is the action function needed to register with WordPress.
2) This is the custom route we created.
3) the callback function name must also be registered with the WordPress engine.
4) This is the callback function. The callback function fetches when the server gets called.
5) This is where we place our actions to process the client's request.

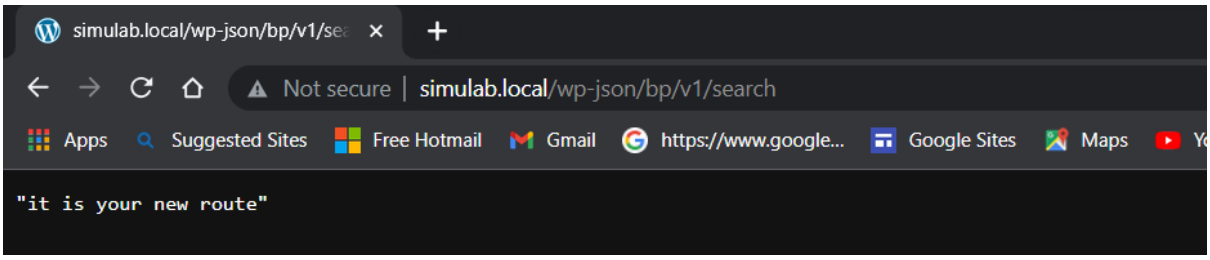

Fig. 4: Test code in the browser

After writing the code, save and close. Open the browser and type: http://xxxxx.local/wp-json/bp/v1/search. xxxxx is the website name. Figure 4 depicts the search result. Figure 4 gives the search result showed inside the browser.

Figure 5 depicts the code for the “connect” button. When we press the “connect,” it will call DB. Connect (), which indicates in line number 35 to 40. Line number 59 to 81 indicates the code to connect with the server. At first, we are creating an HTTP client. Then it tries to authorization with the server. It was then using API url string connecting with the server. The server parses the command and responds, “OK”. Receive the response code and verify the string. If it is “OK,” it shows “connected.”

```csharp
private async void btn_connect_Click(object sender, EventArgs e)
{
    await  db.Connect("http://simulab.local/wp-json/db/connect");
    if (db.Connected) msg.push("Connected With Database OK");
    else msg.push("Error!!! Not able to connect");
}
```

```csharp
/// <summary>
/// @brief This function is used to check the existence of the server. it sends a string "connect" to the server.
/// if the server running, response with "ok" message.
/// @param apiUrl=API url string
/// @return void
/// </summary>
///
public async Task  Connect(string apiUrl)
{
    if (Connected) return;
    HttpClient client = new HttpClient();
    string base64Auth = Convert.ToBase64String(Encoding.ASCII.GetBytes($"{Uid}:{Pwd}"));
    client.DefaultRequestHeaders.Authorization = new System.Net.Http.Headers.AuthenticationHeaderValue("Basic", base64Auth);
    HttpResponseMessage response = await client.GetAsync(apiUrl);

    Task.WaitAll(response.Content.ReadAsStreamAsync());
    // Check if the request was successful
    if (response.IsSuccessStatusCode)
    {
        // Read and display the response content
        string content = await response.Content.ReadAsStringAsync();
        content=content.Trim(new char[] { '\r', '\n', '"' });
        if (content =="ok") Connected=true;
        else                Connected=false;
    }
    else
    {
        Connected=false;
    }
}
```

Fig. 5: the example code for connect button

```csharp
57      private async void btn_create_table_Click(object sender, EventArgs e)
58      {
59          await db.send(bp.Get_Create_Table_obj());
60          if (db.str_response=="<Table Created>") msg.push("Table Created");
61          else msg.push("Error!!! Unable to create Table");
62      }
```

```csharp
28      public bp_data Get_Create_Table_obj()
29      {
30          string createTableQuery =
31            "CREATE TABLE IF NOT EXISTS "+table+"( "+
32            "id mediumint(11) NOT NULL AUTO_INCREMENT, "+
33            "User_ID varchar(10) NOT NULL, "+
34            "DateTime datetime NOT NULL, "+
35            "SIS INT(3) unsigned NOT NULL, "+
36            "DIA INT(3) unsigned NOT NULL, "+
37            "PUL INT(3) unsigned NOT NULL, "+
38            "PRIMARY KEY id(id) )";
39
40          bp_data bp_Data = new bp_data();
41          bp_Data.cmd="create";
42          bp_Data.cmd_string=createTableQuery;
43          return bp_Data;
44      }
```

Fig. 6: The example code for programmatically Table creation

Create Operation: Figure 6 depicts the example code for the Table Create operation. To create a table dynamically, we added a button on the GUI called "CREATE" and added a few lines inside the button handler, which showed lines 57 to 62. At first, we build a JSON object for table creation, which resides in the **Project_BP.cs** module. Once we get the object, send it to the server. Line numbers 28 to 44 show how we build the Table creation object. The **bp_data** is the JSON object class that returns object data. Once the Table is created successfully, The server responds by "<Table Created>, " defined inside the WordPress server response handler php file.

```
99
          1 reference
100       private async void btn_read_all_Click(object sender, EventArgs e)
101       {
102           Check_Connection();
103           if (db.Connected)
104           {
105               await db.send(bp.Get_Read_obj());
106               bp.Fill_DataGrid(db.str_response, dg_display);
107               lbl_record_total.Text="Total Record Count="+dg_display.Rows.Count.ToString();
108           }
109       }
```

```
/// <summary>
/// @brief This asynchronous function is used to send the Data to the server and read the response from the server
/// @param data = json structured to send
/// @return the server response is stored inside the  "str_response" string veriable
/// </summary>
10 references
public async Task send(object data)
{
    HttpClient client = new HttpClient();
    string base64Auth = Convert.ToBase64String(Encoding.ASCII.GetBytes($"{Uid}:{Pwd}"));
    client.DefaultRequestHeaders.Authorization = new System.Net.Http.Headers.AuthenticationHeaderValue("Basic", base64Auth);

    //Tranform it to Json object
    string jsonData = Newtonsoft.Json.JsonConvert.SerializeObject(data);

    // Create the HTTP content from the JSON data
    var StringContent content = new StringContent(jsonData, Encoding.UTF8, "application/json");

    // Make the POST request
    HttpResponseMessage response = await client.PostAsync(route, content);
    // Check if the request was successful (HTTP status code 201 indicates success)
    if (response.IsSuccessStatusCode)
    {
        str_response = await response.Content.ReadAsStringAsync();
        str_response=str_response.Trim(new char[] { '\r', '\n', '"' });
    }
    else
    {
        str_response="Error";
    }
}
```

Fig. 7: The Example code for read operation

Read Operation: Figure 7 depicts the read operation from the server. We added a button named "READ" and added code depicting line numbers 100 to 109. It first checks the connection. If the server is not connected, it will try to connect with the server by sending the string "**connect**." If the server responds with "OK," it is considered connected. Then, we get the JSON object for reading. Once the response is available, we parse the response and fill the data using the "**Fill_DataGrid**" function. Display the record count using the data grid row count. In the second part of the figure is the send function, which is asynchronous. At first, It creates an HTTP client. Then, it generates an authentication header. After that, Convert JSON content to HTTP content. Then, post the content using the async "POST" method.

```
1 reference
private async void txt_insert_Click(object sender, EventArgs e)
{
    DateTime myDateTime = DateTime.Now;
    string sqlFormattedDate = myDateTime.ToString("yyyy-MM-dd HH:mm:ss");

    bp_data b = bp.Get_Insert_String(txt_user_id.Text, sqlFormattedDate, txt_sys.Text, txt_dia.Text, txt_pul.Text);
    await db.send(b);
    if (db.str_response=="Failed to Insert data")
    {
        msg.push("Failed to Insert data");
        return;
    }
    else
    {
        await db.send(bp.Get_Read_obj());
        bp.Fill_DataGrid(db.str_response, dg_display);
        dg_display.ClearSelection();
        dg_display.Rows[dg_display.RowCount - 2].Selected = true;
        dg_display.CurrentCell = dg_display.Rows[dg_display.RowCount - 2].Cells[0];
        lbl_record_total.Text="Total Record Count="+dg_display.Rows.Count.ToString();
    }
}
```

```
1 reference
public bp_data Get_Insert_String(string id, string dt, string sys, string dia, string pul)
{

    bp_data bp_Data = new bp_data();

    bp_Data.cmd="insert";
    bp_Data.cmd_string="";
    bp_Data.tbl_name=table;
    bp_Data.User_ID=id;
    bp_Data.DateTime=dt;
    bp_Data.SIS=sys;
    bp_Data.DIA=dia;
    bp_Data.PUL=pul;

    return bp_Data;
}
```

Fig. 8: The Example code for Insert operation.

Insert Operation: Figure 8 depicts the function of inserting data into the database. We create a button called “INSERT” and add a couple of codes, shown in lines 77 to 98. At first, we are preparing SQL formatted date. Then, we send the insert data as a parameter to the **Get_Insert_String** function. In return, we get one JSON object. It is sent to the server. If data insertion is successful, it returns OK. After that, we read back and display the data to the data grid to confirm that the data is successfully inserted.

```
1 reference
private async void dg_display_PreviewKeyDown(object sender, PreviewKeyDownEventArgs e)
{
    if (e.KeyCode == Keys.Enter)
    {
        object b = bp.Get_Update_data(dg_display);
        await  db.send(b);
    }
}
```

```
1 reference
public object Get_Update_data(DataGridView dg)
{
    int c_row = dg.CurrentRow.Index-1;

    string Record_ID = dg[0, c_row].Value.ToString();
    string User_ID = dg[1, c_row].Value.ToString();
    string STS = dg[3, c_row].Value.ToString();
    string DIA = dg[4, c_row].Value.ToString();
    string PUL = dg[5, c_row].Value.ToString();

    bp_data bp_Data = new bp_data();

    bp_Data.cmd="insert";
    bp_Data.cmd_string="";
    bp_Data.tbl_name=table;
    bp_Data.id=Record_ID;
    bp_Data.User_ID=User_ID;

    DateTime myDateTime = DateTime.Now;
    string sqlFormattedDate = myDateTime.ToString("yyyy-MM-dd HH:mm:ss");
    bp_Data.DateTime=sqlFormattedDate;

    bp_Data.STS=STS;
    bp_Data.DIA=DIA;
    bp_Data.PUL=PUL;

    return bp_Data;
}
```

Fig. 9: the code for the database update operation

Update Operation: Figure 9 depicts the update operation. When we change some parameters inside the data grid and press enter, Datagrid **PreviewKeyDown** is triggered. At first, we get an updated JSON object from the selected DataGrid row. The second part of the figure shows the parsing of the data from the data grid and the creation of the JSON update object. Once we get the object, send it to the server.

```
1 reference
private async void button5_Click(object sender, EventArgs e)
{
    DialogResult result = MessageBox.Show("Do you want to Delete Record?", "Confirmation",
        MessageBoxButtons.YesNo, MessageBoxIcon.Question);

    if (result == DialogResult.Yes)
    {
        int c_row = dg_display.CurrentRow.Index;
        string Record_ID = dg_display[0, c_row].Value.ToString();
        await db.send(bp.Get_Delete_row_obj(Record_ID));
        ///////////////////////////////
        await db.send(bp.Get_Read_obj());
        bp.Fill_DataGrid(db.str_response, dg_display);
        lbl_record_total.Text="Total Record Count="+dg_display.Rows.Count.ToString();

    }
}
```

Fig. 10: the code for delete operation

Delete Operation: Figure 10 depicts the delete operation. When we want to delete any record, select the row in the data grid and press the delete record button. We added a couple of codes inside the button handler. At first, we display a confirmation message. Once confirmation is received from the user, create a JSON object using the record ID. Then, the complete structure is sent to the server for record deletion. After deletion. We read the record and display it to the data grid so that we can see that our record is deleted.

6. RECOMMENDATIONS :

- The project is available: https://github.com/sudipchakraborty/CRUD-Operation-On-WordPress-Database-Using-C-sharp-And-REST-API.git

- The code is not up to the production-worthy. Need to implement error handling. Due to keeping code simplicity, we did not include the try-catch block.

7. CONCLUSION :

REST API is popular nowadays. It is excellent and easy to implement. Using this API, we communicate with the WordPress website server and perform CRUD operations. The researcher who wants to integrate a database operation over REST API can get practical reference information here. The code is available for easy implementation.

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How to Empower Educators through Digital Pedagogies and Faculty Development Strategies

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Subject Area: Education Management.
Type of the Paper: Exploratory Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10392559
Google Scholar Citation: IJAEML

How to Cite this Paper:
Aithal, P. S. & Aithal, S. (2023). How to Empower Educators through Digital Pedagogies and Faculty Development Strategies. *International Journal of Applied Engineering and Management Letters (IJAEML), 7*(4), 139-183. DOI: https://doi.org/10.5281/zenodo.10392559

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0198

Received on: 08/10/2023
Published on: 16/12/2023

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ABSTRACT

Purpose: *In order to fully explore and comprehend the dynamic intersection between digital technology, pedagogical innovation, and faculty development within the higher education landscape, it is currently necessary to empower educators by providing them with training in digital pedagogies and various other faculty development strategies in higher education institutions, including universities. In an era of rapid technological change and shifting educational paradigms, this research aims to identify efficient tactics and approaches that can enable educators to flourish in their roles as mentors, teachers, and researchers. This research seeks to provide important insights that will help educational institutions improve the quality of teaching, learning, and research, thereby fostering a more robust and responsive educational ecosystem. It does this by looking into global trends, synthesizing postulates, and offering useful suggestions.*

Methodology: *Exploratory research methodology is used. Required information are collected using various online sources through Google search engine, Google Scholar search engine, and Various GPTs including ChatGPT and Bard. The information is analysed, evaluated, and interpreted as per the specific framework to develop the postulates and provide suggestions to improve the system.*

Outcome: *Based on systematically identified objectives, analysis, evaluation, comparison, and interpretation, on how to empower educators through digital pedagogies, and faculty development strategies, few postulates and suggestions are presented as the outcome of this exploratory research.*

Originality/Value: *Through systematically reviewing the current status, and collecting secondary information, various digital pedagogies for classroom teaching, blended teaching, and online teaching, faculty development strategies for improving classroom teaching, online teaching, and blended teaching are identified, analysed, compared, evaluated, and interpreted with unique suggestions.*

Type of the Paper: *Exploratory Research*

Keywords: Higher education system, Empowering educators, Faculty development strategies, Digital pedagogy, Education technology, Theory of Accountability in HEI. ABC model of faculty Research productivity

1. INTRODUCTION :

The quality of education and students' readiness for the fast-changing global context are directly impacted by instructors' empowerment in the digital era. Information and technology are fundamental to practically every element of society in the modern digital age, and education is no different. The transmission of crucial digital literacy skills as well as subject-specific knowledge is sped up by educators. By giving them the necessary tools, they can maximize the potential of digital pedagogies and tools to engage students, improve the learning process, and get them ready for a future filled with technological opportunities and challenges [1].

Additionally, the entire nature of teaching and learning has changed as a result of the digital age. With the introduction of blended and online learning settings, instructors must successfully adapt to new teaching strategies, a variety of learning preferences, and the integration of digital resources. By giving educators the skills and confidence, they need to deal with these changes, we can encourage innovation and creativity in the classroom. It also encourages ongoing professional development, allowing teachers to keep abreast of new technology and pedagogical theories, ultimately helping both teachers and students achieve academic achievement in an increasingly digital society [2].

Digital pedagogies and faculty development strategies are important concepts in the field of modern education, particularly in the context of the digital age. "Digital pedagogies" refer to a variety of instructional tactics and teaching methods that use technology and digital technologies to enhance the learning process. These instructional approaches go beyond traditional classroom instruction and take advantage of the vast array of possibilities offered by digital resources, such as multimedia content, online collaboration, and interactive simulations. Students' engagement, tailored instruction, and the development of critical digital literacy skills are all given top priority in digital pedagogies. Educators can use technology to create engaging, diversified learning environments that cater to the needs and preferences of 21st-century students by employing these strategies [3].

On the other hand, faculty development strategies are initiatives and programs made to help and empower teachers as they adopt excellent teaching approaches, including digital pedagogies. These approaches take into account the dynamic nature of the educational environment and the ongoing requirement for educators to increase their knowledge and expertise. The efforts made to enhance faculty include seminars, workshops, online courses, mentorship programs, and chances for peer collaboration. These techniques aim to provide educators with the skills and materials needed to flourish in their positions, accommodate cutting-edge educational technologies, and ultimately enhance student outcomes. The dedication of educational institutions to providing high-quality and creative education in the digital age depends critically on faculty development [4].

A symbiotic link exists between faculty development initiatives and digital pedagogies. Initiatives for faculty development give teachers the knowledge and assistance they need to successfully incorporate digital pedagogies into their teaching methods. On the other hand, by providing fresh and interesting ways to provide professional development content, the adoption of digital pedagogies can revitalize and stimulate faculty development activities. As a result of this dynamic interaction, educators are better able to understand the challenges of the digital age and promote more effective teaching and learning environments for both teachers and students [5].

In this paper, a fundamental and systematic inquiry is made at the center of contemporary education in the digital age is "How can educators be effectively empowered through digital pedagogies and faculty development strategies?" In addition to highlighting the need of providing students with the skills and information necessary to succeed in a society that is becoming more and more technologically dependent, this question underscores the crucial role that educators have in influencing the learning experiences of students. It is crucial to break this question down into three distinct parts in order to investigate it. First, the study has to look into the characteristics of digital pedagogies as a way to give teachers more power. This entails investigating the different pedagogical strategies that make use of technology, including online resources, blended learning, and flipped classrooms. It should investigate how these digital pedagogies affect teaching and learning effectiveness, how they accommodate various learning preferences, and how they help to promote vital digital literacy abilities in both teachers and students. Second, the study should examine the field of faculty development initiatives and how they might help educators feel more empowered. This component entails a study of the several faculty development initiatives and programs that assist teachers in embracing and mastering digital pedagogies. In order to execute faculty development programs that encourage digital competency and pedagogical innovation among educators, it should also evaluate the efficacy of these tactics, identifying best practices and potential implementation difficulties. In order to provide a thorough understanding of the best ways to empower educators through the synergy of digital pedagogies and faculty development techniques, the research should strive to synthesize the data from the preceding dimensions. This synthesis should provide useful advice and insights for educational organizations, decision-makers, and teachers themselves, thereby enhancing the quality of education as a whole in the digital age. The study question attempts to identify the pathways to successful educator empowerment, which is essential to the success of education in our quickly changing environment, by addressing three dimensions.

2. INNOVATIONS IN HIGHER EDUCATION IN TEACHING-LEARNING AREA :

In the rapidly evolving landscape of higher education, universities and institutions worldwide are continually innovating in the teaching-learning domain to enhance the educational experience for students. These innovations are driven by advancements in technology, pedagogical research, and the evolving needs of a diverse student body [6]. Table 1 identifies several noteworthy innovations in the teaching-learning area of higher education institutions:

(1) Blended Learning and Flipped Classrooms:

(a) Blended learning combines traditional classroom instruction with online elements, offering students flexibility and personalized learning experiences. This approach allows students to access course materials and engage in discussions online while attending in-person classes for hands-on activities and discussions.

(b) Flipped classrooms reverse the traditional lecture and homework structure. Professors record lectures for students to watch before class, freeing up in-class time for interactive discussions, problem-solving, and collaborative projects. This approach promotes active learning and deeper engagement.

(2) Massive Open Online Courses (MOOCs) and online learning platforms:

(a) By giving everyone access to top-notch courses from prestigious colleges and institutions around the world, online learning platforms and MOOCs have democratized education. Many of the courses that students can take are free or cost less than what they would pay at a typical college.

(b) These platforms provide flexibility, allowing users to learn at their own speed and opening up education to a worldwide audience. Some colleges also provide fully online degree programs to meet the demands of working adults and non-traditional students.

(3) Personalized Learning and Adaptive Technology:

(a) Personalized learning uses data analytics and adaptive technology to customize learning experiences and content to the needs of particular students. Algorithms monitor student progress and modify learning resources, tempo, and content complexity as necessary.

(b) By accommodating various learning styles and abilities, this method improves student engagement and achievement. It also aids in locating problem areas where kids might require more assistance.

(4) Gamification and Immersive Technologies:

(a) Gamification makes learning more motivating and interesting by incorporating elements of game design. Features like points, badges, leaderboards, and challenges are frequently included.

(b) Immersive technologies give students immersive learning opportunities, such as virtual reality (VR) and augmented reality (AR). For instance, medical students can simulate surgical procedures in a virtual setting, and students of history can use augmented reality apps to learn about historical events.

(5) Active Learning Spaces and Collaborative Learning:

(a) Redesigned classrooms with flexible seating arrangements and interactive technology support active learning. These spaces encourage collaboration, discussion, and group projects.

(b) Collaborative learning emphasizes teamwork, problem-solving, and communication skills. Group projects and peer teaching are common components, fostering a sense of community and shared responsibility among students.

(6) Microcredentials and Digital Badging:

(a) Microcredentials are short, focused learning programs that provide specific skills and knowledge. They are often offered as certificates, badges, or digital credentials.

(b) These microcredentials allow learners to acquire targeted skills relevant to their careers or interests without committing to full-degree programs. They also enable professionals to continuously upskill or reskill in response to changing industry demands.

These innovations in the teaching-learning area of higher education institutions are transforming the way education is delivered and experienced. They address diverse learning styles, facilitate global access to knowledge, and prepare students for the demands of a rapidly changing world. As technology and pedagogical research continue to advance, universities and institutions worldwide will likely continue to embrace innovative approaches to education, ensuring that students receive the best possible learning experiences.

3. REVIEW OF LITERATURE :

3.1 Review existing literature on digital pedagogies, faculty development, and educator empowerment:

Table 1: Review of some scholarly published papers in the area of digital pedagogies

S. No.	Area/ Topic	Focus and Outcome	Reference
1	Digital technologies and pedagogies	This paper delves into the impact of digital technologies on modern classrooms. It explores the shift from classrooms merely delivering information to becoming hubs of active exploration and creative expression. These new digital tools are enabling students to take on roles as researchers, storytellers, historians, oral historians, and cultural theorists in their own unique ways. Whether they're crafting personal narratives or deciphering the stories of others, the digital medium is fundamentally altering students' ability to combine, interpret, theorize, and generate fresh insights into cultural and historical matters.	Weis, T. M., et al. (2002). [7]
2	Philosophies of digital pedagogy	The discussions within this publication highlight the enduring relevance of philosophy and educational theory in addressing practical, sometimes seemingly 'technical' matters. This serves as a reminder of longstanding issues that have been consistently brought up.	Lewin, D., & Lundie, D. (2016). [8]
3	Model for digital pedagogy	The results indicate three key points. Firstly, in numerous instances, the pedagogical approach is described as socio-constructivist and student-focused. Secondly, pedagogical strategies encompass the techniques employed to enhance student learning, including collaborative and social knowledge-building methods. Lastly, aside from technological, pedagogical, and subject matter expertise, educators' effectiveness in integrating digital technologies into their teaching is enhanced by their high self-confidence and robust peer collaboration abilities.	Väätäjä, J. O., & Ruokamo, H. (2021). [9]
4	Critical examination of initial digital pedagogy adoption	The authors engage in a thorough analysis of the conflicts and inconsistencies present within and among interconnected systems, including the educational system, educational policies, and at-home learning. They investigate how various stakeholders - teachers, parents, and policymakers - perceived and implemented remote digital pedagogy. Conflicts emerged as a result of disparities between digital pedagogy, system regulations, and teachers' digital competencies, resulting in diverse student experiences. This shift also brought changes in the distribution of responsibilities, with parents taking on a more substantial role in overseeing their children's learning.	Greenhow, C., (2021). [10]
5	Digital pedagogy – Experience of Implementation	This paragraph outlines the exploration of the structural and content-related aspects of digital pedagogy. These characteristics encompass content-driven, environmental, technological, and	Toktarova, V. I., & Semenova, D. A. (2020). [11]

		competence-oriented components, which have been examined through research methods such as content analysis, discursive analysis, and the synthesis of contemporary digital technology concepts. The article underscores the importance of digital transformation in education, emphasizing its role in crafting unconventional solutions to traditional pedagogical challenges and in shaping and advancing innovative learning processes rooted in artificial intelligence, big data, and distributed computing.	
6	Improving Student Teachers Digital Pedagogy	This investigation delves into the characteristics of meaningful learning experiences that student teachers identify as instrumental in enhancing their digital pedagogical skills. It focuses on how these meaningful learning activities equip student teachers to effectively incorporate digital technologies into their forthcoming teaching endeavours.	Sailin, S. N., & Mahmor, N. A. (2018). [12]
7	Prepare teachers for the digital generation	There is an immediate need to integrate digital pedagogy into the training of these educators, enabling them to understand the significance of technology in the intersection of pedagogy and subject matter knowledge (TPACK). Fortunately, a diverse array of applications can be readily employed on devices like iPads, Androids, eTablets, and smartphones to facilitate pedagogical instruction.	Kivunja, C. (2013). [13]
8	Digital Pedagogy for Sustainable Learning	This paper concentrates on exploring the impact and advantages of digital pedagogy in the context of sustainable learning. The multifaceted nature that underpins the evolving concept of sustainable learning provides an effective platform for fostering interdisciplinary collaboration and networking. The attainment of common objectives, shared values, and sustainable means becomes a formidable challenge until there is swift progress in data innovation, information technology, digital learning, global data access, information communication technologies (ICT), and the development of self-organized socio-technical networks. Additionally, there is a fresh avenue for innovation known as 'Susthingsout,' which encompasses creative pedagogy, an improved teaching platform, and enhanced e-magazines and virtual e-learning platforms.	Nanjundaswamy, C. (2021). [14]
9	Two decades of digital pedagogies in the performing arts	In this article, we present a comprehensive examination of digital teaching methods within the realm of performing arts, specifically focusing on theater and performance while also drawing insights from the domains of dance and music. We categorize three distinct teaching paradigms incorporating technology: the minimalist approach, the blended approach, and the fully online approach. Within the blended approach, we	Wake, C. (2018). [15]

		distinguish three subtypes, each with technology serving as either a supplementary tool, an organizational framework, or a foundational support structure. We conclude by addressing contemporary challenges, such as resistance to digital adoption, cost considerations, issues of equity, and the imperative of embracing diversity.	
10	Mapping of digital pedagogies in higher education	This study reveals the significant evolution of digital pedagogy in the past two decades while underscoring its continued relevance in contemporary education. The paper also paves the way for future research avenues, particularly in the exploration of adaptable and versatile pedagogical approaches capable of meeting diverse educational needs and scenarios.	Santoveña-Casal, S., et al. (2023). [16]
11	The Importance of Using Digital Pedagogy	The article delves into the significance of digital pedagogy in upholding the quality of higher education, exploring key elements that contribute to its effectiveness. It scrutinizes factors that have a positive impact on educational quality and delves into the nuances of implementing both traditional and digital pedagogical methods within the learning environment.	Mashrabovich, A. A. (2022). [17]
12	From traditional pedagogy to digital pedagogy	The horizon of educational technology is currently aglow with promise, thanks to the proliferation of devices such as smartphones, tablets, and netbooks. This sudden proliferation has granted most students and faculty access to robust computing tools, thereby opening the door to innovative teaching and learning methodologies. Consequently, a growing number of educators are departing from conventional instructional methods, which primarily involve the one-way transfer of knowledge from instructors to students, in favour of cutting-edge strategies that empower students to actively construct their own learning experiences.	Blewett, C. (2016). [18]
13	Examining the perspective of teaching digital pedagogy	This study revolves around pedagogical technology, a method that explores how teachers employ technological innovations to enhance their instructional roles. Additionally, pedagogy aids teachers in transitioning into facilitators of student learning, leveraging available technological resources to enhance educational achievements. Furthermore, it fosters the development of students' potential, even when faced with learning challenges brought on by pandemics.	Harahap, S. D., et al. (2022). [19]
14	A collaborative digital pedagogy experience in the tMOOC	This study examined social MOOCs (sMOOCs) characterized by participant engagement and interactive dynamics within an intercreative model, all with the ultimate goal of transferring knowledge through an efficient replication process. The research specifically investigated the sMOOC called "Step by Step" within the European Commission-funded Elearning, Communication, and Open-data (ECO) Project. This sMOOC is	Marta-Lazo, C., et al. (2019). [20]

		designed to create and implement an innovative pedagogical model for training e-teachers, targeting a particular academic community and equipping learners with digital competencies to prepare them for roles as e-teachers.	
15	Digital education and learning	The analysis leads to the observation that the field of education has seen a substantial influx of technology in recent times. This trend has given rise to various concepts, sectors, and domains, such as Educational Technology, E-Learning, Online Education, and Blended Learning. Taken together, these developments can be collectively referred to as Digital Education or Digital Learning.	Paul, P., et al. (2018). [21].
16	Impact of on-line education on higher education system	Explored in this discussion is the online education system, regarded as the next-generation educational approach, and its profound influence on the advancement of science and society within the realm of higher education. The various models of online education and their significance are examined, with a comprehensive analysis of the advantages, benefits, limitations, and drawbacks associated with online education systems. Additionally, we delve into the attributes of specific online platforms, illustrating this through examples like edX, Alison, NPTEL, and UZity. To cap it off, we draw a comparison between the online education system and an idealized hypothetical educational system.	Aithal, P. S., & Aithal, S. (2016). [22]

Table 2: Review of some scholarly published papers in the area of faculty development

S. No.	Area/ Topic	Focus and Outcome	Reference
1	Rethinking faculty development	The survey findings regarding the Faculty Development Program's outcomes unmistakably reveal a transformation in the collaborative practices of interdisciplinary faculty. Furthermore, it has notably enhanced the faculty's capacity to effectively tackle their specific technological development requirements.	Camblin Jr, L. D., & Steger, J. A. (2000). [23]
2	Professional development in higher education	This segment examines the obstacles confronting faculty members in higher education and elucidates how developmental initiatives that acknowledge faculty as adult learners within a learning-centric institution can yield a more fruitful educational journey for both educators and their students.	Brancato, V. C. (2003). [24]
3	The future of faculty development	The authors draw attention to emerging innovations in faculty development, considering the evolving landscape and challenges faced by higher education institutions. They also delve into further considerations regarding the structures and processes within faculty development practices that require focus, particularly in light of the pressing issues within the field as a profession.	Austin, A. E., & Sorcinelli, M. D. (2013). [25]

4	Teaching science in higher education	For this study, faculty members participating in the program were chosen from 30 different institutions. Data collection and analysis were conducted using ethnographic and case study methods. It was observed that a number of faculty members in this study held perspectives on the change process that posed obstacles to successful implementation. The findings of this research offer a predictive model aimed at supporting faculty in their transformation and identifying effective faculty professional development strategies that can effectively address impediments to change in undergraduate science classrooms.	Sunal, D. W., (2001). [26]
5	Components of an effective faculty development program	It is recommended to adopt a holistic approach to faculty development, encompassing the creation of innovative evaluation and diagnostic techniques, the exploration of effective methods for integrating new technology and curricula, and the pursuit of fresh strategies for enhancing teaching. In this context, it is crucial for faculty development to consider the profound effects of change on both the individual faculty member and the institution as a whole. Consequently, personal and organizational development becomes an integral aspect of faculty development. Only through this comprehensive approach can endeavors for improvement achieve enduring and meaningful results.	Bergquist, W. H., & Phillips, S. R. (1975). [27]
6	The professional development of teachers in higher education	This paper elucidates the underlying reasoning guiding the procedures and techniques applied in professional development programs. It also explores the insights gained from this amalgamation of experiences, shedding light on how to effectively bolster the professional growth of higher education teachers. While these programs primarily target the initial training of educators, it's noteworthy that many of the employed processes are equally applicable to ongoing professional development.	Beaty, L. (1998). [28]
7	Role of faculty development programs in improving teaching and learning	This review article provides a concise overview of literature reviews and resource books related to faculty development. It delves into the significance of Faculty Development Programs (FDP), traces their historical evolution, and raises inquiries about their impact on students' academic performance. Additionally, it examines various approaches for assessing the effectiveness of FDPs.	Kamel, A. M. (2016). [29]
8	Mentoring strategies for faculty development	This article centers on the deliberate use of peer mentoring as a strategy to enhance instruction and introduces the concept of mutual mentoring. It entails faculty mentors collaborating with mentees seeking support in the creation and application of innovative teaching materials or methodologies,	Harnish, D., & Wild, L. A. (1994). [30]

		as well as acquiring fresh knowledge. The article also explores the effects of cross-disciplinary mentoring and the influence of mentoring on the teaching and professional development of both novice and seasoned faculty members.	
9	Co-Teaching in Higher Education	Mentoring relationships offer a highly effective means of fostering the growth and professional development of individuals across various fields. When employed as a framework for professional growth, a mentoring model grounded in co-teaching can significantly enhance teaching proficiency and academic advancement for both faculty members and graduate students in higher education. Successfully integrating co-teaching methods into the higher education mentoring context necessitates careful consideration of several elements, such as a thorough grasp of the model, the joint formulation of a teaching plan, and the continuous cultivation of a collaborative partnership. The co-teaching experience, aimed at creating learning opportunities, has the potential to strengthen mentoring relationships, cultivate more proficient faculty members, enrich students' educational journeys, and empower all involved to become more adept and independent learners in the 21st century.	Cordie, L. A., et al (2020). [31]
10	Models of faculty development for problem-based learning	A holistic faculty development approach, informed by the higher education literature, encompasses several key elements: instructional refinement, professional growth, leadership enhancement, and organizational development. Research findings within the faculty development domain affirm the beneficial outcomes of these endeavors. For example, educators exploring problem-based learning tend to traverse well-defined stages of development, commencing with understanding and embracing the rationale behind this approach. They subsequently gain both general and content-specific tutor knowledge and skills, progress to advanced competencies in problem-based learning, and ultimately foster leadership and scholarly capabilities.	Irby, D. M. (1996). [32]
11	Assessing faculty professional development in STEM higher education	The authors assessed the efficacy of the Faculty Institutes for Reforming Science Teaching IV (FIRST), a professional development initiative designed for postdoctoral scholars. They conducted a study involving program alumni to gauge its effectiveness. While professional development programs for faculty play a vital role in enhancing STEM (Science, Technology, Engineering, and Mathematics) teaching and learning, there is a notable dearth of dependable evidence regarding the long-term effects of these initiatives.	Derting, T. L., et. Al. (2016). [33]

12	Faculty development: yesterday, today and tomorrow	This paper is crafted to offer guidance to individuals responsible for equipping faculty members for the diverse teaching and educational responsibilities in medical and allied health science education. It furnishes a historical context for faculty development and draws from the extensive body of medical, health science, and higher education literature to introduce several frameworks that can be customized for the creation of faculty development programs. These frameworks are invaluable tools for faculty developers, allowing them to methodically blueprint, execute, and assess their staff development initiatives.	McLean, M., et. Al. (2008). [34]
13	Faculty empowerment strategies in higher education institutions	The paper has pinpointed a range of faculty empowerment strategies that should be considered for enhancing the quality of higher education institutions in the context of a comprehensive performance management system founded on 360º appraisal.	Aithal, P. S. (2015). [35]
14	Maintaining teacher quality in higher education institutions	This paper examined the strategies employed by Srinivas Institute of Management Studies, Mangalore, in organizing and managing its human resources to address the evolving needs of the curriculum, students, and the learning environment, all while confronting the challenges of time. The study also delved into the institution's approaches for elevating the quality of its teaching staff.	Aithal, P. S., & Kumar, P. M. (2016). [36]
15	Impact of on-line education on higher education system	This paper explores the online education system as a cutting-edge educational paradigm and its influence on the advancement of science and society within higher education. It delves into various models of online education, discussing their significance, and offers a comprehensive analysis of the pros, benefits, limitations, and drawbacks associated with online education systems. Furthermore, the paper scrutinizes the features of online platforms by examining prominent online education models like edX, Alison, NPTEL, and UZity. Finally, it draws a comparison between the online education system and an idealized hypothetical educational framework called the "Ideal Education System."	Aithal, P. S., & Aithal, S. (2016). [37]

Table 3: Review of some scholarly published papers in the area of educator empowerment

S. No.	Area/ Topic	Focus and Outcome	Reference
1	Influence of empowerment on teachers' organizational behaviours	A descriptive and regression study was carried out to ascertain the impact of empowerment on the organizational behaviors of 215 educators within Catholic Higher Education Institutions in the Philippines. The findings indicate that Catholic teachers exhibit considerable levels of empowerment. More precisely, they manifest	Tindowen, D. J. (2019). [38]

		exceptionally elevated levels of status, professional development, self-efficacy, and influence, along with substantial levels of decision-making autonomy in their scheduling.	
2	Embracing the future: empowering the 21st century educator	In this conceptual paper, it is established that the global educational landscape is undergoing a transition from the industrial age to the connected age, primarily driven by the proliferation of Web 2.0 applications. Human nature, as inherently social, compels us to seek connections, exchange ideas, share knowledge, remix content, and reinvent concepts—all of which can now be effortlessly accomplished with the aid of technology, often in the company of a few friends.	Franklin, T. J. (2015). [39]
3	Measurement of teacher empowerment	Teaching performance among educators pertains to their accomplishments in designing, executing, and assessing educational initiatives. This study adopts a quantitative methodology, with a specific focus on two key variables: professional ethics (X) and the teaching performance of teachers (Y).	Kusumaningrum, D. E., [40]
4	Empowerment: Teacher Perceptions, Aspirations and Efficacy	This paper investigates the alignment between teachers' perceived and desired levels of shared decision-making and their self-efficacy, a pivotal element in the process of reshaping the education system.	Enderlin-Lampe, S. (2002). [41]
5	Leveraging social media and scholarly discussion for educator empowerment	This paper offers insights from a global community of educators who have harnessed the power of social media to create a virtual platform for their scholarly reading group, known as #edureading. The narratives shared by these educators highlight the utilization of social networks on platforms like Twitter and Flipgrid as inclusive spaces for teacher-led professional development.	Kolber, S., et al. (2021). [42]
6	Catalysing change in higher education for sustainable development	ESD has gained global prominence and recognition, particularly within the realm of higher education, where activity in this field has notably expanded. Higher education is increasingly perceived as a potent catalyst for societal transformation, given its role in preparing future professionals and leaders across various sectors. Nonetheless, universities currently face challenges in seamlessly integrating ESD into mainstream teaching practices and faculty training. Integrating ESD into the institutional teaching and learning priorities of universities also presents challenges. A significant proportion of ESD efforts focus on addressing teaching challenges emerging from sustainable development research and providing specialized sustainability modules or courses. Moreover, only a handful of countries and institutions have established substantial staff development initiatives aimed at enhancing the ESD	Mulà, I., et. al. (2017). [43]

		capabilities of university educators and nurturing their academic leadership roles in ESD.	
7	Empowerment or limitation of the teachers' rights and abilities in the prevailing digital environment	The findings indicate that respondents generally hold favorable views regarding learning in virtual environments. The benefits of e-learning are multifaceted, and the analysis revealed that specific factors, such as "age," exhibit statistically significant differences. Conversely, "gender" and "teaching experience" were not found to be influential factors in evaluating the four variables provided.	Toktamysov, S., et al. (2021). [44]
8	From a Guided Teacher into Leader	The research demonstrates that engagement in the TSPD course facilitated teachers in forming a cohesive community with shared objectives. It boosted their self-assurance, enhanced their effectiveness in the classroom, and amplified their capacity to serve as leaders in the realm of education.	Abramovich, A., & Miedijensky, S. (2019). [45]
9	Raising teacher's empowerment in gamification design of adaptive learning systems	The findings indicate that teachers perceived certain aspects of gamification elements, such as missions and levels, as useful and relevant for grasping students' interactions and progress. However, the visualization of students' engagement with trophies was not regarded as relevant. Furthermore, teachers expressed a high degree of appreciation for the creation of personalized missions, especially for demotivated students, to enhance their involvement and help them attain their educational objectives. As a result, this study offers valuable insights to inform the design and refinement of gamified adaptive learning systems.	Tenório, K., et al. (2020). [46]
10	Empowering the frontline	The paper examines six sub-dimensions of empowerment, namely: a) decision-making, b) professional growth, c) a supportive culture, d) self-efficacy, e) work autonomy, and f) utilization of performance data. It underscores the vital role of responsive leadership in promoting empowerment while also highlighting that other organizational factors, including organizational type, structure, size, and past performance, account for substantial variations in empowerment.	Kang, M. M., Park, S., & Sorensen, L. C. (2022). [47]
11	Empowering university educators for contemporary open and networked teaching	This paper outlines six areas of competence that are of particular significance: personal data management, the ability to harness the open web, intercultural digital dialogues, a discerning perspective on media, ethical considerations in the digital realm, and ensuring accessibility. These competences are progressively gaining importance for educators, enabling them to effectively involve learners in the fundamental aspects of our digitally-connected and open societies. They guide learners in collaborative,	Nascimbeni, F. (2020). [48]

		open approaches to address the emerging challenges of our contemporary era.	
12	Teaching as social influence	The research findings suggest that when teachers embrace the role of mentors over that of gatekeepers and prioritize the development of their students' knowledge, they have the potential to foster deep learning, long-term educational growth, and equitable treatment. This perspective could inform the design of teacher training programs and school reform initiatives, with the aim of fully unlocking the learning potential of every student and empowering teachers to act as catalysts for significant individual and societal transformations.	Butera, F., et al. (2021). [49]
13	Effect of demographic variables of university teachers on their perceived teacher empowerment	The study identifies six facets of empowerment, namely "Decision Making, Professional Growth, Status, Self-Efficacy, Autonomy, and Impact." The data analysis involved the use of descriptive and inferential statistical techniques, encompassing mean calculations, t-tests, correlations, and ANOVA. The findings from the research indicate that teachers exhibit a notably high perception of empowerment. It is worth noting that variations in mean scores were observed across different demographic variables, with the exception of qualification.	Rafique, A., & Akhtar, M. M. S. (2020). [50]

3.2 Research gaps, contradictions, and areas where further research is needed:

With the introduction of digital pedagogies and faculty development techniques, the area of education has seen a tremendous transformation recently. These developments could improve teaching and learning results, empower teachers, and better prepare students for the challenges of the twenty-first century. To ensure the successful use of these tactics, further research is essential in areas where there are research gaps, contradictions, and inconsistencies.

Regarding the long-term effects of digital pedagogies on teachers and students alike, there is a considerable study void. There is little research that explores the long-term effects of these instructional approaches, despite a growing corpus of literature suggesting short-term benefits including greater engagement and access to resources. It is necessary to conduct ongoing research on the academic achievement and employability of students who have been exposed to digital pedagogies, as well as the career development of educators who have used digital resources extensively. Such research would provide light on whether these tactics actually empower teachers and equip pupils for success in a world that is becoming more and more digital.

Further research is also needed to resolve contradictions in the published literature. According to some studies, digital pedagogies can improve the educational experience for students with different learning preferences, while detractors contend that these tactics may worsen educational disparities by pushing some students farther behind. It is crucial to investigate the conditions in which digital pedagogies work best and if they create or lessen educational gaps. The role of educator assistance and training in resolving these conflicts should also be the subject of investigation, as faculty development techniques may be essential to guaranteeing equitable results.

Further study is required in the field of how to incorporate digital pedagogies into various educational situations. From elementary and secondary schools to higher education, various educational levels may call for specialized strategies. The success of digital tactics is also influenced by cultural and contextual factors. To ensure that educators are empowered in a way that is sensitive to their particular needs and problems, research should attempt to identify best practices for the integration of digital pedagogies across varied contexts, including rural and urban locations.

Another important area for research is how faculty development initiatives help educators feel more empowered. The most efficient ways to teach and assist educators in implementing digital pedagogies must be determined. Investigating the effects of different professional development programs, internet tools, mentoring methods, and cooperative learning communities is part of this. The relationship between faculty development and educator motivation should also be the subject of research, as motivated teachers are more willing to adopt digital strategies and innovative teaching techniques.
Additionally, further research is still needed on how digital pedagogies interact with cutting-edge technologies like augmented reality, virtual reality, and artificial intelligence. Although there has been little research on how to efficiently harness these technologies' power, there is a great potential for them to improve education. To fully comprehend how these cutting-edge technologies may empower teachers and enhance student results, more research is required.
Though many research studies published on empowering educator by systematic and periodic training to cope the student engagement in the classroom, it has been found that the use of technology, especially, digital technology to develop digital pedagogy and use them effectively in higher education is still need further focus. Various digital pedagogies and training of their use through systematic faculty development programs are still required to familiarise and upgrade educators to use these advanced and effective tools and techniques with confidence to improve the quality of both classroom and online teaching-learning interactions.
Despite the enormous potential for empowering teachers that digital pedagogies and faculty development initiatives offer, there are still significant research gaps, inconsistencies, and uncharted territory that deserve our attention. Future research is necessary in order to fully understand long-term effects, the equitable use of digital techniques, contextual considerations, efficient faculty development, and future technology. In order to ensure that the transformation of education through digital means effectively empowers educators and helps students in a quickly changing digital ecosystem, it is important to address these gaps and contradictions.

3.3 Key theories and frameworks related to educator empowerment and digital pedagogies:

Understanding the key theories and frameworks related to educator empowerment and digital pedagogies is essential for designing effective strategies in the field of education. Table 4 describes some prominent theories and frameworks.

Table 4: Some prominent theories and frameworks on educator empowerment and digital pedagogies

S. No.	Key Theories	Description
1	Constructivism and Social Constructivism	Constructivist theories, notably Jean Piaget's and Lev Vygotsky's work, emphasize the role of active learning and social interaction in knowledge acquisition. In the context of digital pedagogies, these theories underpin the idea that technology can facilitate active learning and collaborative knowledge construction. Educators can empower students by creating digital environments that encourage exploration, problem-solving, and interaction, aligning with constructivist principles [51].
2	TPACK Framework	The Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler, emphasizes the integration of technology, pedagogy, and content knowledge. Educators are empowered when they possess a deep understanding of how to effectively blend technology into their teaching practices while considering subject-specific content and pedagogical strategies. This framework provides guidance on the skills and knowledge required for successful digital pedagogies [52].
3	SAMR Model	Dr. Ruben Puentedura's Substitution, Augmentation, Modification, and Redefinition (SAMR) model provides a framework for classifying how technology affects teaching and learning. It motivates educators to pursue more transformative strategies as opposed to merely replacing conventional methods with digital ones. As educators advance through

		the SAMR levels, from improving current practices to reimagining learning experiences through technology, empowerment takes place [53].
4	Community of Inquiry (CoI) Framework	The CoI paradigm by Garrison, Anderson, and Archer proposes that effective learning happens when there is a balance of three presences: cognitive, social, and teaching, in the context of online and blended learning. Creating a sense of presence and involvement among students is necessary for educator empowerment in digital environments. This paradigm directs educators in encouraging fruitful online conversations, insightful debate, and group knowledge creation [54].
5	Andragogy and Heutagogy	According to the andragogy hypothesis of Malcolm Knowles, adults should be self-directed learners since they learn differently than children. This idea is expanded upon by heutagogy, which emphasizes self-directed learning. These theories imply that empowering educators involves recognizing their autonomy and supporting their ability to design and manage their learning experiences, which is especially relevant in the context of faculty development strategies [55].

Understanding these theories and frameworks provides a strong foundation for educators and institutions seeking to empower educators through digital pedagogies and faculty development strategies. By applying these concepts thoughtfully, educators can harness the potential of technology to create more effective and engaging learning experiences, ultimately benefiting both educators and students in the digital age.

4. OBJECTIVES OF THE PAPER :

(1) Conduct a comprehensive examination of recent innovations in teaching and learning within higher education institutions (HEIs), encompassing universities on a global scale.
(2) Investigate, analyze, and propose strategies for empowering faculty members as effective mentors across diverse Higher Education Institutions, including universities worldwide.
(3) Identify, assess, and critically evaluate a range of strategies employed globally to empower mentors within the higher education landscape.
(4) Thoroughly describe, analyze, and evaluate various digital pedagogical approaches, specifically designed for enhancing classroom teaching within Higher Education Institutions, including universities worldwide.
(5) Delve into the description, analysis, and evaluation of diverse digital pedagogical methods tailored for effective online teaching and blended teaching within Higher Education Institutions, including universities on a global scale.
(6) Compare conventional non-digital pedagogies with futuristic digital pedagogies.
(7) Examine and categorize a spectrum of faculty development strategies utilized in the contexts of classroom teaching, online teaching, and research & publications within Higher Education Institutions, encompassing universities worldwide.
(8) Employ theoretical frameworks to systematically analyze, evaluate, and interpret enhancements in faculty efficiency and annual productivity within the realm of Higher Education Institutions, while drawing upon global perspectives.
(9) Synthesize postulates and practical suggestions derived from the findings of this exploratory research, aimed at empowering educators through the strategic integration of digital pedagogies and faculty development initiatives within Higher Education Institutions, including universities worldwide.

5. METHODOLOGY & INFORMATION COLLECTION :

Exploratory research methodology is used. Exploratory research is typically conducted to gain a deeper understanding of a topic, generate hypotheses, and gather preliminary data before embarking on a full-scale research project. Information are collected using various online sources through Google search engine, Google Scholar search engine, and Various GPTs including ChatGPT and Bard. The information are analysed, evaluated and interpreted as per specific framework to develop the postulates and provide suggestions to improve the system.

6. ANALYSIS OF EMPOWERING MENTORS IN HIGHER EDUCATION :

In the realm of higher education, empowering educators is a paramount objective that directly influences the quality of teaching, learning, and academic innovation within universities worldwide. This comprehensive analysis seeks to explore the multifaceted dimensions of empowering educators in higher education institutions, focusing on the global context. To achieve this, we will delve into the various facets of educator empowerment, the challenges faced, the strategies employed, and the outcomes of these efforts.

6.1 Analysis:

(1) The Importance of Educator Empowerment: By providing students with the knowledge, skills, and critical thinking abilities, educators in higher education institutions play a crucial role in determining the destiny of society. In this context, empowerment refers to the process of giving educators the skills, information, and support they need to flourish in their positions, adjust to shifting educational environments, and continuously improve their instructional methods. Empowered teachers are better able to satisfy the many needs of their pupils, encourage innovation, and promote knowledge in a quickly globalizing environment where technology and educational paradigms are always changing.
(2) Obstacles to Educator Empowerment: There are obstacles to empowering educators in institutions of higher learning. These difficulties varied among areas and institutions, but they frequently include a lack of funding for faculty development programs, reluctance to change, and a mismatch between conventional academic structures and modern expectations. Additionally, attempts to empower instructors may be hampered by the tenure and promotion structures that are common in academia, which occasionally favour research production over excellent instruction.
(3) Techniques for Educator Empowerment: Effective methods for empowering teachers at higher education institutions span from professional development programs to the use of technology to the promotion of a collaborative and innovative culture. Education professionals receive the knowledge and skills they need to improve their teaching methods through faculty development programs, which include workshops, mentoring, and peer learning communities. Digital pedagogies, such as flipped classrooms, blended learning, and online learning platforms, give teachers the tools they need to engage students in more dynamic and individualized ways. Additionally, promoting a culture of innovation and cooperation motivates educators to exchange best practices, try out novel teaching techniques, and contribute to the field of teaching and learning studies.
(4) International Viewpoints on Educator Empowerment: Due to regional, cultural, and contextual variations, there are discrepancies in the empowerment of educators around the world. Faculty development programs and innovative pedagogy are highly valued in many Western nations. Institutions in the United States, for instance, frequently provide tenure-track academics with opportunity to engage in teaching-related scholarship in addition to typical research obligations. On the other hand, certain poor nations provide difficulties for educators in terms of resources and access to technology, which may prevent the adoption of digital pedagogies. In these situations, empowering educators may entail overcoming resource limitations and advancing inclusive, technologically enhanced education.

6.2 Evaluation:

(1) Measuring the Impact of Educator Empowerment: Evaluating the impact of initiatives to empower educators is a challenging endeavour because the results might be complicated and take some time to manifest fully. Student feedback, increased learning outcomes, and educator satisfaction are some common evaluation criteria. These metrics, though, might not fully reflect the range of transformations brought about by educator empowerment. The quality of research output connected to teaching, the ability of educators to adapt to changing educational technology, and the impact on institutional culture should all be taken into account in long-term evaluations of faculty development programs and the incorporation of digital pedagogies.
(2) Obstacles and Restrictions in International Implementation: Although the value of empowering educators is widely acknowledged, putting good ideas into practice on a global level is difficult. Some educators may not have access to opportunities for faculty development and digital infrastructure due to resource differences across institutions and nations. Additionally, institutional norms and cultural aspects may have an impact on how open educators are to change and innovation. As a result, it is

crucial to adapt empowerment techniques to the unique requirements and environment of each institution while taking into account more general worldwide trends.
(3) The Empowerment of Educators: Across the board, technology has a big impact on empowering educators. The digital era has brought about cutting-edge platforms and tools that improve teaching and learning. But there are big regional differences in how these technologies are being adopted. Some colleges may struggle with poor connectivity and access, while others may benefit from robust digital infrastructures and a multitude of online resources. International partnerships and collaborations can promote knowledge transfer and technology transfer in order to close this gap, giving instructors in institutions with limited resources access to digital pedagogies.
(4) Educator empowerment in higher education: Higher education's environment is always changing as a result of technological breakthroughs, shifting student demographics, and societal demands. In this setting, even greater incorporation of digital pedagogies, more advanced online learning environments, and a larger focus on the improvement of educators' digital literacy abilities are all likely to be part of the future of educator empowerment. The post-pandemic era, which has seen a rise in online and hybrid teaching and learning, will also require universities all over the world to adapt. This change emphasizes the value of continual faculty development and the requirement that educators be responsive to and flexible to shifting educational paradigms.
As a result, empowering faculty members in higher education institutions is a universal necessity with significant ramifications for the standard and value of education. Although there are difficulties, the methods used to support educators, such as faculty development programs and the incorporation of digital pedagogies, offer optimistic avenues forward. In order to ensure that educators are adequately prepared to address the changing demands of students and societies in the 21st century, it is essential for institutions, policymakers, and educational stakeholders to work together and engage in these initiatives. Universities may enhance knowledge, innovation, and international progress in this way.

7. STRATEGIES OF EMPOWERING MENTORS IN HIGHER EDUCATION :

Mentors, who are frequently faculty members, play a crucial part in influencing students' academic and professional development in higher education. A key component of creating a positive learning environment in colleges all around the world is empowering mentors. This thorough analysis tries to investigate the various facets of mentor empowerment initiatives while taking the larger context into account. We will examine many dimensions of mentor empowerment, difficulties encountered, methods used, and the results of these efforts.

Empowering educators in higher education institutions, including universities, is crucial for enhancing the quality of education and fostering a positive learning environment. The table 5 contains a list of various strategies to empower educators:

Table 5: Various strategies used in HEIs to empower Educators

S. No.	Key Strategies	Description
1	Continuous Faculty Development (CFDP)	Give educators continual opportunities for training and development so they may stay up to date in their disciplines, update their teaching techniques, and adopt new pedagogical approaches.
2	Peer Mentoring:	Establish peer mentoring programs in which seasoned teachers assist and guide junior or inexperienced faculty members.
3	Faculty Development Centers:	Create centers for faculty development that provide materials, training, and assistance to improve research, teaching, and academic leadership abilities.
4	Encourage Research	Motivate teachers to conduct research and offer incentives to support their academic endeavours, such research grants.
5	Teaching Workshops	Plan seminars on technology integration in the classroom, efficient teaching methods, and classroom administration.
6	Technology Integration through	By offering instruction on the use of educational technology tools, platforms, and pedagogies, you may encourage the

	training them in various digital pedagogies	incorporation of technology into the teaching and learning process.
7	Inclusive Teaching Practices	Encourage the use of inclusive teaching methods by providing instruction on how to create inclusive, diverse classrooms.
8	Flexible Course Design	Encourage instructors to create courses—including those offered in online and hybrid formats—that are adaptive, flexible, and sensitive to the varied needs of their students.
9	Curriculum Development	Involve teachers in the creation and updating of curricula to make sure that they meet the demands of both the labour market and pupils.
10	Student Feedback	Make sure there is a two-way communication channel by gathering, evaluating, and using student input for faculty development.
11	Recognition and Rewards	Reward and honour instructors who have made exceptional contributions to the university community, research, and teaching.
12	Faculty Leadership Opportunities	Give teachers the chance to assume leadership positions in committees, academic departments, or university governance.
13	Interdisciplinary Collaboration:	To promote creativity and comprehensive learning experiences, instructors should be encouraged to collaborate across disciplines.
14	Community Engagement:	Encourage educators to participate in collaborations, outreach initiatives, and service-learning programs that foster community engagement.
15	Research Support:	Provide assistance with grant writing, research facility access, and scholarly engagement in order to support research efforts.
16	Well-being Programs:	Encourage educators to participate in physical and mental health programs to help them cope with stress and have a good work-life balance.
17	Feedback Mechanisms:	Provide educators with channels for providing feedback so they can offer ideas and suggestions for institutional enhancements and procedures.
18	Resources and Infrastructure:	Ascertain that instructors have access to the tools, facilities, and resources required for efficient instruction and research.
19	Assessment Tools:	Give teachers the instruments and processes for assessment so they may assess and enhance the caliber of their instruction and the learning objectives of their students.
20	Collaborative Learning Communities:	Establish communities of practice where educators can exchange difficulties, best practices, and experiences to promote a sense of community.

By implementing these strategies, higher education institutions can empower their educators, leading to improved teaching and learning experiences for students and a stronger academic community. Out of the above twenty identified strategies of empowerment of educators, continuous faculty development (CFD) and Technology Integration through training them in various digital pedagogies are discussed further.

7.1 Analysis:

(1) The Importance of Mentor Empowerment: In higher education institutions, mentors—typically faculty members—act as mentors, advisors, and role models for students. Beyond educating students about certain subjects, they also foster critical thinking abilities, job aspirations, and personal development. It is crucial to empower mentors because it improves their capacity to offer their mentees

appropriate guidance and assistance, which improves student outcomes, career readiness, and overall academic achievement.
(2) Obstacles to Mentor Empowerment: Different regions and institutions face different obstacles when it comes to empowering mentors in higher education institutions. Common challenges include a lack of time and money, competing roles and duties, and explicit incentives and recognition for mentoring. Mentoring can also be taxing, and mentors may find it challenging to adjust to shifting student demographics, requirements, and expectations. It's essential to overcome these obstacles if mentor empowerment is to be successful.
(3) Techniques for Mentor Empowerment: Effective mentor empowerment initiatives in higher education can take a variety of forms, from mentor development programs to the development of a mentoring-positive culture. Mentor training programs equip mentors with the abilities and information they need to do their jobs well. These courses include topics including intercultural communication and the dynamics of mentor-mentee relationships. Institutions can also promote a culture of mentoring by praising and rewarding successful mentors, developing mentorship networks, and offering continuous assistance and resources.
(4) International Viewpoints on Mentor Empowerment: Globally, there are different mentor empowerment tactics due to cultural, economic, and institutional variations. Mentorship is valued as a crucial component of higher education in many Western nations, where institutional programs and regulations are in place. For instance, teacher development programs that emphasize mentoring skills are frequently available in the United States. In contrast, mentoring may be less institutionalized and mentors may not have access to resources or expertise in some underdeveloped nations. Despite these variances, the fundamental ideas of good mentoring—guidance, support, and development—are constant and flexible enough to be applied in a variety of situations.

7.2 Evaluation:

(1) Measuring the Impact of Mentor Empowerment: In order to determine the effectiveness of mentor empowerment activities and to improve strategy, it is crucial to evaluate the impact of these programs. Academic achievement, employment success, and mentee satisfaction are important evaluation criteria. Though it may last longer than a student's academic career, evaluating the long-term effects of mentoring can be difficult. Institutions ought to think about conducting follow-up studies to monitor the professional progression and accomplishments of mentees who have benefited from empowered mentors.
(2) Obstacles and Restrictions in International Implementation: Although the value of empowering mentors is well acknowledged, it can be difficult to put successful techniques into practice on a worldwide level. Disparities in resources between institutions and nations may restrict faculty members' access to mentor training programs and support services. In addition, institutional norms and cultural aspects may have an impact on how ready faculty members are to take on mentorship responsibilities. Institutions may need to customize mentor empowerment initiatives to the unique requirements and settings of their faculty members in order to solve these problems, while also taking into account more general worldwide trends in higher education.
(3) The Role of Technology in Mentor Empowerment: Throughout the world, technology has a big impact on the empowerment of mentors. Communication, information sharing, and collaboration between mentors and mentees can be facilitated via online platforms and digital resources. Technology can also help mentors connect with mentees from a variety of backgrounds and locations. To guarantee that it enriches rather than detracts from the unique and important characteristics of mentorship relationships, technology integration in mentoring should be addressed carefully.
(4) Higher Education's Future of Mentor Empowerment: The environment of higher education is always changing due to shifting student demographics, technological advancements, and shifting pedagogical paradigms. The formalization of mentorship programs, increased acknowledgment of the importance of mentors, and incorporation of mentoring into faculty development activities are likely to be key components of the future of mentor empowerment. Additionally, mentor empowerment should be consistent with the overarching objectives of developing an inclusive, diverse, and equitable culture in higher education.
In conclusion, it is critical for higher education institutions to empower mentors (faculty members) in order to support student success, academic development, and professional readiness. Despite

obstacles, mentor empowerment measures including mentor training programs and the promotion of a mentorship culture present optimistic future directions. In order to ensure that mentors are properly prepared to lead and support students in the 21st century, it is critical for institutions, policymakers, and educational stakeholders to work together and engage in these efforts. Universities can promote knowledge, help students succeed, and improve the standard of higher education globally by doing this.

8. ANALYSIS AND EVALUATION OF DIGITAL PEDAGOGIES FOR CLASSROOM TEACHING :

The incorporation of digital pedagogies into classroom instruction has become a cornerstone of higher education institutions globally in the rapidly changing educational landscape of today. This in-depth investigation intends to investigate the varied aspects of digital pedagogies for classroom instruction from a worldwide perspective. We will explore several facets of digital pedagogies, their importance, the difficulties involved in implementing them, the methods used, and an assessment of their effects on universities and higher education institutions around the world.

8.1 Different Digital Pedagogies for Teaching in Classrooms:

Higher education institutions' use of digital pedagogies in the classroom has revolutionized how instructors interact with students and present material. A collection of numerous digital pedagogies is provided below, along with explanations in more detail:

(1) Flipped Classroom:

(a) Explanation: In a flipped classroom, traditional lectures are replaced by online videos or other readings that students autonomously review before class. The remainder of the class period is then devoted to debates, group projects, and active learning.

(b) Benefits: Encourages participation, student-centered learning, and a greater comprehension of the subject matter.

(2) Blended Learning:

(a) Explanation: Blended learning combines face-to-face instruction with online learning components. It offers flexibility for students to access content and engage in activities online while still participating in traditional classroom sessions.

(b) Benefits: Enhances access to resources, allows for differentiated instruction, and accommodates diverse learning styles.

(3) Online Discussions and Forums:

(a) Explanation: Online discussion boards and forums provide a platform for students to engage in asynchronous discussions, share ideas, and collaborate on assignments. Educators moderate and guide the discussions.

(b) Benefits: Encourages critical thinking, fosters peer interaction, and accommodates diverse schedules.

(4) Collaborative Online Projects:

(a) Explanation: Collaborative online projects involve students working together on assignments, presentations, or research using digital tools and platforms. They may collaborate in real-time or asynchronously.

(b) Benefits: Promotes teamwork, communication skills, and global collaboration opportunities.

(5) Gamification:

(a) Explanation: Gamification involves integrating game elements, such as points, badges, and leaderboards, into educational content. It makes learning more engaging and motivating for students.

(b) Benefits: Increases student motivation, participation, and retention of course material.

(6) Virtual Labs and Simulations:

(a) Explanation: Virtual labs and simulations provide realistic, interactive environments for students to conduct experiments and explore concepts. They are particularly useful in science and engineering disciplines.

(b) Benefits: Offers a safe and cost-effective way to conduct experiments, allows for repetition and experimentation, and accommodates remote learning.

(7) Personalized Learning Platforms:

Explanation: Personalized learning platforms use data analytics and artificial intelligence to tailor content and assignments to individual student needs and preferences. They adapt to students' learning progress.
Benefits: Enhances student engagement, addresses diverse learning needs, and promotes self-directed learning.

(8) Augmented Reality (AR) and Virtual Reality (VR):
(a) Explanation: AR and VR technologies create immersive learning experiences. AR overlays digital content onto the real world, while VR transports users to virtual environments, both of which can be used for educational purposes.
(b) Benefits: Provides experiential learning opportunities, enhances understanding of complex topics, and fosters creativity.

(9) Interactive Multimedia Content:
(a) Explanation: Interactive multimedia content includes videos, simulations, quizzes, and interactive e-books that engage students and promote active learning.
(b) Benefits: Enhances content retention, supports visual and auditory learners, and allows for self-paced learning.

(10) Peer Assessment and Feedback:
(a) Explanation: Peer assessment involves students evaluating and providing feedback on their peers' work. Online platforms facilitate this process and may anonymize the assessment.
(b) Benefits: Encourages critical thinking, promotes self-assessment skills, and provides diverse feedback perspectives.

(11) Social Media Integration:
(a) Explanation: Incorporating social media platforms into the classroom enables discussions, information sharing, and collaboration beyond the confines of the course. Educators can create closed groups or hashtags for specific topics.
(b) Benefits: Encourages active participation, connects students with current events, and fosters networking opportunities.

(12) E-portfolios:
(a) Explanation: E-portfolios allow students to compile and showcase their work, achievements, and reflections throughout a course or program. They often include written reflections on learning experiences.
(b) Benefits: Promotes metacognition, encourages self-assessment, and provides a tangible record of skills and accomplishments.

Each of these digital pedagogies offers unique advantages and can be tailored to the specific learning objectives, content, and preferences of educators and students in higher education institutions worldwide. Implementing a combination of these pedagogical approaches can create a dynamic and engaging learning environment that supports diverse student needs and promotes academic success.

8.2 Analysis:

(1) Importance of Digital Pedagogies: Technology and digital tools are used to enhance classroom instruction through a variety of teaching and learning strategies known as Digital Pedagogies. Digital pedagogies are extremely important in higher education. They present chances for involving students in more interactive, individualized, and group learning experiences. Digital pedagogies can help students strengthen their critical thinking, problem-solving, and active learning skills. Additionally, they give pupils the fundamental technological and digital literacy skills they need to succeed in the digital age.
(2) Difficulties in Adopting Digital Pedagogies: The adoption of digital pedagogies in higher education is not without difficulties, despite its many advantages. Faculty members can run into opposition to change, a lack of technical knowledge, or doubts regarding the effectiveness of these techniques. Due to budget limitations, institutions are forced to spend money on infrastructure, teacher assistance, and training. Additionally, the digital gap can make educational disparities worse by limiting access to technology and digital skills.
(3) Techniques for Using Digital Pedagogies in Education Faculty development, the creation of technology infrastructure, and pedagogical innovation are all key components of successful

implementation methods for digital pedagogies. Faculty development programs give teachers the knowledge and assurance they need to integrate digital tools into their teaching methods. These initiatives should be ongoing and offer peer collaboration and mentoring possibilities. The digital infrastructure that institutions need to invest in includes strong Wi-Fi, learning management systems, and multimedia materials. To match with digital pedagogies like flipped classrooms, blended learning, and online debates, pedagogical innovation entails rethinking curriculum design and evaluation techniques.
(4) International Viewpoints on Digital Pedagogies Due to regional differences in culture, economy, and technology, different digital pedagogies are used in different parts of the world. Digital pedagogies are more prevalent and are being included into the curriculum in places with advanced technical infrastructure, such North America and Western Europe. However, in developing nations, a lack of digital resources and limited access to technology can impede wider adoption. International collaborations, technology partnerships, and open educational materials can make it easier to share information and transfer technology, giving instructors in institutions with fewer resources access to digital pedagogies.

8.3 Evaluation:

(1) Measuring the Impact of Digital Pedagogies: In order to determine their efficacy and improve tactics, it is crucial to gauge the impact of digital pedagogies. Student engagement, learning results, and educator satisfaction are important evaluation indicators. Institutions might also think about how digital pedagogies fit with their objectives and mission. Long-term evaluations should take into account how digital pedagogies help students develop critical abilities like teamwork, problem-solving, and digital literacy, which are essential for their future success.
(2) Obstacles and Restrictions in International Implementation: The global adoption of digital pedagogies poses difficulties because of differences in technological infrastructure, cultural norms, and resource availability. Digital pedagogies may be difficult for institutions and areas with limited access to technology to completely adopt. The readiness of educators and organizations to adopt digital teaching approaches may also be influenced by cultural norms and teaching traditions. It is crucial to adapt digital pedagogy tactics to the unique requirements and situations of each institution while taking larger, global trends in higher education into account in order to handle these problems.
(3) The Role of Technology in Empowerment: Through the use of digital pedagogies, technology has a significant impact on the empowerment of both teachers and students. Technology gives teachers more freedom in their lessons, gives them access to a multitude of digital resources, and gives them possibilities for professional growth. Technology-enabled active learning, individualized education, and access to material outside of traditional textbooks all help students. However, it is crucial to guarantee equal access to technology in order to prevent escalating educational disparities.
(4) Future of Digital Pedagogies in Higher Education: The use of technology in teaching and learning is projected to become even more pervasive in the future of digital pedagogies in higher education. This might involve using data analytics, augmented reality, virtual reality, and artificial intelligence to tailor learning opportunities and offer in-the-moment feedback. Institutions will also need to change to accommodate the post-pandemic era's increased use of online and hybrid teaching and learning. To equip teachers with the skills they need to traverse these shifting pedagogical settings, faculty development will be of utmost importance.
As a result, higher education institutions across the globe are changing due to the adoption of digital pedagogies for classroom instruction. Despite difficulties, the methods used to apply these pedagogies present optimistic future directions. Collaboration and investment in these initiatives are essential from institutions, politicians, and educational stakeholders to give educators and students the tools they need to succeed in the digital age. Universities can do this to improve the standard of instruction, encourage creativity, and better educate students for the constantly evolving demands of the twenty-first century.

9. ANALYSIS AND EVALUATION OF DIGITAL PEDAGOGIES FOR ONLINE TEACHING:

Due to the quick development of technology, online learning has become a crucial component of academic training all over the world. This thorough examination examines the various facets of digital pedagogies for online teaching from a worldwide standpoint. We explore several facets of digital pedagogies, their significance, the difficulties encountered during their implementation, the techniques used to increase their efficiency, and an assessment of their effects on universities and higher education institutions around the world.

9.1 Various Digital pedagogies for online teaching:

Higher education institutions' use of digital pedagogies for online instruction has developed to offer engaging and productive learning opportunities. The following is a collection of different digital pedagogies, accompanied by thorough explanations:

(1) Synchronous Online Classes:

(a) Explanation: Synchronous online classes involve real-time, scheduled virtual meetings between instructors and students. These sessions often use video conferencing tools to facilitate interactive discussions, lectures, and collaborative activities.

(b) Benefits: Promotes real-time interaction, fosters a sense of community, and enables immediate clarification of doubts.

(2) Asynchronous Learning:

(a) Explanation: Asynchronous learning allows students to access course materials and complete assignments at their own pace, within specified deadlines. This flexible approach accommodates diverse schedules and learning styles.

(b) Benefits: Provides flexibility, supports self-paced learning, and accommodates students with varying commitments.

(3) Discussion Boards and Forums:

(a) Explanation: Online discussion boards and forums enable asynchronous text-based discussions among students and instructors. Participants can share thoughts, ask questions, and engage in meaningful dialogue.

(b) Benefits: Encourages critical thinking, supports peer interaction, and provides a space for reflective discussions.

(4) Peer Teaching and Learning:

(a) Explanation: Peer teaching and learning involve students taking on the role of instructors for specific topics or assignments. This approach promotes knowledge sharing, collaboration, and active engagement.

(b) Benefits: Enhances understanding of course material, encourages peer mentoring, and reinforces content mastery.

(5) Flipped Classroom Model:

(a) Explanation: In a flipped classroom, students review pre-recorded lectures or materials independently before synchronous class sessions. Class time is then dedicated to discussions, activities, and clarifying concepts.

(b) Benefits: Promotes active learning, fosters critical thinking, and maximizes in-class engagement.

(6) Gamification and Game-Based Learning:

(a) Explanation: Gamification integrates game elements (e.g., points, badges, competition) into the learning process. Game-based learning uses educational games to teach concepts and skills.

(b) Benefits: Enhances motivation, encourages problem-solving, and provides immediate feedback.

(7) Interactive Multimedia Content:

(a) Explanation: Interactive multimedia content includes videos, simulations, quizzes, and interactive e-books that engage students and promote active learning.

(b) Benefits: Enhances content retention, supports visual and auditory learners, and allows for self-paced learning.

(8) Online Collaborative Projects:

(a) Explanation: Online collaborative projects involve students working together on assignments, presentations, or research using digital tools and platforms. Collaborations can be synchronous or asynchronous.

(b) Benefits: Promotes teamwork, communication skills, and global collaboration opportunities.

(9) Self-Assessment and Reflection:

(a) Explanation: Self-assessment and reflection activities encourage students to assess their own learning progress and reflect on their understanding of course material.

(b) Benefits: Fosters metacognition, encourages self-directed learning, and supports goal setting.

(10) Personalized Learning Paths:
(a) Explanation: Personalized learning paths use data and adaptive technologies to tailor content and assignments to individual student needs and progress.
(b) Benefits: Addresses diverse learning needs, promotes autonomy, and maximizes learning efficiency.
(11) Augmented Reality (AR) and Virtual Reality (VR):
(a) Explanation: AR overlays digital content onto the real world, while VR immerses users in a virtual environment. Both technologies offer immersive learning experiences.
(b) Benefits: Enhances experiential learning, provides simulations for real-world scenarios, and engages learners through immersive content.
(12) Social Media Integration:
(a) Explanation: Incorporating social media platforms into online courses allows for discussions, information sharing, and collaboration beyond the course environment. It connects students with current events and enables networking.
(b) Benefits: Encourages active participation, connects students with real-world applications, and fosters networking opportunities.
(13) E-portfolios:
(a) Explanation: E-portfolios allow students to compile and showcase their work, achievements, and reflections throughout a course or program. They often include written reflections on learning experiences.
(b) Benefits: Promotes metacognition, encourages self-assessment, and provides a tangible record of skills and accomplishments.
These digital pedagogies offer higher education institutions and universities worldwide the tools and approaches needed to create engaging and effective online learning experiences. Educators can choose and adapt these strategies based on their specific learning objectives, course content, and the diverse needs of their students.

9.2 Analysis:

(1) The Value of Digital Pedagogies in Online Education Digital pedagogies for online learning include a wide range of teaching strategies that make use of technology to promote learning in virtual settings. It is impossible to overestimate their importance in higher education, particularly in light of world events like the COVID-19 epidemic, which hastened the use of online learning. Universities may now reach a larger audience, increase student access to education, and offer flexible learning possibilities for students, regardless of their location or available time.
(2) Problems in Putting Digital Pedagogies into Practice for Online Teaching: While digital pedagogies have many advantages, they also present difficult practical problems. Concerns regarding retaining engagement in the online format, guaranteeing accessibility for all students, and addressing issues with online assessment and academic integrity are a few prevalent challenges. Faculty training and development is also frequently needed. The digital divide, which is characterized by unequal access to technology and the internet, is another significant issue, particularly in areas with poor infrastructure.
(3) Digital Pedagogy Implementation Strategies for Online Teaching Faculty development, technological infrastructure, and instructional design are just a few of the techniques that must be used in conjunction for the implementation of digital pedagogies for online teaching to be successful. Faculty development programs give educators the knowledge and assurance they need to use online learning environments, produce interesting digital content, and lead online conversations and activities. Institutions must make investments in a strong technology foundation, such as learning management systems, video conferencing equipment, and safe online testing infrastructure. To produce compelling online courses, instructional design concepts are crucial. These principles include clear learning objectives, multimedia content, and interactive evaluations.
(4) International Viewpoints on Digital Pedagogies for Online Teaching: Due to differences in culture, economy, and technology, digital pedagogies are adopted and integrated for online instruction in different ways around the world. Online education is a well-established and often used method of instruction in technologically advanced nations like North America and Western Europe. However, in developing nations, a lack of digital resources and limited access to technology can impede wider

adoption. International collaborations, partnerships, and projects focusing on technology accessibility, digital literacy, and capacity-building for educators in resource-poor countries are needed to close these gaps.

9.3 Evaluation:

(1) Measuring the Impact of Digital Pedagogies for Online Teaching: In order to determine their efficacy and maximize their use, digital pedagogies for online teaching must be evaluated for their impact. Student involvement, learning outcomes, and instructor satisfaction are important evaluation measures. Institutions should also evaluate the affordability and scalability of online teaching strategies. Long-term assessments have to take into account how well children are acquiring vital abilities like digital literacy, adaptability, and self-directed learning.
(2) Obstacles and Restrictions in International Implementation: The application of digital pedagogies for online instruction encounters difficulties due to differences in technology infrastructure, cultural aspects, and resource availability around the globe. Regions and institutions without widespread access to technology may find it difficult to properly implement online education. The readiness of educators and organizations to adopt digital teaching approaches may also be influenced by cultural norms and teaching traditions. It is crucial to adapt digital pedagogy tactics to the unique requirements and situations of each institution while taking larger, global trends in higher education into account in order to handle these problems.
(3) The Role of Technology in Empowerment: Through digital pedagogies for online instruction, technology plays a critical role in empowering both instructors and students. Tools that improve teaching abilities, facilitate collaboration, and offer real-time feedback are available to educators. Access to a multitude of digital materials, engaging educational opportunities, and more flexibility are all advantages for students. However, it is essential to guarantee equal access to technology in order to prevent escalating educational disparities.
(4) The Evolution of Digital Pedagogies for Online Learning in Higher Education Digital pedagogies for online instruction will continue to be innovative and adapt to new technology advances. Personalized learning experiences and immersive educational content will be made possible by artificial intelligence, data analytics, virtual reality, and augmented reality in online education. Institutions will also need to improve their approaches to online evaluation, faculty development, and combining online teaching with other types of instruction.
Digital pedagogies for online instruction have therefore been included into higher education institutions all around the world. Despite difficulties, the methods used to apply these pedagogies present optimistic future directions. Institutions, governments, and educational stakeholders must work together and invest in these initiatives to make sure that online teaching is efficient, inclusive, and in accordance with students' changing needs and the requirements of the digital age. Universities may continue to offer high-quality instruction that is accessible worldwide and crosses regional barriers by doing this.

10. ANALYSIS AND EVALUATION OF DIGITAL PEDAGOGIES FOR BLENDED LEARNING :

An educational strategy called blended learning, sometimes known as hybrid learning mixes traditional in-person classroom instruction with online or digital components. By combining the best aspects of both in-person and online education, it seeks to give students a flexible and individualized learning environment.
In a blended learning setting, students might participate in in-person instruction for some portions of the curriculum while remotely accessing digital materials like video lectures, discussion boards, or interactive assignments. This method is becoming more and more common in contemporary education since it allows for self-paced learning, encourages student engagement, and takes into account different learning styles.

10.1 Various Digital Pedagogies for Blended Teaching:

Higher education has seen a rise in the popularity of blended learning, which provides a flexible and successful method of teaching and learning. Students' blended learning experiences are being improved by the use of various digital pedagogies. Here are some new proposals about these digital pedagogies:

(1) Flipped Classroom Model:

The usual techniques of instruction are turned around in the flipped classroom concept. Through reading assignments or video lectures, students participate in learning outside of class, and class time is devoted to active learning, debate, and application. The development of interesting pre-class materials is becoming simpler for instructors thanks to emerging technology like interactive video platforms.

(2) Hybrid Synchronous Learning:

In-person and online learning environments are combined in hybrid synchronous learning. Students are required to participate in live, on-campus or online classes. Remote students can take part in conversations and group projects by using cutting-edge video conferencing tools and virtual reality (VR) software to create immersive experiences.

(3) Microlearning Modules:

Providing information in brief, concentrated bursts is known as microlearning. Universities are developing microlearning modules that fit seamlessly into hybrid courses. These modules, which are frequently accessible through mobile apps, are particularly beneficial for just-in-time learning.

(4) AI-Powered Personalization:

Personalized learning paths are being developed using artificial intelligence (AI). AI may personalize the blended learning experience to each student's needs by identifying relevant online resources, activities, and assignments based on their performance and preferences.

(5) Gamification and Simulations:

To boost engagement, gamification components like leaderboards and badges are incorporated into blended courses. In addition, realistic simulations are employed in industries like engineering and healthcare to give students the opportunity to hone their skills and solve problems in a virtual setting.

(6) Peer Learning Communities:

Blended learning must include peer-led learning communities and online discussion boards. Students can share ideas, work on projects together, and encourage one another in these groups.

(7) AR and VR Applications:

Applications for virtual reality (VR) and augmented reality (AR) are being used to build immersive learning environments. For instance, history students might investigate historical events in VR simulations while medical students can practice surgical operations in virtual operating rooms.

(8) Digital Portfolios and e-Portfolios:

The creation of digital portfolios by students is encouraged as a way to highlight their learning, development, and achievements. Students use e-Portfolios as reflecting tools to monitor their learning and skill growth over the course of the course.

(9) Data-Driven Insights:

Analytics technologies that are included in blended learning management systems give teachers information about the engagement and performance of their students. This information can be used by teachers to identify kids who need more help and modify their pedagogical approaches accordingly.

(10) Blended Learning Pathways:

Well-defined blended learning routes are being developed by higher education institutions. For instance, students can decide to complete their degrees using a particular blended curriculum that mixes online and on-campus courses. Such routes provide convenience and flexibility while providing a high standard of education.

(11) Interactive eBooks and OER:

Open educational resources (OER) and interactive digital textbooks are being incorporated into blended learning courses. The learning process is improved by the inclusion of multimedia components, interactive tests, and linkages to other resources in these resources.

(12) Remote Laboratories:

Remote laboratories are being used in science and engineering classes so that students can conduct experiments from any location with an internet connection. These virtual labs provide real-time data analysis and hands-on experience.

(13) Digital Assessment Tools:

Digital assessment tools give teachers effective means of assessing student achievement. For a thorough understanding of student learning results, they may also integrate analytics, plagiarism detection, and autograding tools.

The use of cutting-edge digital pedagogies has aided in the further evolution of blended learning in higher education. These methods seek to give students a rich, interesting, and adaptable learning experience that responds to their particular requirements and goals.

10.2 Analysis of Digital Pedagogies for Blended Learning:

(1) Pedagogical Objectives:
(i) Advantages: Digital pedagogies promote flexible learning, active participation, and tailored instruction.
(ii) Challenges: It's critical to ensure alignment with the course objectives and avoid overloading students.
(2) Technology Integration:
(i) Advantages: LMS and AI are only two examples of the many digital tools that improve engagement and assessment.
(ii) Challenges: Disparities in faculty training and access to technology must be addressed.
(3) Student Engagement:
(i) Advantages: Online chats, rapid feedback, and gamification all boost motivation.
(ii) Challenges: Concerns include social isolation and maintaining motivation.
(4) Assessment and Feedback:
Advantages: Automated grading and a variety of assessment tools save time and offer feedback.
Challenges: It's critical to retain academic integrity and balance different methods of assessment.
(5) Flexibility and Accessibility:
(i) Advantages: With blended learning, different demands and timetables may be met.
(ii) Challenges: It is crucial to provide course accessibility while balancing flexibility.
(6) Monitoring and Evaluation:
(i) Advantages: Tools for monitoring and data analytics provide insights and early interventions.
(ii) Challenges: Attention must be paid to data privacy and accurate analytics interpretation.
(7) Faculty Development:
(i) Advantages: Through training in digital pedagogy, professors can enhance their teaching techniques.
(ii) Challenges: It's crucial to have resources and get past change-resistance.
(8) Learner-Centered Approach:
(i) Advantages: In-depth investigation and student responsibility are encouraged via blended learning.
(ii) Challenges: A culture shift and student support may be necessary for the transition to a learner-centered approach.

10.3 Evaluation of Digital Pedagogies for Blended Learning:

(1) Effectiveness:
(i) Advantages: Digital pedagogies have demonstrated potential for enhancing engagement and individualized instruction.
(ii) Challenges: Depending on the course design and student engagement, effectiveness varies.
(2) Accessibility and Inclusivity:
(i) Advantages: Diverse learners may find blended learning more convenient.
(ii) Challenges: All student needs, including those of students with impairments, should be met by accessibility measures.
(3) Faculty and Student Satisfaction:
(i) Advantages: Many teachers say they are happier now that they are embracing digital pedagogies.
(ii) Challenges: The effectiveness of course design and the usability of the technology both affect student happiness.
(4) Learning Outcomes:
(i) Advantages: Blended learning may result in better learning results.
(ii) Challenges: Effective mechanisms for evaluation and feedback are required.

(5) Cost and Resource Management:
(i) Advantages: Blended learning might use less resources and cost less money.
(ii) Challenges: Technology and faculty development can need significant upfront costs.
(6) Data-Driven Improvement:
(i) Advantages: Analytics of data offer insights for ongoing development.
(ii) Challenges: Concerns about ethics and privacy must be addressed.
(7) Long-Term Viability:
(i) Advantages: Long-term promise exists for blended learning, which is adaptive.
(ii) Challenges: Demanding factors include the speed of technology advancement and the requirement for continual faculty development.
(8) Equity and Inclusion:
(i) Advantages: There are prospects for more equitable education with digital pedagogies.
(ii) Challenges: Focused efforts are necessary for closing the digital divide and promoting inclusivity.

In summary, digital pedagogies in blended learning offer substantial advantages, but they come with a range of challenges. A careful evaluation of their effectiveness, accessibility, cost-efficiency, and impact on learning outcomes is essential. Institutions must address these challenges to harness the full potential of digital pedagogies for blended learning.

11. COMPARISON OF TRADITIONAL NON-DIGITAL PEDAGOGIES WITH DIGITAL PEDAGOGIES IN HIGHER EDUCATION TEACHING AND TRAINING METHODS :

The following table 5 lists a comparison of "traditional non-digital Pedagogies" with "digital Pedagogies" used in Higher Education Teaching and Training methods.

Table 5: Comparison of traditional non-digital Pedagogies with digital Pedagogies

S. No.	Key Indicator	Traditional non-digital Pedagogies	Digital Pedagogies
1	Engagement Levels	Traditional non-digital pedagogies often rely on passive learning.	Digital pedagogies in higher education can enhance engagement through interactive multimedia and online activities.
2	Accessibility	Traditional methods require physical presence.	Digital pedagogies provide greater accessibility for remote learners, breaking down geographical barriers.
3	Personalization	Traditional pedagogies often employ a one-size-fits-all approach.	Digital pedagogies can be personalized to cater to individual learning styles and paces.
4	Interactivity	Real-time interactions, discussion forums, and collaborative tools, fostering dynamic student engagement, etc. are limited in traditional methods.	Digital pedagogies offer real-time interactions, discussion forums, and collaborative tools, fostering dynamic student engagement,
5	Resources	Online resource usage is limited	Provide easy access to a wide range of online resources, including multimedia, databases, and e-books,
6	Feedback and Assessment	Traditional pedagogies may rely more on manual grading and face-to-face feedback.	Digital pedagogies enable rapid feedback and automated assessment tools.
7	Flexibility	Traditional pedagogies follow fixed class times.	Digital pedagogies offer greater flexibility with on-demand access to content, accommodating diverse schedules.

8	Active Learning	New learning techniques like simulations, gamification, and virtual labs, etc. may be less prevalent in traditional settings.	Digital pedagogies often emphasize active learning, problem-solving, and critical thinking through digital simulations, gamification, and virtual labs, etc.
9	Cost-Efficiency	Traditional methods often require substantial investments on physical resources and infrastructure.	Digital pedagogies can reduce costs associated with physical resources and infrastructure, making higher education more affordable.
10	Environmental Impact	Traditional pedagogies may rely on more physical materials and in-person gatherings.	Digital pedagogies have a smaller environmental footprint by reducing paper consumption and commuting.

12. FACULTY DEVELOPMENTAL STRATEGIES :

Strategies for faculty development are essential for boosting teachers' efficacy in universities and institutions of higher learning all around the world. A collection of different faculty development techniques is provided below, along with thorough justifications:

(1) Workshops and Seminars:

(a) Explanation: Workshops and seminars provide faculty members with opportunities for professional growth and skill development. They cover a range of topics, including teaching techniques, assessment methods, and technology integration.

(b) Benefits: Facilitates hands-on learning, encourages peer collaboration, and addresses specific pedagogical challenges.

(2) Mentoring Programs:

(a) Explanation: Mentoring programs pair experienced faculty members (mentors) with less-experienced colleagues (mentees). Mentors provide guidance, support, and expertise to help mentees navigate their teaching and research roles.

(b) Benefits: Offers personalized support, facilitates knowledge transfer, and promotes a sense of community among faculty.

(3) Peer Observation and Feedback:

(a) Explanation: Faculty members observe each other's classes and provide constructive feedback. This practice helps educators refine their teaching methods and learn from their peers.

(b) Benefits: Encourages reflective teaching practices, promotes a culture of continuous improvement, and fosters collegiality.

(4) Communities of Practice (CoPs):

(a) Explanation: CoPs are groups of faculty members who share common interests or teaching approaches. They meet regularly to discuss and exchange ideas, resources, and best practices.

(b) Benefits: Fosters collaboration, provides a platform for idea sharing, and supports ongoing professional development.

(5) Online Learning and Webinars:

(a) Explanation: Online learning platforms and webinars offer flexible, self-paced, or live learning opportunities for faculty. They cover a wide range of topics related to teaching, technology, and research.

(b) Benefits: Allows access to professional development from anywhere, accommodates busy schedules, and promotes digital literacy.

(6) Innovative Teaching Grants:

(a) Explanation: Institutions offer grants or funding to faculty members to explore and implement innovative teaching methods, technologies, or curriculum enhancements.

(b) Benefits: Encourages experimentation, supports pedagogical innovation, and provides financial resources for faculty projects.

(7) Teaching Portfolios:

(a) Explanation: Faculty members create teaching portfolios that document their teaching philosophy, strategies, and evidence of effective teaching. These portfolios are often used for promotion and tenure.

(b) Benefits: Encourages self-reflection, provides a comprehensive view of teaching accomplishments, and supports career advancement.

(8) Inclusive Teaching Workshops:

(a) Explanation: Workshops on inclusive teaching strategies help faculty create equitable and diverse learning environments. They focus on addressing the needs of all students, including those from underrepresented groups.

(b) Benefits: Promotes diversity and inclusion, enhances student engagement, and addresses accessibility and equity issues.

(9) International Collaborations and Exchanges:

(a) Explanation: Faculty members engage in international collaborations and exchanges with institutions abroad. These experiences expose educators to different teaching methods, cultures, and perspectives.

(b) Benefits: Broadens cultural competence, fosters global awareness, and enhances teaching and research through international perspectives.

(10) Assessment and Feedback Mechanisms:

(a) Explanation: Institutions implement assessment tools and feedback mechanisms, such as course evaluations, to gather input from students and peers about faculty teaching effectiveness.

(b) Benefits: Provides actionable insights for faculty improvement, encourages accountability, and supports data-driven decision-making.

(11) Leadership Development Programs:

(a) Explanation: Leadership development programs prepare faculty for administrative roles within higher education institutions. These programs offer training in leadership skills, strategic planning, and management.

(b) Benefits: Equips future academic leaders, supports succession planning, and enhances institutional governance.

(12) Research Support and Grants:

(a) Explanation: Institutions offer research support, grants, and resources to help faculty members advance their research agendas. This includes financial support, access to research databases, and proposal development assistance.

(b) Benefits: Encourages research productivity, contributes to academic excellence, and enhances faculty's scholarly contributions.

(13) Interdisciplinary Collaboration Initiatives:

(a) Explanation: Institutions promote interdisciplinary collaboration by facilitating interactions between faculty from different departments or disciplines. These initiatives encourage the development of multidisciplinary courses and research projects.

(b) Benefits: Fosters innovative approaches, addresses complex problems, and promotes a holistic view of education.

These faculty development strategies provide higher education institutions and universities worldwide with a comprehensive toolbox to support the growth and professional development of their faculty members. Faculty can choose and tailor these strategies based on their career goals, interests, and areas of improvement to continually enhance their teaching, research, and leadership skills.

12.1 Analysis and Evaluation of Faculty Developmental Strategies for Classroom Teaching:

The foundation of all higher education institutions and universities around the world is effective classroom instruction. The learning experiences of students are significantly shaped by the teaching staff. This thorough examination examines the various facets of faculty development strategies for classroom instruction from a worldwide standpoint. We examine several facets of faculty development, including its importance, the difficulties encountered, the methods used, and an assessment of their effects on universities and higher education institutions around the world.

Analysis:

(1) The Value of Faculty Development for Classroom Instruction: A variety of programs are included in faculty development for classroom teaching with the goal of strengthening educators' pedagogical abilities, subject-matter knowledge, and instructional techniques. One cannot stress its importance in higher education. In addition to having an impact on students' academic achievement, effective classroom instruction also advances their general development. Faculty development gives teachers

the tools they need to design inclusive, engaging learning environments, adjust to changing educational technologies, and use practices that are supported by research.

(2) Obstacles to Faculty Development for Teaching in the Classroom: Although it is crucial, faculty growth is not without difficulties. Limited resources, varied faculty motivations, resistance to change, and the need for continual assistance are common challenges. Additionally, time, institutional culture, and competing obligations may present challenges for faculty. Overcoming these difficulties calls for a methodical strategy that takes into account the unique requirements and environments of various institutions.

(3) Faculty Development Strategies for Classroom Teaching: Effective faculty development initiatives use a diverse approach that incorporates pedagogical research, workshops, mentoring, and technology integration. Educators have the chance to learn about cutting-edge teaching strategies, assessment methodologies, and best practices at workshops and seminars. In order to promote knowledge transfer and professional development, mentoring programs match inexperienced professors with experts. With the help of technology integration strategies, educators can effectively use digital tools and platforms in the classroom. Faculty are encouraged to do scholarly research and enhance their teaching strategies by pedagogical research.

(4) International Viewpoints on Faculty Development for Classroom Teaching: Globally, there are different approaches to faculty development because of institutional, cultural, and economic disparities. Faculty development is highly organized in several Western nations, with specific facilities and substantial resources. In contrast, faculty development may be less regulated and professional development opportunities for educators may be more scarce in developing nations. But engagement, active learning, and assessment are the cornerstones of effective teaching and learning that cut beyond cultural and geographic barriers and can be used to a variety of circumstances.

Evaluation:

(1) Measuring the Impact of Faculty Development: In order to evaluate the success of faculty development for classroom instruction and optimize techniques, this impact must be measured. Changes in instructional strategies, student learning results, and teacher satisfaction are important evaluation measures. Long-term evaluations might take into account how faculty growth has affected institutional culture and students' success outside of the classroom.

(2) Obstacles and Restrictions in International Implementation: The application of faculty development methodologies around the globe involves difficulties because of resource inequalities, cultural aspects, and institutional norms. Comprehensive faculty development programs may be challenging for institutions with limited resources to provide. The willingness of faculty members to adopt new teaching strategies may also be influenced by cultural norms and teaching traditions. Institutions should adapt faculty development methods to their unique circumstances and needs while taking into account global trends in higher education in order to meet these difficulties.

(3) The Role of Technology in Faculty Development: Digital platforms such as webinars, online workshops, and the ability to share best practices all play important roles in faculty development. Technology should, however, enhance rather than replace the collaborative and individualized components of teacher development. For successful application, educational knowledge and technical advancements must coexist.

(4) Faculty Development for Classroom Teaching in the Future: Faculty development must constantly adapt to changing educational environments if it is to succeed. The incorporation of diversity, equity, and inclusion (DEI) ideas into faculty development programs is one of the newest developments, along with microlearning and tailored development routes. Additionally, faculty development will keep addressing the difficulties and chances brought on by online and hybrid instructional methods.

In conclusion, faculty development for classroom instruction is essential for raising the caliber of universities and colleges around the world. Despite the difficulties, the techniques used present optimistic future directions. It is imperative that institutions, governments, and educational stakeholders work together to ensure that teachers have the tools they need to deliver inclusive, effective, and engaging lessons that will help students succeed in a world that is changing quickly. Universities can achieve their goal of encouraging excellence in teaching, research, and service on a worldwide scale by investing in the growth of their faculty.

12.2 Analysis and Evaluation of Faculty Developmental Strategies for Online Teaching:

Online instruction has become a crucial part of higher education institutions and universities all over the world in an era of rapid digital development. Faculty members are in the vanguard of this movement since they are responsible for providing high-quality education in virtual settings. This thorough examination examines the various facets of faculty development techniques for online education from a worldwide standpoint. We examine several facets of faculty development, including its importance, the difficulties encountered, the methods used, and an assessment of their effects on universities and higher education institutions around the world.

Analysis:

(1) The Importance of Faculty Development for Online Teaching: In higher education institutions all over the world, faculty development for online teaching is of utmost importance. Online learning provides more learning access, student freedom, and the potential to reach a worldwide audience. However, efficient online instruction necessitates a certain set of abilities that merge pedagogical knowledge with digital literacy. Faculty development provides educators with the skills and resources they need to design inclusive, effective, and engaging online learning environments, ensuring that all students, regardless of where they live, receive a high-quality education.

(2) Obstacles to Faculty Development for Online Teaching: There are a number of obstacles to faculty development for online instruction. Faculty members may encounter opposition to implementing online teaching strategies, worries about losing face-to-face encounters, and reservations about using technology. Additionally, it is logistically difficult to give instructors the proper assistance and training. Accessibility, equity, and the digital divide are further challenges that must be addressed while educating online, especially in places with poor infrastructure.

(3) Faculty Development techniques for Online Teaching: Successful faculty development techniques for online teaching take a complete approach that includes education, mentorship, technology assistance, and continuing evaluation. Workshops and webinars on online pedagogy, course design, and the use of digital tools are open to faculty members. Mentoring programs match beginners with seasoned online educators to offer advice and discuss best practices. Faculty members have access to dependable digital infrastructure, as well as the required tools and resources, thanks to technological support. Continuous improvement is aided by ongoing assessment, which looks at student input, course outcomes, and teacher performance.

(4) International Viewpoints on Faculty Development for Online Teaching: Due to regional cultural, economic, and technological disparities, faculty development strategies for online teaching are adopted and put into practice in different ways around the world. Online education is still developing in certain areas while others have considerable infrastructure and resources supporting it. The fundamentals of good online teaching, such as engagement, interactivity, and assessment, are universal and may be used in any situation. Programs for faculty development must be tailored to the resources and needs of the local area, and international cooperation can help to share expertise and improve capacity.

Evaluation:

(1) Measuring the Impact of Faculty Development: To determine its efficacy and improve techniques, online teaching must evaluate the impact of faculty development. Changes in instructional strategies, student learning results, and teacher satisfaction are important evaluation measures. Long-term evaluations ought to take institutional culture, technological readiness, and the general standard of online education into account.

(2) Obstacles and Restrictions in International Implementation: Faculty development plans for online education have difficulties when implemented globally due to resource imbalances, cultural considerations, and varied levels of technology infrastructure. Faculty development programs may be more extensive at institutions in resource-rich nations than they are at resource-limited ones, which may find it difficult to offer adequate support. Faculty readiness to accept online education can be influenced by cultural norms and instructional traditions. Faculty development strategies should be flexible and customized to particular circumstances while taking into account global trends in higher education in order to handle these problems.

(3) The Role of Technology in Faculty Development: By providing chances for webinars, virtual workshops, and the distribution of best practices via digital platforms, technology plays a crucial role in faculty development for online teaching. To balance technical advancements with pedagogical

experience, though, is crucial. Faculty members should receive training in both technology use and efficient online teaching techniques.

(4) The Future of Faculty Development for Online Teaching: The future of faculty development in online teaching will be marked by continued adaptation to evolving educational landscapes. Emerging trends include microlearning, personalized development pathways, and the integration of diversity, equity, and inclusion (DEI) principles into faculty development programs. Additionally, faculty development will continue to address the challenges and opportunities presented by hybrid and fully online teaching modalities.

Consequently, faculty development for online teaching is essential for raising the caliber of universities and higher education institutions around the world. Despite the difficulties, the techniques used present optimistic future directions. To guarantee that teachers are well-equipped to deliver engaging, efficient, and inclusive online learning experiences that prepare students for success in a fast-changing world, collaboration among institutions, legislators, and educational stakeholders is crucial. Universities can achieve their goal of encouraging excellence in teaching, research, and service on a worldwide scale by investing in the growth of their faculty.

12.3 Analysis and Evaluation of Faculty Developmental Strategies for Research and Publications:

Universities and other higher education institutions all throughout the world see research and scholarly publication as essential to their missions. In developing knowledge, solving societal issues, and reshaping the academic landscape, faculty members are crucial. This in-depth investigation examines the various facets of faculty development plans for research and publication from a global standpoint. We examine several facets of faculty development, including its importance, the difficulties encountered, the methods used, and an assessment of their effects on universities and higher education institutions around the world.

Faculty development strategies for research and publications:

Faculty development strategies for research and publications are crucial for promoting scholarly productivity and advancing the mission of higher education institutions and universities worldwide. Here is a list of various faculty developmental strategies, along with detailed explanations:

(1) Research Workshops and Seminars:

(a) Explanation: Research workshops and seminars provide faculty members with opportunities to enhance their research skills, stay updated on emerging trends, and receive guidance on various aspects of the research process, including grant writing, data analysis, and manuscript preparation.

(b) Benefits: Fosters a research-oriented mindset, encourages interdisciplinary collaboration, and supports faculty in producing high-quality research.

(2) Research Mentoring Programs:

(a) Explanation: Research mentoring programs pair experienced researchers with junior faculty or graduate students to provide guidance, share expertise, and facilitate knowledge transfer. Mentors offer valuable insights into the research process and scholarly career development.

(b) Benefits: Accelerates research productivity, promotes a culture of research excellence, and cultivates a supportive research community.

(3) Grant Writing Workshops and Support:

(a) Explanation: Workshops and support services focus on grant proposal writing, budget development, and navigating the funding landscape. Faculty receive guidance on identifying funding opportunities and preparing competitive grant applications.

(b) Benefits: Increases the likelihood of grant success, secures research funding, and enables faculty to pursue ambitious research projects.

(4) Research Collaborations and Networking Events:

(a) Explanation: Events and programs facilitate research collaborations, both within and beyond the institution. Faculty members can connect with peers, industry partners, and researchers from other institutions through conferences, symposia, and collaborative initiatives.

(b) Benefits: Enhances research opportunities, promotes knowledge exchange, and broadens research networks.

(5) Research Ethics and Integrity Training:

(a) Explanation: Training in research ethics and integrity ensures that faculty members are aware of ethical guidelines, responsible conduct of research, and the importance of upholding high ethical standards in their research endeavors.
(b) Benefits: Supports research credibility, mitigates ethical dilemmas, and reinforces trust in research outcomes.
(6) Interdisciplinary Research Centers and Institutes:
(a) Explanation: Institutions establish interdisciplinary research centers and institutes that bring together faculty from diverse fields to address complex, interdisciplinary research questions. Faculty members have the opportunity to collaborate on multidisciplinary projects.
(b) Benefits: Promotes cross-disciplinary innovation, fosters a culture of collaboration, and strengthens the institution's research profile.
(7) Publication Workshops and Scholarly Writing Support:
(a) Explanation: Workshops and writing support services assist faculty in improving their scholarly writing skills, understanding the publication process, and navigating the intricacies of academic publishing.
(b) Benefits: Enhances the quality of research publications, increases faculty's visibility in the academic community, and accelerates the dissemination of research findings.
(8) Research Leave and Sabbaticals:
(a) Explanation: Faculty members are granted research leave or sabbaticals, which provide dedicated time and resources to focus on their research projects. During this period, they can immerse themselves in scholarly work without the distractions of teaching or administrative duties.
(b) Benefits: Supports deep immersion in research, encourages productivity, and allows faculty to pursue ambitious research goals.
(9) Peer Review and Collaborative Feedback Groups:
(a) Explanation: Peer review and collaborative feedback groups involve faculty members sharing their research manuscripts or proposals with peers for constructive critique and feedback. This process helps refine research outputs before submission.
(b) Benefits: Improves the quality of research work, provides diverse perspectives, and fosters a culture of peer support and accountability.
(10) Research Analytics and Bibliometrics Training:
(a) Explanation: Training in research analytics and bibliometrics equips faculty with the skills to track and analyze research impact metrics, citations, and publication trends. This knowledge aids in optimizing research strategies.
(b) Benefits: Provides insights into research impact, informs strategic decision-making, and enhances research visibility.
(11) International Research Collaborations:
(a) Explanation: Faculty members engage in international research collaborations by partnering with researchers from institutions around the world. These collaborations facilitate cross-cultural research and access to diverse resources.
(b) Benefits: Enhances research quality, broadens global perspectives, and expands research opportunities.
(12) Institutional Research Incentives and Awards:
(a) Explanation: Institutions establish research incentives, grants, and awards to recognize and reward faculty members for their research achievements. These incentives may include research funds, travel grants, and recognition programs.
(b) Benefits: Motivates faculty to excel in research, fosters a culture of recognition, and supports research excellence.
These faculty developmental strategies empower educators to advance their research and publication efforts, contributing to the scholarly output and reputation of higher education institutions and universities worldwide. Faculty can choose and tailor these strategies based on their research interests, career goals, and institutional resources to continuously enhance their research productivity and impact.
Analysis:
(1) The Significance of Faculty Development for Research and Publication: Faculty development for research and publication is paramount in higher education institutions worldwide. High-quality

research and scholarly publication contribute to the institution's reputation, foster academic excellence, and provide a platform for knowledge dissemination. Faculty development equips educators with the skills, resources, and support necessary to excel in research, produce impactful publications, and contribute to the intellectual growth of their disciplines.
(2) Challenges in Faculty Development for Research and Publication: Faculty development in research and publication faces several challenges. Faculty members may encounter barriers such as heavy teaching loads, administrative duties, and limited research funding. Additionally, navigating the increasingly competitive academic publishing landscape and staying current with evolving publication norms can be daunting. Addressing these challenges requires tailored faculty development strategies that consider institutional contexts and individual needs.
(3) Strategies for Faculty Development for Research and Publication: Effective strategies for faculty development in research and publication encompass a multifaceted approach that includes training, mentorship, access to resources, and a culture of research support. Faculty members can participate in research workshops and seminars to enhance their research methodologies and publication strategies. Mentorship programs pair experienced researchers with junior faculty to provide guidance and foster collaboration. Institutions should provide access to research funding, library resources, and publication outlets. Creating a culture of research support involves recognizing and valuing faculty research contributions through promotion and tenure policies that prioritize research and scholarly activities.
(4) Global Perspectives on Faculty Development for Research and Publication: The adoption and implementation of faculty development strategies for research and publication vary globally due to cultural, economic, and institutional differences. With plenty of resources and faculty incentives, research and publishing are highly valued in several areas. In contrast, teachers may only have restricted access to research support in areas with inadequate resources. However, the core tenets of high-caliber research, such as exacting methodology and the public publication of results, continue to apply to all fields of study. Programs for faculty development should be flexible enough to adapt to local conditions and attentive to international trends in scholarly communication.

Evaluation:

(1) Measuring the Impact of Faculty Development: Research and publishing impact evaluation of faculty development is crucial for determining efficacy and optimizing tactics. Faculty research production, publication output, citation impact, and research funding achievement are important evaluation criteria. Long-term evaluations should take into account how academic research contributes to the growth of knowledge and the reputation of the institution.
(2) Obstacles and Restrictions in International Implementation: Global resource inequalities, cultural differences, and diverse institutional priorities present obstacles to the implementation of faculty development methods for research and publication. Institutions with appropriate funding may have more robust faculty development initiatives, whereas those with insufficient funding may find it difficult to offer sufficient assistance. Faculty readiness for research and publication can be influenced by cultural norms and scholarly traditions. Faculty development plans should be flexible, inclusive, and attentive to the situation in order to solve these issues.
(3) The Impact of Technology on Faculty Development: Through options for online research training, virtual research collaborations, and access to digital research resources, technology has a significant impact on faculty development for research and publishing. Faculty members can participate in international intellectual communities and spread the word about their research discoveries more broadly thanks to it as well. But it is crucial to prevent technological advancements from causing unequal access to research opportunities and resources.
(4) Faculty Development for Research and Publication in the Future: To adapt to the shifting demands of higher education, faculty growth in research and publication will continue to change. Emerging trends include multidisciplinary research, open access publishing, and incorporating diversity, equality, and inclusion (DEI) ideals into research procedures. Faculty development will also focus on the difficulties and possibilities brought on by changing research methodology and collaborative structures.
The quality and effect of universities and higher education institutions around the world can therefore be greatly improved by faculty development for research and publication. Despite the difficulties, the techniques used present optimistic future directions. To guarantee that faculty members are adequately prepared to contribute to the growth of knowledge and the academic success of their institutions,

collaboration among institutions, policymakers, and educational stakeholders is crucial. Universities can achieve their goals of encouraging research excellence and making significant contributions to society on a global scale by investing in the growth of their faculty.

13. IMPROVING FACULTY EFFICIENCY AND FACULTY ANNUAL PRODUCTIVITY USING THEORETICAL FRAMEWORKS :

13.1 Improving Faculty Efficiency Using Theory of Accountability:

Theory of Accountability (also called Theory A) is a systematic organizational development theory for 21st century organizations for optimizing human productivity published by Aithal et al. [56-67]. The eight postulates of Theory of Accountability (Theory A) are:
(1) Planning: Institutional evaluation, issue identification, and collaborative policy formulation.
(2) Target setting: Action planning, communication, and common understanding.
(3) Motivation: Adoption of the concept and improved output.
(4) Work Strategies: Teamwork, empowerment, and support are effective work strategies.
(5) Responsibility: dedication, reliability, and achievement of objectives.
(6) Role model: Setting an example and being eager to get better.
(7) Monitoring and guiding: Consensual evaluation, self-evaluation, and affirmation of success.
(8) Accountability: Making a contribution by being dedicated and innovative.

In all sectors of the economy, including higher education, Theory A can be applied to increase human output. Using the Theory of Accountability (Theory A), colleges can increase faculty productivity by putting in place a methodical plan that prioritizes accountability, motivation, and responsibility. This idea offers a framework for improving organizational excellence and teacher performance. Let's look at how to gradually increase faculty productivity utilizing the elements of the Theory of Accountability:

(1) Problem Identification Based on Organizational Objectives:
(a) Start by identifying the specific challenges and inefficiencies that hinder the achievement of the institution's educational objectives. These objectives may include research productivity, teaching quality, student retention rates, or other institutional goals.
(b) Analyze the root causes of these problems and understand how they affect faculty efficiency.

(2) Planning Based on Set Objectives:
(a) Develop a strategic plan that aligns with the institution's objectives. This plan should outline the specific goals and milestones for improving faculty efficiency.
(b) Ensure that the planning process involves faculty members at various levels, encouraging their input and innovative contributions.

(3) Target Setting:
(a) Establish clear and measurable targets for both teams and individual faculty members. These targets should be directly related to the institution's objectives and should be time-bound.
(b) Communicate these targets to faculty members and provide them with a sense of ownership and responsibility for achieving them.

(4) Motivation:
(a) Implement motivational strategies that inspire faculty members to discover and leverage their potential. Motivation should be tailored to address individual weaknesses and encourage collaborative efforts.
(b) Recognize and appreciate the contributions of faculty members who actively engage in achieving the institution's goals.

(5) Work Strategies:
(a) Develop work strategies that provide a structured and time-bound plan for faculty members to reach their targets. These strategies should also incorporate the flexibility to adapt to changing circumstances.
(b) Encourage faculty members to collaborate with other teams and individuals, promoting a culture of multitasking and efficiency.

(6) Responsibility:
(a) Emphasize the importance of responsibility among faculty members. Encourage them to take ownership of their roles and contribute actively to achieving the institution's objectives.

(b) Identify and nurture employees who demonstrate a high level of responsibility, as they can serve as role models for others.

(7) Role Model:

(a) Showcase role models within the organization who have achieved exceptional results and productivity. These role models can be internal or external individuals who have excelled in similar fields.

(b) Use role models to demonstrate that the set targets are achievable and inspire faculty members to aim for excellence.

(8) Monitoring:

(a) Implement a continuous monitoring system to track faculty performance in real-time. Compare actual performance against planned targets and provide timely feedback to faculty members.

(b) Monitoring creates a sense of responsibility among employees and helps identify areas for improvement.

(9) Accountability:

(a) Establish a culture of accountability where every faculty member is held responsible for their actions and contributions to the institution's objectives.

(b) Define accountability criteria based on performance and consistency with the organization's policies.

(10) Accountability-Based Incentives:

(a) Introduce accountability-based incentives to reward faculty members who consistently meet or exceed their targets. These incentives can include positive recognition, career advancement, or financial rewards.

(b) Ensure that the incentive system is transparent, fair, and aligned with the institution's goals.

Universities and other higher education institutions can raise the standard of instruction overall by putting these measures into practice in a way that is consistent with the Theory of Accountability. This strategy places a strong emphasis on the value of personal growth, inspiration, and accountability for achieving both individual and organizational success.

13.2 Improving Faculty Annual Productivity using ABC Theory of Faculty Research Performance:

ABC model of Annual Research Productivity of researchers and faculty members of Higher Education Institutions is published in 2018 by P. S. Aithal [68]. Further, this model is used for many variations of research related to research productivity [69-79]. Improving faculty annual productivity using the ABC model of Faculty Research Performance in higher educational institutions and universities worldwide involves a systematic approach to measure, assess, and enhance research productivity. This theory emphasizes the importance of research and publications as key indicators of institutional quality. Here's a detailed description of how to improve faculty annual productivity using the ABC Model:

(1) Understanding the ABC Model:

(a) Begin by understanding the ABC model, which measures institutional performance based on research and publications.

(b) The ABC model posits that the quality of higher education depends on the institution's ability to create new knowledge, which, in turn, depends on research and publications by both faculty members and students.

(c) The model calculates institutional publication ability using the number of Articles published in Journals (A), the number of Books published (B), and the number of Business cases and Book chapters (C).

(2) Calculate the Research Index (α):

(a) The research index per year (α) is calculated using the formula: $\alpha = (2A + 5B + C)/F$.

Where:

A = Number of publications in Journals in that year.

B = Number of books published in that year.

C = Number of Publications of Business Cases published in that year.

F = Number of full-time faculty members in that institution during that year.

(b) The weightage for a research article (A) is two, for a book (B) is five, and for a case study (C) is one, based on the relative significance and efforts involved in generating each type of publication.

(3) Calculate the Weighted Research Index (β):

(a) The weighted research index per year (β) is calculated using the formula: $\beta = (2A + 5B + C)/8F$.

(b) This formula considers the same factors as in the α calculation but provides a weighted average.

(c) The weighted research index assigns weightage to each type of publication based on its significance.

(4) Set Clear Research Objectives:

(a) Institutions should set clear research objectives that align with their mission and vision.

(b) Determine the desired level of research productivity based on the institution's goals and the ABC model's parameters.

(5) Foster a Research-Friendly Environment:

(a) Create a conducive environment that supports research activities. Provide resources such as libraries, research funding, and access to academic journals.

(b) Encourage interdisciplinary collaboration and research teams to facilitate knowledge sharing and innovation.

(6) Faculty Development and Support:

(a) Offer faculty members opportunities for professional development in research methodology, grant writing, and publication strategies.

(b) Provide mentorship programs to guide junior faculty and promote a culture of research excellence.

(7) Tracking and Monitoring:

(a) Continuously track and monitor faculty research activities, including the number of publications in journals, books, and business cases.

(b) Use data analytics to assess progress toward research objectives and identify areas for improvement.

(8) Incentives and Recognition:

(a) Implement an incentive system that rewards faculty members for achieving and exceeding research targets.

(b) Recognize and celebrate faculty accomplishments in research and publication to motivate further productivity.

(9) Collaboration and Networking:

(a) Encourage faculty to collaborate with peers within and outside the institution.

(b) Participation in research networks and collaborations can lead to increased research opportunities.

(10) Review and Adapt:

(a) Periodically review the institution's research performance using the ABC model's parameters. - Make necessary adjustments to strategies and resources based on the results of the evaluation.

(11) Institutional Research Productivity Index:

(a) Calculate the institutional research productivity index using the formula: $[\ (2A + 5B + 1C) / F]$. - This index provides a quantitative measure of the institution's research productivity, considering the weights assigned to different types of publications.

(12) Continuous Improvement:

(a) Emphasize a culture of continuous improvement in research and publications. - Encourage faculty to set personal research goals and strive for excellence in their respective fields.

By implementing these steps in line with the ABC Theory of Faculty Research Performance, higher educational institutions and universities can enhance faculty annual productivity, elevate research quality, and contribute to the institution's overall excellence. This approach emphasizes the importance of research as a cornerstone of institutional success and academic advancement.

14. POSTULATES AND SUGGESTIONS :

14.1 Postulates:

Postulate 1: The adoption of digital pedagogies is essential for enhancing teaching and learning in higher education institutions (HEIs) worldwide.

Postulate 2: Faculty members can be effectively empowered as mentors in HEIs through structured mentorship programs and support.

Postulate 3: Empowering faculty members as mentors contributes to improved student outcomes and overall institutional excellence in HEIs.
Postulate 4: Strategies for empowering mentors should be context-specific and take into account the various requirements and difficulties faced by HEIs worldwide.
Postulate 5: Both in-person and online learning environments, digital pedagogies should take into account the various learning preferences and styles of students.
Postulate 6: Faculty development initiatives are essential for improving the caliber of research and publications, online instruction, and classroom instruction in HEIs.
Postulate 7: For measuring and enhancing faculty effectiveness and yearly production in HEIs, the theoretical frameworks of Theory of Accountability (Theory A) and the ABC model of Faculty yearly Research production offer invaluable insights.
Postulate 8: Educators in HEIs must undergo ongoing training and professional development in order for technology to be fully integrated into the classroom.
Postulate 9: Innovative teaching strategies and breakthroughs in research can result from collaborative and interdisciplinary approaches to faculty development.
Postulate 10: Strong institutional support and a culture of continual improvement are essential for empowerment programs for instructors in HEIs to be successful.

14.2 Suggestions:

Suggestion 1: HEIs should spend money creating and implementing comprehensive digital pedagogies that meet the demands of all types of students.
Suggestion 2: Create mentorship programs that gives faculty members the education, tools, and incentives they need to be successful in mentoring students.
Suggestion 3: Regularly analyze mentorship programs' effects on student achievement and make the necessary improvements.
Suggestion 4: Establish a global network of educators to share best practices and experiences in empowering mentors and implementing digital pedagogies.
Suggestion 5: Develop customized faculty development plans that address the specific needs of educators in classroom teaching, online teaching, and research & publications.
Suggestion 6: Encourage faculty members to engage in interdisciplinary collaborations and research projects to foster innovation and knowledge dissemination.
Suggestion 7: Provide ongoing support and resources for educators to stay updated on the latest advancements in digital technologies and teaching methodologies.
Suggestion 8: Implement data-driven approaches to monitor and measure faculty efficiency and productivity, using two theoretical frameworks (Theory of Accountability (Theory A) and ABC model of Faculty Annual Research Productivity) as guidance.
Suggestion 9: Foster a culture of research and scholarship among faculty members by offering incentives and recognition for their contributions to the field.
Suggestion 10: Institutional leaders should prioritize faculty development and digital pedagogy initiatives as integral components of the HEI's strategic plan, ensuring long-term commitment and sustainability.

15. CONCLUSION :

In order to empower educators in Higher Education Institutions (HEIs) around the world, this exploratory research article set out on a quest to unravel the subtle relationship between digital pedagogies and faculty development techniques. This work explored unknown ground by using an exploratory research style in an effort to gain a deeper understanding of this complex topic. The quest was motivated by a number of all-encompassing goals that included innovative teaching and learning techniques, mentorship empowerment, digital pedagogical practices, and tactics for faculty development.
The paper used a variety of internet resources during the investigation, including search engines, GPTs, such as ChatGPT and Bard, and more specialist tools like Google Scholar. The study carefully considered, assessed, and interpreted the vast amount of data we acquired, adhering to a certain framework that allowed us to combine hypotheses and helpful recommendations. These ideas have been developed with the goal of accelerating transformative change at HEIs and universities all around

the world. The experience has been eye-opening, exposing both the benefits and challenges of empowering teachers in an increasingly digitalized educational environment. The integration of digital pedagogies and faculty development strategies holds enormous promise for boosting teaching, mentoring, and research, as the study explores the constantly changing landscape of higher education. This research work, although exploratory in nature, lays a sturdy foundation for future endeavours that may delve deeper into these realms, further refining the understanding and paving the way for more innovative and effective approaches to empower educators in HEIs across the globe.

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Enhancing Industrial Automation through Efficient Technology Management in Society

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Subject Area: Technology Management.
Type of the Paper: Exploratory Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10392661
Google Scholar Citation: IJAEML

How to Cite this Paper:
Aithal, P. S. (2023). Enhancing Industrial Automation through Efficient Technology Management in Society. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 184-215. DOI: https://doi.org/10.5281/zenodo.10392661

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0199

Received on: 18/10/2023
Published on: 16/12/2023

International Journal of Applied Engineering and Management Letters (IJAEML), ISSN: 2581-7000, Vol. 7, No. 4, December 2023

SRINIVAS PUBLICATION

Enhancing Industrial Automation through Efficient Technology Management in Society

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ABSTRACT

Purpose: *The accelerated advancement of technology has revolutionized industries across the globe, enabling unprecedented levels of automation and efficiency. An in-depth examination of the vital field of technology management and its crucial part in orchestrating the smooth automation of primary, secondary, tertiary, and quaternary industries is provided in this study. Information, communication, and computation technologies (ICCT underlying technologies) and nanotechnologies are included in the broad range of Universal technologies of the 21st century that fall under the purview of technology management. The first point made in the article is how crucial good technology management is to the success of industrial automation. It looks at how technology management techniques have changed to meet the varied and dynamic nature of contemporary industries.*

Design/Methodology/Approach: *ICCT can be used to connect and coordinate processes, as well as for intelligent decision-making. Additionally, the potential of nanotechnologies for precise and miniature automation components is being explored. Examining the intricacies related to technology integration, scalability, and sustainability, key challenges and opportunities in technology management are examined.*

Findings/Result: *The paper provides insights into best practices for matching organizational goals and strategies with technology management, emphasizing the necessity for flexible frameworks that can adjust to changing market demands. Based on the proposed developments of Super Intelligent Machines and technology-based singularity, and their impact on Industrial Automation, the consequences of socio-economic and environmental effects of technology-driven automation in companies are also covered in this article, highlighting the significance of ethical and sustainable technology management. It emphasizes the requirement for moral concerns, skill development, and laws that guarantee a fair transition to automated industrial processes while minimizing potential negative effects.*

Originality/Value: *In summary, competent technology management forms the basis for the successful automation of industries in all spheres of society. This paper includes a comprehensive overview of the principles, strategies, and applications of technology management along with ABCD analysis emphasizing the potential for transformative change in the landscape of modern industries in all four sectors and the pressing need to ensure ethical and sustainable practices.*

Type of paper: *Exploratory Research.*

Keywords: Technology management, Universal Technologies, ICCT underlying technologies, Effective automation, Technology-based social transformation, ABCD analysis, Quality of life.

1. INTRODUCTION :

Technology has evolved into an unstoppable force that is reshaping the basic foundation of enterprises and civilizations in the twenty-first century. Unparalleled automation across industrial sectors is now possible because of innovation's constant march, which is symbolized by the creation of Universal technologies. Information, communication, and computation technologies (ICCT) and the cutting-edge field of nanotechnologies are just two examples of the wide range of universal technologies. These technological fields serve as the cornerstones of our modern world, allowing for a major transformation of industries that is defined by effectiveness, accuracy, and adaptability [1].

The crucial role of technology management is brought to the fore as the integration of Universal technologies assumes center stage in industry. In order to achieve effective automation in the primary, secondary, tertiary, and quaternary sectors, this paper sets out on a trip into the core of effective technology management. Technology management acts as the directing hand that conducts the automation symphony, harmonizing various technologies and business procedures [2].

The first section of this introduction emphasizes how quickly technology is developing and how this has a significant impact on the industrial landscape. The current period is defined by a never-ending cycle of invention, which is propelled by advances in nanotechnology and the underlying ICCT technologies. These Universal technologies are coming together in a way that opens up new possibilities for automation and gives businesses the chance to advance, compete, and prosper in the face of adversity on a global scale. Technology management enables enterprises to fully utilize Universal technologies by acting as the compass guiding them through this unpredictable landscape. It includes the processes for resource allocation, strategic planning, and decision-making that guarantee the effective integration of technology into industrial operations. Industries may achieve previously unheard-of degrees of automation by integrating Universal technology, which boosts productivity, cost-efficiency, and competitiveness [3].

A closer examination reveals the multifaceted nature of technology management, which involves coordinating the deployment of ICCT underlying technologies, and Nanotechnologies across the entire industrial spectrum. In the primary sector, which includes agriculture and natural resource extraction, technology management plays a pivotal role in precision farming, resource management, and sustainable practices. In the secondary sector, encompassing manufacturing and construction, automation optimizes production processes, leading to improved product quality and lower production costs. In the tertiary sector, where services are paramount, technology management enhances customer experiences, streamlines operations, and facilitates data-driven decision-making. Even in the quaternary sector, comprising knowledge-based activities like research and development, the integration of technology underpins innovation and accelerates breakthroughs in various fields [4].

Challenges are inherent in the journey towards efficient technology management and effective industrial automation. These include the complexities associated with technology integration, interoperability, and scalability. The paper addresses the need for organizations to adapt to this shifting technological landscape and embrace agile management frameworks capable of rapid responses to evolving industry demands. Such adaptability is paramount in a world where new technologies emerge with increasing frequency, offering both opportunities and challenges [5].

Moreover, technology management goes beyond mere efficiency; it encompasses the responsible and ethical use of technology. As industries automate processes, ethical considerations, such as data privacy, cybersecurity, and environmental sustainability, must be woven into the fabric of technology management. The paper underscores the imperative of a holistic approach to technology management that ensures the ethical use of technology while mitigating any potential negative consequences for society and the environment [6].

The socio-economic impact of technology-driven automation is profound. While it promises increased productivity and economic growth, it also raises concerns about workforce displacement and the digital divide. Responsible technology management should not only focus on deploying technology but also on upskilling the workforce and establishing policies that support a just transition to automated industrial processes. This is a pressing issue as industries and societies grapple with the transformative potential of Universal technologies. In summary, technology management is the linchpin for effective automation of industries in society [7].

This paper will traverse the intricate web of Universal technologies, delving into their applications in the primary, secondary, tertiary, and quaternary sectors. It will examine the difficulties and possibilities of managing technology, as well as the moral and social ramifications of automation. In the end, this paper will serve as a thorough guide, illuminating the technological management tactics and tenets that have the capacity to change the global industrial landscape.

2. REVIEW BASED CURRENT STATUS :

The current status in technology management and effective industrial automation is determined by a systematic review of available important scholarly articles obtained from Google Scholar search using the keywords technology management and effective industrial automation. The results of review are summarized in Table 1 and Table 2 respectively.

Table 1: Technology management

S. No.	Focus	Outcome	Reference
1	The art of high-technology management	The paper identifies six themes under the paradox of High technology management with two grouping: First group contains Business focus, Organizational Cohesion, and Sense of integrity. The second group contains Adaptability, Entrepreneurial culture, and hands on management. The two solutions suggested are managing different parts of the firms differently either through innovations or for efficiency. Both need high technology.	Maidique, M. A., & Hayes, R. H. (1984). [8]
2	Technology management tools	The development of a complete management tool catalog that includes more than 850 examples falling into the "matrix" category is presented in this work. These tools have made it possible to create a classification scheme that recognizes the four primary categories of matrix tools: matrices, grids, tables, and scored profiles. For managers, consultants, and academics, creating integrated, well-researched, and useful tools, procedures, and frameworks proves to be a challenging endeavor. To overcome this difficulty, they must adopt an iterative "process approach."	Phaal, R., Farrukh, C. J., & Probert, D. R. (2006). [9]
3	A framework for technology management activities	Using the dynamic capacities theory as a lens, this study explores the field of technology management (TM). A never-ending stream of opportunities and challenges in the fields of new product, service, process, and organizational development are presented by the constantly changing technological world. Nevertheless, competent and dynamic technology management is crucial to maximizing the potential of these opportunities and turning them into value. This calls for a novel approach to comprehending TM that takes into account both its managerial and dynamic elements.	Cetindamar, D., Phaal, R., & Probert, D. (2009). [10]
4	Information technology management	The critical issues surrounding the knowledge transfer between organizations are examined in this essay. It examines the various kinds of knowledge created and disseminated by businesses, stressing the particular difficulties associated with knowledge management in this setting. The paper continues by highlighting the effects of Information and Communication Technology (ICT) applications, highlighting how diverse ICT systems—each created for a particular sort of information and data—align with the efficient dissemination of various knowledge forms.	Bolisani, E., & Scarso, E. (1999). [11]

5	Technology management in product development	The paper "Establishing PACE (Product and Cycle-time Excellence) in Product Development" describes how to successfully manage the elements of time, quality, skill, and resources that are required for successful product development.	Eldred, E. W., & Shapiro, A. R. (2012). [12]
6	Technology management in complex product systems	A new area of innovation research that focuses on the complicated field of complex product systems (CoPS) is beginning to take shape. These CoPS include expensive, engineering- and software-intensive items, networks, systems, and buildings that are frequently produced in project- or small-batch-based environments. Ten questions are posed in the study, which explore the fundamental elements of innovation processes, business strategy, management techniques, and project efficacy and efficiency related to CoPS.	Hobday, M., & Rush, H. (1999). [13]
7	A framework for supporting the management of technological knowledge	This research presents a framework for improving technological innovation management's theoretical and applied understanding. The two main sets of business processes that make up the core of this framework are the three "core" processes of strategy, innovation, and operations, as well as an additional set of five technology management processes, including identification, selection, acquisition, exploitation, and protection. By highlighting the need of "pull" and "push" knowledge transfers between the business and technology departments within an organization, the framework encourages the seamless integration of these operations.	Phaal, R., Farrukh, C. J., & Probert, D. R. (2004). [14]
8	Benchmarking global strategic management of technology	In-depth information gathered from the most well-known R&D-driven companies in North America, Western Europe, and Japan reveals that the connections made between top-level management in terms of aligning business and technology strategies and the wise use of outside resources are the critical factors for a successful technology strategy. Businesses are increasingly relying on universities for research projects, procuring critical technology components from outside sources, and developing collaborations through joint ventures and alliances to speed up development.	Roberts, E. B. (2001). [15]
9	Alliance portfolio diversity, radical and incremental innovation	This study investigates the relationship between an alliance portfolio's variety and a company's innovation outcomes. The toolkit of technology management tools (TM-tools) is one aspect of an alliance portfolio capabilities. By presenting this model, the authors add to the corpus of theoretical information regarding the performance effects of alliance portfolio variety while also illuminating the specific	Oerlemans, L. A., Knoben, J., & Pretorius, M. W. (2013). [16]

		circumstances under which businesses might successfully take use of this diversity.	
10	Management of technology: Themes, concepts and relationships.	In this study, authors explore the key ideas influencing the literature on technology management, as seen in Technovation, using bibliometric methodologies, specifically co-citation analysis and social network analysis tools. Additionally, we make use of network analytic tools to demonstrate the stark differences in research goals among academics from different parts of the world. Authors assert that these differences might have contributed to the lengthened time it took to establish technology management as a respected academic discipline.	Pilkington, A., & Teichert, T. (2006). [17]
11	The technology fallacy: people are the real key to digital transformation	Companies must address three crucial business problems to successfully navigate the digital transformation landscape: adjusting to digital disruption, reevaluating leadership and personnel strategies, and transforming into a digital organization.	Kane, G. (2019). [18]
12	Sustainable management of digital transformation in higher education	In order to adapt to the changes caused by emerging technologies, the education sector's evolution through digital transformation has called for the adoption of sustainable management techniques. An analysis of the development of this field's research worldwide from 1986 to 2019 has been done.	Abad-Segura, E., et al. (2020). [19]
13	How to Create Business Value Through Technological Innovations	The twelve ICCT Underlying Technologies that form its foundation, including AI, Blockchain, Business intelligence, Cloud computing, Cybersecurity, 3D printing, IoT, Quantum computing, Mobile marketing, Information storage technology, Ubiquitous education technology, and VR & AR, are crucial in creating business value in a variety of ways. In order to achieve financial performance and growth, these dimensions must be prioritized, including fostering innovation and differentiation, concentrating on customer needs, improving operational efficiency, forming strategic partnerships and alliances, managing talent effectively, optimizing marketing and branding initiatives, fostering sustainability and corporate social responsibility, and encouraging adaptability and agility.	Aithal, P. S. (2023). [20]
14	Tech-Business Analytics in Primary Industry Sector.	The differences between traditional business analytics and tech business analytics in the primary industry sector are described in this passage. It also offers a general architecture that evaluates 30 recently introduced TBA research ideas in the Primary Industries sector, which is a useful tool for technological applications.	Kumar, S., & Aithal, P. S. (2023). [21]

Table 2: Effective Industrial Automation

S. No.	Focus	Outcome	Reference
[24]	A real-time service-oriented architecture for industrial automation	The paper provided an improved Service-Oriented Architecture (SOA) with real-time capabilities incorporated specifically for industrial automation in this study. The architectural framework we suggest enables the temporal encapsulation of certain tasks coupled with the negotiation of Quality of Service (QoS) preferences by clients using Web services. This method makes it easier to evaluate each service's temporal dynamics in advance, successfully preventing any inadvertent interference between them.	Cucinotta, T., et al. (2009). [22]
2	Industrial automation using Internet of things	The Internet of Things (IIoT) is extensively examined in this chapter's section on industrial automation. In a revolutionary age where physical manufacturing is becoming more and more entwined with the information-driven economy, Advanced Industries are setting the pace. The seamless fusion of cognitive manufacturing technologies with physical machinery is what distinguishes the idea of "Industrie 4.0" as the fourth paradigm change in production. The Internet of Things (IIoT) fundamentally represents the integration of industrial systems with cutting-edge, nearly real-time analytics and computing, made possible by affordable, energy-efficient sensor devices that tap into global internet access.	Jain, S., & Chandrasekaran, K. (2022). [23]
3	The internet of thing (IoT) and industrial automation	This article provides a thorough analysis of how the current automation business is evolving into a future sector powered by the Internet of Things (IoT). It not only offers a theoretical foundation for the Industrial Internet of Things (IIoT), but it also offers insightful information. IIoT refers to the incorporation of IoT technology into procedures, goods, and services in order to promote communication between these components as well as with people all over the world. The article focuses on clarifying how industrial automation and control systems in the process and manufacturing sectors will be impacted by the Internet of Things, especially its industrial counterpart known as the Industrial Internet of Things (IIoT).	Mondal, D. (2019). [24]
4	A cyber–physical system-based approach for industrial automation systems	The authors adopt a system-centric approach to creating Industrial Automation Systems (IASs) in this research. We present a framework for enhancing the software component's extracted System Modeling Language (SysML) model in Unified Modeling Language (UML) and converting it	Thramboulidis, K. (2015). [25]

		into implementation code. The authors look at two implementation strategies that make use of integrated boards that are widely available nowadays as well as programmable logic controllers (PLCs). The paper use the updated version of IEC 61131 for PLCs, which includes Object-Orientation along with Java on embedded boards.	
5	Efficient and change-resilient test automation: An industrial case study	This paper examines a thorough case study that takes place in a challenging production environment and centers on a corporate web application. This program has two versions, requires maintenance of approximately 6500 manual test cases, is frequently updated, and necessitates testing across many browsers within constrained time frames and resources for regression cycles. The effectiveness of the first automation process is assessed in terms of how much the ATA (Automated Testing Approach) improves it.	Thummalapenta, S., et al. (2013). [26]
6	Key performance monitoring and diagnosis in industrial automation processes	Industrial processes are notably becoming more complex and automated as technology develops. Modern manufacturing lines frequently have numerous control loops, each having a variety of integrated components including sensors and actuators. However, dealing with anomalous events, an important and complex component of process management, continues to rely significantly on manual intervention and human operators.	Hao, H. (2014). [27]
7	Analyzing the factors in industrial automation using analytic hierarchy process	Industrial automation (IA) is a key component of production strategies, utilizing modern techniques to maintain a competitive edge in the manufacturing industry. This study's goal is to categorize different Artificial Intelligence (AI) aspects and evaluate their importance for improving deployment in industrial businesses. Analytic Hierarchy Process (AHP) application, expert conversations, and a thorough analysis of the literature were used to assess the relative importance and prioritizing of AI aspects in the manufacturing business.	Acharya, V., Sharma, S. K., & Gupta, S. K. (2018). [28]
8	The future of industrial communication: Automation networks in the era of the internet of things and industry 4.0.	In this paper, the authors looked carefully at technology developments and how they might affect business communications. The authors examined how Industry 4.0-inspired technologies like the Internet of Things (IoT) and Cyber-Physical Systems (CPS) have an impact on industrial automation. Additionally, a summary of recent advancements in Ethernet time-sensitive networking (TSN) and examine the value of fifth-generation (5G) communications networks for automation is given. Also emphasized how important it is to	Wollschlaeger, M., Sauter, T., & Jasperneite, J. (2017). [29]

		harmonize on a wider scale than just from a networking perspective.	
9	Machine learning-enabled smart industrial automation systems using internet of things.	The Elaborative Stepwise Stacked Artificial Neural Network (ESSANN) algorithm was developed by the authors to greatly improve automation processes in industrial control and environmental monitoring. An industrial dataset freely given by KLEEMANN Greece was used to start the process. This dataset underwent comprehensive preprocessing methods, including the use of the Least Absolute Shrinkage and Selection Operator (LASSO) for feature selection and the application of Principal Component Analysis (PCA) for feature extraction.	Al Shahrani, A. M., et al. (2022). [30]
10	Industrial robot control and operator training using virtual reality interfaces.	In order to create a truly immersive virtual reality environment, commercial gaming technologies are integrated into this paper's exploration of the dynamic interaction between virtual reality and robotics. This setting has a controller interface that integrates crucial mathematical models for the accurate control of the virtual robot. The solution we suggest offers a fresh approach to applications for cost-effective and unified robot control, as well as multiple functions like training and simulation.	Pérez, L., et al. (2019). [31]
11	Ai-based modeling: Techniques, applications and research issues towards automation	This paper provides a comprehensive view of "AI-based modeling," illuminating the core ideas and prospective capabilities of several AI approaches that hold great promise for designing sophisticated and intelligent systems for a wide range of practical applications. These programs cover a wide range of industries, including commerce, banking, healthcare, agriculture, smart cities, cybersecurity, and more. We also emphasize the difficulties and complexities associated with doing research within the scope of our study.	Sarker, I. H. (2022). [32]

In this discussion about industrial automation and its effects on society, effective technology management, with a focus on the integration of Universal technologies, is at the fore. The current state of this developing topic is examined in this literature review, along with recent trends, problems, and prospects.

(1) Universal Technologies in Industrial Automation:

The use of Universal technologies, which include Information and Communication Technologies (ICT), Computation Technologies, and Nanotechnologies, has significantly increased in recent years. These technologies are now the cornerstone of industrial automation. While Computation Technologies power shrewd decision-making and data analytics, ICT enables the continuous flow of data and communication. Meanwhile, nanotechnologies hold the promise of precise, miniature automation parts.

(2) Industry-Specific Automation:

Literature highlights the industry-specific nature of technology management and automation. In the primary sector, technologies such as precision agriculture and sensor-based resource management have revolutionized farming and resource extraction. In the secondary sector, the adoption of Industry 4.0 principles, which combine automation, data exchange, and smart manufacturing, is accelerating. The tertiary sector is witnessing a surge in AI-powered customer service and data-driven decision-making. The quaternary sector, with its knowledge-based activities, is leveraging Universal technologies to expedite research and development processes.

(3) Challenges in Technology Integration:

A recurring theme in the literature is the challenge of technology integration. Researchers emphasize the need for seamless integration of various Universal technologies, often requiring organizations to overhaul their existing infrastructure and processes. Achieving interoperability and ensuring that the systems work harmoniously is crucial but non-trivial. The need for agile and adaptable technology management frameworks to accommodate these changes is evident.

(4) Ethical and Responsible Automation:

In the conversation around technological management and automation, ethical issues have taken center stage. It has become morally necessary to ensure data privacy, cybersecurity, and environmental sustainability. A growing concern for responsible automation can be seen in recent writing. In order to balance efficiency advantages and ethical obligations, organizations are obliged to abide by ethical standards in their technology management processes.

(5) Socio-Economic Implications:

The socioeconomic effects of automation are still a major worry. According to recent studies, automation may cause job displacement even while it increases productivity and economic growth. Upskilling and retraining programs for the workforce are required as more industries use automation in order to prevent job losses. In order to guarantee that the advantages of automation are dispersed fairly throughout society, the digital gap must also be addressed.

(6) The Role of Policy and Regulation:

The significance of governmental rules and laws in directing technology management and automation is recently highlighted in literature. Globally, governments are creating systems to encourage responsible technology usage, safeguard individual rights, and guarantee environmental sustainability. Discussions about how regulators might strike a balance between innovation and moral issues are ongoing.

(7) Case Studies and Success Stories:

Case studies and success tales offer useful context for how technology management is used across industries. Numerous examples from recent literature show how effective technology management has raised productivity, cost-effectiveness, and product quality. These real-world examples might serve as an inspiration for businesses thinking about or implementing automation efforts.

(8) Emerging Trends:

The literature review also identifies new trends that will influence effective technology management for industrial automation in the future. The rise of the Internet of Things (IoT) for data collecting and analysis, the rising usage of artificial intelligence (AI) and machine learning (ML) in decision support systems, and the adoption of blockchain technology for safe and open data management are some of these trends.

(9) Sustainability and Green Technology:

The emphasis on sustainability and green technology in industrial automation is another important development in recent literature. Researchers are looking on ways to leverage Universal technology to optimize resource use, reduce waste, and reduce industry carbon footprint as environmental concerns gain in popularity.

In conclusion, the current state of successful technology management for the automation of society's industries is characterized by a dynamic environment where innovation, integration, ethical issues, and socioeconomic concerns collide. The ongoing studies and literature in this area give us a thorough awareness of the potential and difficulties that businesses encounter on the road to automation. In order to make automation a catalyst for good societal development rather than a cause of disruption, it is crucial to handle technology responsibly. A major problem for legislators, researchers, and business executives alike is keeping up with the advancements in technology and answering the changing needs of industries and society.

3. OBJECTIVES OF THE PAPER :

The following could be included in the objectives of a research paper on "Efficient Technology Management for Effective Automation of Industries in Society," with the parts listed:

(1) To Provide an In-Depth Examination of Universal Technologies of the 21st Century:
In order to fully understand the concepts, applications, and possible effects of information communication technologies, computation technologies, and nanotechnologies on industrial automation, this purpose sets out to thoroughly examine each of these fields.

(2) To Examine the Technology's Impact on Industry Automation:
With regard to the primary, secondary, tertiary, and quaternary sectors, this purpose focuses on analyzing how technology, in particular Universal technologies, has changed industrial processes. It will explore the most recent developments and trends in automation.

(3) To Investigate Effective Strategies for Managing Universal Technologies for Industry Automation:
Identifying and analyzing frameworks and techniques for the effective administration of Universal technologies is the aim of this purpose. It will examine how businesses can successfully incorporate these technologies into their operations while resolving integration, scalability, and sustainability issues.

(4) To Examine the Emergence of Super-Intelligent Machines and Their Impact on Industry Automation:
This objective delves into the cutting-edge domain of super-intelligent machines, investigating their capabilities, potential applications, and implications for industrial automation. It will discuss how these machines can contribute to advanced automation processes.

(5) To Explore the Concept of Technology-Based Singularity in Industry Automation:
This objective aims to explore the theoretical concept of singularity in the context of industrial automation, where technology and AI systems reach a point of exponential growth and self-improvement. It will assess the feasibility, challenges, and ethical considerations surrounding this concept.

(6) To Conduct an ABCD Analysis of Technology-Based Total Automation:
This objective involves conducting an ABCD analysis (Advantages, Benefits, Constraints, and Disadvantages) of technology-based total automation across primary, secondary, tertiary, and quaternary sectors. It seeks to provide a comprehensive overview of the advantages, drawbacks, and practical considerations for achieving complete industrial automation.

These objectives collectively serve as the paper's direction as it explores the intricate interactions between industrial automation, effective technology management, and universal technologies. They offer a methodical framework for thoroughly examining and debating this complex subject, taking into account recent technology developments, moral considerations, and the real-world difficulties that various industries encounter in their quest for automation.

4. METHODOLOGY :

It employs an exploratory research methodology. Before beginning a more extensive research project, exploratory research is frequently carried out to get a deeper grasp of a subject, formulate hypotheses, and collect preliminary data. Information is gathered from a variety of online sources, including as Google, Google Scholar, and several GPTs like ChatGPT and Bard. In order to establish the postulates and offer recommendations for system improvement, the data are analyzed, assessed, and interpreted in accordance with a certain framework.

5. UNIVERSAL TECHNOLOGIES OF THE 21ST CENTURY :

The 21st century has borne witness to a remarkable surge in Universal technologies, fundamentally reshaping the way we live and conduct business. Universal technologies encompass Information Communication and Computation technologies (ICCT) and Nanotechnologies [1], [2], [3], [33], forming the cornerstone of the technological revolution that has unfolded in recent years. ICCTs, also referred to as ICCT underlying technologies [34-57], play a pivotal role in this transformative era. These technologies have evolved to encompass a broad spectrum of applications, each revolutionizing specific aspects of modern life.

(i) Artificial Intelligence & Robotics: Robotics and artificial intelligence (AI) are at the forefront and have made tremendous strides. AI systems are crucial in industries ranging from healthcare and banking to transportation and manufacturing because they can process enormous amounts of data, learn from it, and make judgments. In fields like manufacturing and logistics, where automation and accuracy are crucial, robotics and AI have seen increased application.
(ii) Blockchain technology: Another important innovation is blockchain technology, which has upended conventional record-keeping and data security procedures. In order to provide transparency and security, it offers a decentralized, irreversible ledger that is being used in a variety of industries, from finance and supply chain management to healthcare and voting systems.
(iii) Big Data and Business Intelligence technology: Data management and analytics have undergone a revolution thanks to the widespread adoption of Big Data and Business Intelligence technology. Large datasets can now be used by organizations to gather important information, guide decisions, and improve operations. Through the application of predictive analytics and data-driven tactics, these technologies have changed entire sectors.
(iv) Cloud computing technology: Flexible, scalable, and economical data processing and storage are now possible because to cloud computing technology. It has encouraged remote work options and made it possible for businesses to scale up without investing heavily in physical infrastructure.
(v) Cyber Security and Forensic technology: Protecting sensitive data from online attacks now requires a combination of forensic technologies and cyber security. These technologies use cutting-edge techniques to find and reduce security breaches as cyberattacks continue to develop.
(vi) Digital Marketing and Mobile Business technology: The way businesses interact with their customers has changed as a result of digital marketing and mobile business technology. Mobile applications and targeted advertising have changed marketing strategies by giving firms new ways to connect with and interact with their customers.
(vii) 3D Printing technology: 3D Printing technology has revolutionized manufacturing processes by enabling the creation of intricate and customized objects with speed and precision. From healthcare, where 3D printing is used for prosthetics and medical models, to aerospace and automotive industries, the applications are vast.
(viii) Internet of Things (IoT): The Internet of Things (IoT) has given rise to interconnected devices that exchange data and enhance automation in both industrial and domestic settings. IoT technology is the backbone of smart homes, smart cities, and Industry 4.0, where, automation and data exchange drive efficiency.
(ix) Quantum Computing technology: Quantum Computing technology is pushing the boundaries of classical computing, promising unprecedented computational power for solving complex problems in fields such as cryptography, materials science, and drug discovery.
(x) Information Storage technology: Through advancements in data storage and retrieval, information storage technology has been crucial in handling the everyday production of ever-increasing volumes of digital information. Accessibility, dependability, and long-term data preservation are all guaranteed by this technology.
(xi) Ubiquitous Education technology: Digital tools are used by ubiquitous education technology to increase accessibility and engagement in learning. In particular during times of remote learning, e-learning platforms, internet materials, and virtual classrooms have expanded educational opportunities and reach.
(xii) Virtual Reality (VR) and Augmented Reality (AR) technology: Technology such as virtual reality (VR) and augmented reality (AR) is altering how we view and engage with the environment. They provide immersive experiences that increase user engagement and comprehension in industries like gaming, education, healthcare, and design.

Similarly, nanotechnology holds enormous promise for changing many industries through the manipulation of materials at the nanoscale, and hence is a crucial part of the Universal Technologies of the 21st century [58-65]. With the help of this ground-breaking technology, nanoscale structures and devices can be designed and engineered, giving businesses in fields as diverse as medical, electronics, materials research, and energy previously unheard-of accuracy and control. The development of innovative materials with extraordinary qualities, improved medicine delivery systems, and ultra-efficient energy storage and conversion technologies are all possible thanks to

nanotechnology. Its uses are numerous, and it has the power to transform entire industries and spark creativity in ways that were previously thought of as science fiction. Nanotechnology, one of Universal Technologies, is a prime example of the limitless potential that technology offers in the 21st century, advancing us toward a future of unmatched progress.
In conclusion, ICCT underlying technologies and nanotechnology have experienced tremendous expansion in the twenty-first century, radically altering how we live, work, and invent. These technologies are still developing and will have a huge impact on how our linked world develops in the future, providing countless opportunities and difficulties.

6. TECHNOLOGY-BASED INDUSTRY AUTOMATION :

The global economy and society are being significantly impacted by technology-based industry automation, which is being propelled by a number of ICCT underpinning technologies including Nanotechnology. Industries across the board, from manufacturing and agriculture to services and knowledge-based sectors, are being reshaped by these disruptive technologies. The consequences affect a number of facets of the economy and society:
(1) Enhanced Productivity and Efficiency: Automation of industries based on technology has the potential to improve productivity and efficiency dramatically. Robotics and AI technology, for instance, are speeding production procedures, cutting errors, and improving supply chains. This leads into cost savings for companies and maybe lower prices for consumers, which promotes economic expansion.
(2) Job Displacement and Transformation: While automation increases efficiency, it can also contribute to job displacement, especially for repetitive and routine work. It's important to remember, though, that automation frequently changes the nature of employment rather than completely replacing it. In the areas of technology development, maintenance, and oversight, new employment are created. To close the skills gap between job displacement and job creation, the workforce must be retrained and upgraded.
(3) Economic Growth and Innovation: Through innovation, technology-based automation drives economic growth. For instance, quantum computing technology has the potential to disrupt industries and promote innovation in sectors like drug research, materials science, and encryption. By opening up new horizons, the creation and use of cutting-edge technology can promote economic growth.
(4) Data-Driven Decision-Making: By enabling businesses to gather, process, and analyze enormous amounts of data, big data and business intelligence technology play a crucial role in automation. This in turn facilitates decision-making based on data. Businesses can make better decisions, streamline processes, and improve consumer experiences, all of which will help the economy as a whole.
(5) Sustainability and Resource Efficiency: Technology-based automation can have a positive impact on environmental sustainability. For example, the Internet of Things technology can be applied to smart grids and resource management, reducing waste and energy consumption. Furthermore, 3D Printing technology allows for the creation of intricate, lightweight structures, saving material and energy resources.
(6) Challenges in Ethical and Regulatory Frameworks: The rapid advancement of technology-based automation necessitates the development of comprehensive ethical and regulatory frameworks. Cyber Security & Forensic technology becomes vital in safeguarding data and systems. Blockchain technology, with its decentralized and secure ledger, ensures the integrity of transactions. Ensuring ethical practices, data privacy, and cybersecurity is essential to maintain public trust in these technologies.
(7) Increased Connectivity and Accessibility: Technology-based automation, particularly through Cloud Computing technology, has increased connectivity and accessibility. People and businesses can access data and services remotely, enabling remote work and e-learning. This has implications for improving access to education and employment opportunities in various regions, contributing to societal equity.
(8) Virtual Reality and Augmented Reality in Education and Training: Ubiquitous Education technology, combined with Virtual Reality and Augmented Reality technology, is revolutionizing education and training. These immersive technologies offer engaging learning experiences and practical training simulations, reducing the need for physical facilities and making education more accessible and interactive.

(9) Nanotechnology for Industrial Automation:
The 21st century's Universal Technologies for industrial automation, which include nanotechnology, usher in a microcosmic revolution in the macrocosmic world of business.
With its ability to operate at the nanoscale, it enables precise material engineering and modification, fostering innovation in industries including manufacturing, healthcare, and energy. Unique materials with unequaled properties can be created using nanotechnology, improving product quality, increasing energy efficiency, and optimizing resource use in industrial automation. Additionally, nanoscale sensors and devices provide real-time data collection and processing, which enhances the monitoring and management of industrial activities. A future of greater efficiency and technical advancement is made possible by the vital role that nanotechnology plays in redefining the boundaries of what is feasible in the realm of industrial automation. It serves as a catalyst for improvements in advanced sensors, tiny parts, and material science.

In conclusion, technology-based industry automation that utilizes ICCT and underlying nanotechnology technologies is a double-edged sword that poses both amazing opportunities and challenges. It can drive economic growth, boost efficiency, and foster innovation even while it raises problems with job displacement and ethical dilemmas. As society accepts new technologies, it is critical to strike a balance that optimizes their beneficial effects while limiting any adverse repercussions. This will contribute to the development of a technologically advanced and equitable society.

7. MANAGEMENT OF UNIVERSAL TECHNOLOGIES FOR INDUSTRY AUTOMATION :

The management of Universal Technologies for industry automation is a challenging endeavor that requires a systematic approach. This management requires managing a complex interplay of Information Communication and Computation Technologies (ICCT underpinning technologies) and Nanotechnology in order to achieve effective and successful industrial automation. The main rules and methods for managing Universal Technologies in the context of industry automation are as follows:
(1) Integration and Interoperability: The peaceful coexistence of multiple technologies must be ensured. Management should focus on integrating various ICCT underlying technologies and Nanotechnology components in order to establish a comprehensive automation system. Interoperability standards, which allow data and processes to transfer readily between different technologies, make this integration possible.
(2) Scalability and Flexibility: The management structure must be flexible and scalable as technology advances. The ability to adapt to changing technological surroundings and take into consideration the advancement of automation systems is meant by this.
The management approach should enable these transitions without causing disturbance, whether an organization is scaling up or down.
(3) Resource Allocation and Optimization: Effective resource management is necessary for managing Universal Technologies for industry automation. It also refers to personal, financial, and technological resources. The organization can harness the advantages of automation while limiting expenses and waste by optimizing resource use. This can entail spending money on staff development and training so they can manage and maintain the technologies.
(4) Risk Management and Security: Risk management and security are becoming essential elements of technology management because of the growing significance of data in automation. Identifying possible threats, putting cybersecurity safeguards in place, and developing disaster recovery plans are all part of this. The integrity and security of the automated systems are ensured by effective risk management.
(5) Ethical and Sustainable Practices: Sustainability and ethical considerations are increasingly important as automation develops. The management framework should place a strong emphasis on using technology ethically, taking into account issues like data privacy, job loss, and the environmental effects of automation. To reduce the ecological footprint, it is also crucial to adopt sustainable activities, such as cutting back on waste and energy use.
(6) Regulatory Compliance: It is crucial to keep up with changing laws and compliance standards. There might be particular regulations governing the use of technology in automation in different

businesses and places. A key component of technology management is making sure the company complies with these laws.
(7) Data Management and Analytics: Utilizing Big Data and Business Intelligence technology to extract insights from the enormous amounts of data produced by automated processes is essential for effective management. Organizations may make better decisions, work more efficiently, and spot areas for improvement by utilizing data analytics technologies.
(8) Maintenance and Upkeep: To avoid downtime and guarantee smooth operations, the technology infrastructure must be continuously monitored and maintained. To maintain the automation systems operating effectively, the management approach should include routine updates, troubleshooting, and preventive maintenance.
(9) Change Management: Organizational cultural shifts are frequently required in order to manage Universal Technologies for industry automation. In order to achieve a smooth transition and employee buy-in, effective change management tactics are needed when employees may need to adjust to new ways of working.
In conclusion, managing Universal Technologies for industry automation is a complex process that includes integrating various technologies, ensuring scalability and flexibility, optimizing resources, managing risks and security, upholding ethical and sustainable practices, adhering to regulations, harnessing data, and maintaining the technology infrastructure. For enterprises to effectively benefit from automation while navigating the difficulties and complexities posed by this technological environment, effective management of these technologies is crucial.

8. SUPER INTELLIGENT MACHINES AND EFFECTIVE INDUSTRY AUTOMATION :

Super Intelligent Machines are artificial intelligence systems that have attained a degree of intellect and problem-solving capacity that is superior to human capabilities across a wide range of tasks. They are also known as Superintelligent AI or Superintelligent Systems. Due to their amazing cognitive powers, which include complex thinking, problem-solving, learning, adaptation, and the ability to do difficult tasks with a high degree of autonomy, these machines stand out from other artificial intelligences.

8.1 Characteristics of Super Intelligent Machines:

Super intelligent machines frequently have the following characteristics:
(1) Advanced Learning: They are able to learn from a vast amount of data, adapt to new knowledge and situations, and continuously enhance their performance.
(2) High-Level Reasoning: These machines are capable of high-level discussions, critical evaluations, and conclusions, frequently while understanding broader implications and abstract notions.
(3) Autonomy: They can function autonomously in situations where conventional automation or artificial intelligence (AI) systems would not be able to. Without constant human supervision, they are capable of making decisions.
(4) Adaptability: Due to their great adaptability, which enables them to adapt to changing settings, uncertainties, and unforeseen events, super intelligent machines are beneficial in a variety of applications.
(5) Prediction and Planning: They excel in forecasting events based on both historical and current data, and they might create plans or strategies to accomplish specific goals.
(6) Cross-Domain Competence: These robots have the intelligence to apply it to a wide range of tasks and disciplines, frequently beating human experts in each.
As they have the potential to cause large societal changes, disrupt established sectors, and pose issues of ethics, control, and governance, super intelligent machines are the focus of extensive research. In the domains of artificial intelligence, machine learning, and philosophy, there is discussion and interest in the idea of a superintelligent AI, which is frequently linked to the notion of the technological singularity. It calls into question the appropriate design and implementation of such cutting-edge AI systems as well as their long-term effects.

8.2 Super Intelligent Machines and Industrial Automation:

The potential for Super Intelligent Machines to transform industry automation in a number of ways makes them the apex of artificial intelligence and automation technologies.

(1) Advanced Decision-Making: Super Intelligent Machines are able to process and interpret enormous volumes of data at rates that are faster than those of humans. They can now make intricate, data-driven judgments in real time thanks to this. This translates into more effective and improved operations in industrial settings. For instance, in manufacturing, these machines may instantly modify production procedures in response to shifting conditions, resulting in less waste and more output.
(2) Autonomous Adaptability: Super Intelligent Machines are extremely flexible and are capable of making changes to their environment on their own. This entails that they can reorganize production lines, modify manufacturing processes, and even foresee maintenance requirements without requiring human interaction. With less downtime and disturbance because to this adaptability, the automation systems continue to operate at their peak efficiency.
(3) Predictive Maintenance: Super Intelligent Machines are able to foresee when machinery and equipment may break down. They can plan maintenance or repairs in advance by reviewing historical data and current performance parameters. Predictive maintenance increases the longevity of industrial equipment while reducing unplanned downtime and maintenance expenses.
(4) Enhanced Safety: Safety is a top priority in industrial settings, and SIMs may play a significant part in maintaining a secure working environment. They may keep an eye out for anomalies that could endanger safety and monitor processes and equipment accordingly. They can then take prompt corrective action, including turning off machinery or warning human workers. The possibility of accidents and injury is decreased by this capability.
(5) Resource Optimization: The efficient use of resources like energy, raw materials, and labor is possible with super intelligent machines. They can modify procedures to cut down on energy use, lessen material waste, and make the best use of the personnel that is on hand. Costs are reduced as a result, and industrial activities are approached more sustainably.
(6) Quality Control: These devices are excellent at quality assurance and can reliably generate goods that adhere to stringent criteria. They may identify and reject inferior products during manufacture, ensuring that only high-quality products are sold. The product quality and client happiness are improved by this capability.
(7) Supply Chain Management: Supply chain processes can be improved by super intelligent machines. They can monitor inventory levels, foresee changes in demand, and alter distribution and procurement in real-time. The risk of stockouts and overstock situations is decreased as a result of the supply chain becoming more effective and responsive.
(8) Customization and Personalization: Super Intelligent Machines are capable of creating products that are specifically tailored to the needs of each consumer in sectors where personalization and customization are crucial, such as the pharmaceutical or automobile industries. They can give a level of customisation that was previously impractical by adjusting production procedures and specifications with astonishing precision.
(9) Enhanced Research and Development: By running simulations and experiments far more quickly than people can, super intelligent machines can speed up research and development. They can speed up innovation and aid in the discovery of new chemicals in fields like materials science and pharmaceuticals.
(10) Collaboration with Humans: These machines can work effortlessly in tandem with people. They can handle labor-intensive, repetitive activities, freeing up human workers to concentrate on jobs that call for imagination, problem-solving, and emotional intelligence. The total productivity and job satisfaction that can result from this human-machine collaboration.

As a result of their superior decision-making, adaptability, predictive maintenance, safety enhancements, resource optimization, quality control, supply chain management, customization, accelerated research and development, and seamless collaboration with human workers, Super Intelligent Machines offer an unmatched potential for effective industry automation. In the quest for industrial automation that is more effective, productive, and creative, these devices stand as a transformative force.

9. TECHNOLOGY BASED SINGULARITY :

Technology-Based Singularity, often referred to as Technological Singularity, is a hypothetical point in the future where the rapid and exponential growth of advanced technologies, including both ICCT underlying technologies and Nanotechnology, reaches a critical juncture. At this juncture, the capabilities of these technologies become so advanced and interconnected that they radically transform human civilization and existence in ways that are difficult to predict.

9.1 Universal Technology Based Singularity:

Here's how Universal Technologies, incorporating ICCT underlying technologies and Nanotechnology, play a pivotal role in the concept of Technology-Based Singularity:

(1) Exponential Technological Growth: Universal Technologies drive the exponential growth of knowledge and innovation. Artificial Intelligence & Robotics technology, for example, continues to advance, enabling machines to perform increasingly complex tasks, from natural language processing to autonomous decision-making. As these technologies progress, they amplify the rate of discovery and development across various domains.

(2) Interconnected Intelligence: The convergence of technologies, facilitated by Universal Technologies, leads to interconnected and superintelligent systems. These systems can collaborate, share information, and augment each other's capabilities. For instance, IoT technology can gather vast amounts of data, which is processed by AI and utilized by Quantum computing for advanced simulations and predictions.

(3) Unprecedented Data Processing: Big Data and Business Intelligence technology become fundamental in managing and extracting insights from the overwhelming volume of data generated by interconnected systems. This data-driven decision-making fuels further advancements and informs strategic choices at an unprecedented scale.

(4) Security and Trust: As Universal Technologies advance, the importance of Cyber Security & forensic technology and Blockchain technology cannot be overstated. Trust and security in this interconnected world are paramount. Blockchain provides decentralized, tamper-proof record-keeping, while Cyber Security technology safeguards networks and data against evolving threats.

(5) Transformation of Industries: The integration of Universal Technologies transforms industries across the board. 3D Printing technology revolutionizes manufacturing, enabling on-demand, customized production. Cloud Computing technology allows for resource sharing and access from anywhere, making it easier for businesses to adapt and scale rapidly.

(6) New Realities and Ubiquitous Learning: Virtual reality and Augmented reality technology create immersive learning and working environments. Ubiquitous Education technology makes learning accessible worldwide, breaking down traditional educational barriers and fostering a continuous learning culture.

(7) Breakthroughs in Healthcare and Materials Science: Nanotechnology, as an integral component of Universal Technologies, contributes to breakthroughs in healthcare and materials science. Nano-sized structures enable precise drug delivery, advanced materials with unique properties, and innovative energy solutions.

(8) Quantum Leaps in Computing: Quantum computing technology pushes the boundaries of computation, tackling problems that were previously insurmountable. This can revolutionize fields such as cryptography, materials design, and optimization, leading to transformative advances.

In essence, Technology-Based Singularity driven by Universal Technologies represents a future where the synergy of ICCT underlying technologies and Nanotechnology results in a paradigm shift. It has the potential to solve complex global challenges, create new opportunities for exploration and discovery, and redefine the boundaries of what's possible. However, it also poses ethical, societal, and regulatory challenges that require thoughtful consideration to ensure that the benefits are harnessed responsibly for the betterment of humanity.

9.2 Management of Technology Based Singularity in Society:

Management of Technology-Based Singularity in society represents a complex and multifaceted challenge that requires careful consideration, proactive planning, and responsible governance.

The rapid development and convergence of cutting-edge technologies, such as artificial intelligence, nanotechnology, and others, which is known as the technology-based singularity, holds immense promise and potential for civilization. But managing this shift necessitates attending to numerous crucial issues.

(1) Ethical Frameworks: The Technology-Based Singularity has serious ethical ramifications. Ethics must be established and followed by society to direct the creation and application of these technologies. This encompasses values pertaining to confidentiality, openness, justice, and the ethical application of artificial intelligence and other cutting-edge techniques.

(2) Regulatory Governance: To ensure that the advantages of the technology-based singularity are realized while hazards are reduced, effective regulation is crucial. For the purpose of providing supervision, establishing standards, and enforcing adherence to ethical principles, regulatory organizations must adjust to the quickly changing technology landscape.

(3) Education and Upskilling: The workforce will be affected by the change that the technology-based singularity brings about. Society must make investments in education and upskilling programs that give people the skills they need in this technologically sophisticated environment in order to handle potential job displacement and prepare for new opportunities.

(4) Data Privacy and Security: Cybersecurity and data privacy protection must be prioritized. Strong steps are needed to protect private and sensitive data and to keep people's faith in technology given the exponential rise in data collection and sharing.

(5) Access and Equity: Making sure that everyone can benefit from the Technology-Based Singularity is essential. In order to provide fair access to opportunities in education, healthcare, and the economy, efforts should be made to close the digital divide.

(6) Environmental Impact: In order to reduce ecological harm and promote sustainability, the environmental effects of sophisticated technology, including energy use and resource exploitation, should be properly monitored.

(7) International Collaboration: International cooperation is crucial because of the technology-based singularity's global nature. To ensure a coordinated and responsible approach, this involves agreements on data exchange, cybersecurity requirements, and ethical norms.

(8) Transparency and Accountability: Organizations and technology developers must be accountable for their actions and transparent about how they conduct their business. This includes assuring justice, reducing prejudice in AI systems, and describing how algorithms operate.

(9) Public Engagement: Effective management of the Technology-Based Singularity depends on public input into decision-making. To ensure that the technologies serve the greatest good, it is essential to solicit public participation and feedback.

(10) Risk Assessment: Scenario planning and ongoing risk assessment are necessary to spot possible problems and deal with them before they become catastrophes. This involves assessing how technology is affecting employment, privacy, and security.

(11) Crisis Preparedness: Rapid technological progress may result in unanticipated disruptions or catastrophes, thus society must be ready for them. This includes strategies for fending off cyberattacks, handling incorrect information, and limiting the impact of unanticipated results.

In conclusion, managing the technology-based singularity in society requires a multifaceted approach that takes into account ethical, sociological, governmental, and educational considerations. In order to maximize gains from Singularity while reducing dangers and problems, careful development and deployment of cutting-edge technologies are essential. To successfully traverse this transformational era, a diverse, cooperative, and forward-looking strategy is required.

10. ABCD ANALYSIS OF TECHNOLOGY-BASED TOTAL AUTOMATION OF INDUSTRIAL PROCESSES :

The ABCD analysis of Technology-Based Total Automation of Industrial Processes offers a comprehensive evaluation of the implications and impact of full-scale automation. Advantages are manifested in increased productivity, enhanced product quality, reduced operational costs, and a safer work environment. The benefits extend to sustainability, as automation can optimize resource utilization and minimize waste. Constraints often revolve around initial investment costs, as implementing comprehensive automation can be capital-intensive, requiring significant financial resources. Disadvantages, particularly in the context of job displacement, demand close attention, as some routine tasks may be automated, potentially leading to workforce challenges. However, strategic planning, upskilling, and job transition opportunities can mitigate these disadvantages. In essence, the ABCD analysis underscores the transformative potential of total automation while highlighting the need for a well-balanced approach to maximize its advantages and benefits while addressing constraints and disadvantages [66-109].

10.1 Advantages of Technology Based Total Automation of Industrial Processes:

Advantages of Technology-Based Total Automation of Industrial Processes are listed in the Table 3.

Table 3: Advantages

S. No.	Key Advantage	Description
1	Increased Productivity	Automation reduces manual labour and enables continuous and efficient production, leading to a significant increase in productivity. Machines can operate around the clock without fatigue or breaks, ensuring consistent output.
2	Improved Product Quality	Automation promotes accuracy and uniformity in manufacturing, which results in a higher-quality end product with fewer flaws. Products that fulfill exacting criteria are produced under strict oversight.
3	Cost Savings	Automation can save a lot on running expenses. It saves money by reducing labor expenses, reducing waste, maximizing resource use, and reducing the demand for physical space.
4	Greater Efficiency	Automation makes procedures more efficient by eliminating bottlenecks. Additionally, it can shorten cycle times and result in more effective resource management, improving overall operational efficiency.
5	Continuous Operations	Automated systems can run continuously, allowing for real-time data monitoring and 24/7 manufacturing. Faster time-to-market and improved responsiveness to market demands may result from this continuous operating.
6	Safety Enhancements	Automation frees personnel from hazardous or physically taxing duties, improving safety. This lowers the possibility of accidents and injuries and creates a safer work environment.
7	Data-Driven Decision-Making	Automated processes produce enormous volumes of data that may be analyzed. Businesses are able to optimize operations, identify problems early, and make wise strategic decisions thanks to this data-driven decision-making.
8	Resource Optimization	Automation systems effectively use resources like water, energy, and raw materials. This has positive effects on the environment and sustainability.
9	Scalability	To adapt to changing demands, automation systems may be readily scaled up or down. This scalability offers flexibility in responding to changes in the market
10	Customization and Personalization	Products can be personalized to suit the needs of certain customers using automation. This personalization is useful in sectors like fashion or auto production where demand for personalized items is high.
11	Reduction in Monotonous jobs	Automation replaces monotonous and repetitive jobs, allowing human workers to concentrate on more complex, creative, and problem-solving duties. This can increase job satisfaction.
12	Competitive Advantage	Adopting automation can give businesses a competitive edge in sectors where quality, cost, and efficiency are crucial factors. It enables businesses to react quickly to changes in the market and client needs.
13	Flexibility	Automation systems may be altered and modified to account for new goods or adjustments in production needs, allowing for quick response to market demands.
14	Durability and Reliability	When maintained properly, automated machinery may operate for longer periods of time than manual labour. This dependability reduces manufacturing hiccups and downtime.

15	Real-Time Monitoring	Remote control and real-time monitoring made possible by automation make it possible to identify problems right away, cut down on delays, and boost productivity.
16	Consistent Workforce	Automation doesn't depend on variations in the workforce's availability due to things like sick days or labour strikes, which makes for a steady working environment.

These advantages collectively contribute to improve industrial processes and, when well-managed, can lead to higher product quality, cost savings, and increased competitiveness, eventually benefiting both businesses and consumers.

10.2 Benefits of Technology Based Total Automation of Industrial Processes:

Benefits of Technology-Based Total Automation of Industrial Processes are listed in table 4.

Table 4: Benefits

S. No.	Key Benefits	Description
1	Optimized Resource Utilization	Automation makes the most effective use possible of resources including raw materials, energy, and water. It is possible to optimize processes to reduce waste, which will save money and have a positive effect on the environment.
2	Enhanced Product Quality	Automation guarantees accurate and consistent manufacturing, leading to higher-quality goods with fewer flaws. As a result, clients are more satisfied and devoted.
3	Greater Productivity	Continuous, round-the-clock work made possible by automation results in higher output rates and shorter cycle times. The company's financial performance can be improved while the expanded output can satisfy the escalating demand.
4	Operational Cost Reduction	Automation lowers labor costs and reduces human error by eliminating the need for manual labor. Additionally, it reduces operating expenses, enhancing the competitiveness of organizations.
5	Greater Safety	Automation frees workers from dangerous or physically taxing duties, making the workplace safer. A healthier and more effective workforce results from fewer accidents and injuries.
6	Scalability	Automated systems may be expanded with ease to meet changing demand. This scalability guarantees that a company can adjust to market changes and keep up operational effectiveness.
7	Personalization and customization	Automation makes it possible to produce personalized goods quickly. This is especially useful in sectors like fashion or auto manufacture where personalization is a selling element.
8	Data-Driven Decision-Making	Automation produces a lot of data, which may be examined to help in decision-making. This data-driven methodology aids in process optimization, forecasts maintenance requirements, and boosts effectiveness.
9	Increased Efficiency	Automation improves efficiency by streamlining procedures and removing bottlenecks. Costs are reduced as a result, and time to market is shortened.
10	Sustainability and Environmental Benefits	Automation systems are frequently made to be environmentally friendly and energy-efficient. This emphasis on sustainability lessens a company's impact on the environment and improves its reputation.
11	Competitive Advantage	Automation offers a competitive edge in sectors where effectiveness, cost containment, and product quality are crucial. Companies are able to react quickly to changes in the market and customer needs.
12	Longevity and Reliability	Automated equipment that is well-maintained can operate for longer periods of time than manual labour. Production pauses and downtime are reduced by this reliability.

13	Real-Time Monitoring	Real-time monitoring and remote control made possible by automation enable prompt issue detection and correction, minimizing delays and increasing overall efficiency.
14	Consistent Workforce	Automation ensures a consistent production environment since it is not affected by changes in personnel availability, such as sick days or labour strikes.
15	Adaptability	Automated systems offer flexibility in addressing market demands because they may be adjusted and modified to suit new goods or adjustments to production needs.
16	Reduction in Monotonous Tasks	Automating routine chores frees up human workers to concentrate on more imaginative, complicated, and problem-solving duties, which can improve job satisfaction.

A more competitive, effective, and environmentally responsible industrial landscape is the outcome of these advantages taken together. By embracing automation, businesses and customers can both gain from cost savings, increased competitiveness, and improved product quality.

10.3 Constraints of Technology-Based Total Automation of Industrial Processes:

Constraints of Technology-Based Total Automation of Industrial Processes are listed in table 5:

Table 5: Constraints

S. No.	Key Constraints	Description
1	Initial Investment Costs	Total automation implementation can be expensive. The expenditures of purchasing, setting up, and retraining the workforce for automation technologies might be significant. Long-term advantages frequently surpass these expenses, though.
2	Skilled Workforce Requirement	Complex machinery needs to be operated, maintained, and troubleshot by qualified personnel in order for automation to be effective. Finding and keeping experienced technicians and engineers can be difficult for businesses.
3	Technological Dependence	Businesses that fully automate become reliant on technology. Production might be halted by any system malfunctions or technological issues, necessitating proactive maintenance procedures and contingency preparations.
4	Job Displacement Concerns	Concerns regarding job displacement may arise as a result of the automation trend, particularly in sectors that depend largely on physical labour. Although automation opens up new job prospects, this problem is frequently solved by reskilling and transition programs.
5	Security Risks	Automation systems may be more susceptible to data breaches and cyberattacks as a result of growing connectivity. To protect themselves against these hazards, businesses must invest in forensic technology and strong cyber security.
6	Resistance to Change	Employees worried about losing their jobs or management teams reluctant to alter current procedures may oppose the use of automation. It is crucial to overcome this resistance through change management and education.
7	Maintenance and Downtime	Automated systems require regular maintenance to prevent costly breakdowns. Downtime for maintenance can disrupt production schedules and require careful planning.
8	Lack of Flexibility	Automation systems are designed for specific tasks and can lack the adaptability of human workers. Adapting to changes in production requirements or introducing new product lines may be challenging.

9	Interoperability Issues	Integrating various automation systems can be complex, especially if they come from different manufacturers. Ensuring interoperability and data flow between systems can be a constraint.
10	Ethical and Societal Concerns	Automation raises ethical questions related to job displacement, data privacy, and the impact on society. Addressing these concerns through ethical frameworks and regulatory guidelines is crucial.
11	Limited Creativity	Automation excels at repetitive and predefined tasks but may lack the creativity and adaptability of human workers. Certain industries may require human intervention for complex or novel problem-solving.
12	Environmental Impact	While automation can be more resource-efficient, it may still consume significant energy and materials. Mitigating the environmental impact of automation systems is a challenge.
13	Complex Troubleshooting	Diagnosing and rectifying issues in complex automation systems can be challenging. Companies need to invest in skilled personnel and resources for efficient troubleshooting.
14	Regulatory Compliance	Adhering to industry-specific regulations and standards in an increasingly automated environment can be complex and necessitates ongoing compliance efforts.
15	Customization Costs	Modifying automation systems to accommodate specific product variations or customization may incur additional costs and require a degree of flexibility in the technology.
16	Long Implementation Period	Implementing total automation can be time-consuming. The planning, installation, testing, and adjustment phases can extend over a considerable period, affecting business operations.

Balancing the advantages of total automation with these constraints requires strategic planning, investment, and a holistic approach to technology integration and workforce management. Addressing these constraints effectively can result in a more productive, efficient, and competitive industrial landscape.

10.4 Disadvantages of Technology Based Total Automation of Industrial Processes:

Disadvantages of Technology-Based Total Automation of Industrial Processes are listed in table 6.

Table 6: Disadvantages

S. No.	Key Constraints	Description
1	Job Displacement	One of the primary disadvantages of total automation is the potential displacement of human workers. There is a risk of employment loss when machines and robots take over duties, especially those that are routine and repetitive, which can have negative social and economic effects. It's crucial to remember that automation also generates new job possibilities in disciplines like system oversight, maintenance, and technical support.
2	High Initial Investment	Total automation implementation frequently necessitates a sizable initial investment in technology, including the procurement of automation equipment, software, and the required infrastructure. The financial capacity of a business may be put under pressure.
3	Skilled Workforce Requirements	Advanced automation systems require competent personnel, including technicians and engineers, to maintain and operate. It can be difficult to find and keep this qualified staff, and it can be necessary to invest in education and training.
4	Technological Dependence	Businesses that rely significantly on technology may be more susceptible to cyberattacks, technical problems, and system failures. Maintaining the reliability and security of automation systems is a critical and ongoing task.

5	Security Risks	Increased connectivity and reliance on digital systems create cybersecurity risks. Cyberattacks can compromise sensitive data and disrupt operations, necessitating robust Cyber Security & forensic technology.
6	Resistance to Change	Employees may resist automation due to fears of job displacement or concerns about adapting to new technology. Overcoming this resistance requires effective change management strategies.
7	Maintenance and Downtime	Automated systems require regular maintenance, and downtime for maintenance can disrupt production schedules and impact productivity.
8	Lack of Flexibility	Automation systems are typically designed for specific tasks and may lack the adaptability and creativity of human workers. Adapting to changes in production requirements or introducing new product lines may be challenging.
9	Interoperability Challenges	Integrating different automation systems, especially if they come from different manufacturers, can be complex. Ensuring seamless interoperability and data flow between systems is a challenge.
10	Ethical and Societal Concerns	Automation raises ethical questions related to job displacement, data privacy, and its impact on society. Addressing these concerns through ethical frameworks and regulatory guidelines is crucial.
11	Environmental Impact	While automation can be more resource-efficient, it may still consume significant energy and materials. Mitigating the environmental impact of automation systems is a challenge.
12	Complex Troubleshooting	Diagnosing and resolving issues in complex automation systems can be challenging. Companies need to invest in skilled personnel and resources for efficient troubleshooting.
13	Regulatory Compliance	Adhering to industry-specific regulations and standards in an increasingly automated environment can be complex and necessitates ongoing compliance efforts.
14	Customization Costs	Modifying automation systems to accommodate specific product variations or customization may incur additional costs and require flexibility in the technology.
15	Long Implementation Period	Implementing total automation can be time-consuming. The planning, installation, testing, and adjustment phases can extend over a considerable period, affecting business operations.

Balancing the advantages of total automation with these disadvantages requires a strategic approach that considers the impact on the workforce, technology investment, maintenance, security, and ethical considerations. A well-planned automation strategy can help maximize benefits while mitigating potential drawbacks.

11. PRECAUTIONS & SUGGESTIONS :

Postulates for Efficient Technology Management for Effective Automation of Industries in Society using Universal Technologies:

(1) Interdisciplinary Integration: Successful technology management requires interdisciplinary collaboration. Integrating expertise from various fields, including engineering, data science, cybersecurity, and ethics, is essential for holistic automation solutions.

(2) Strategic Alignment: Technology management should align with the strategic goals of an organization. Automation initiatives should support the company's long-term vision and mission, ensuring that technology serves as an enabler rather than a standalone solution.

(3) Resource Optimization: Effective technology management involves optimizing resources, both human and financial. Prioritizing investments in automation technologies and ensuring efficient resource utilization are fundamental to success.

(4) Data-Centric Decision-Making: Data-driven decision-making is a core postulate. Leveraging data from Big Data and Business Intelligence technology is key to understanding operations, identifying opportunities, and driving informed choices.
(5) Security by Design: Incorporating Cyber Security & forensic technology as a fundamental element of technology management is non-negotiable. Security should be a core consideration from the outset to safeguard against threats and vulnerabilities.
(6) Ethical Frameworks: Ethical considerations must guide technology management practices. Addressing issues related to data privacy, job displacement, and societal impact is essential to ensure responsible automation.

Suggestions for Efficient Technology Management for Effective Automation of Industries in Society using Universal Technologies:
(1) Invest in Skill Development: Focus on upskilling the workforce to effectively manage and operate automation systems. Continuous training and education in areas like AI, cybersecurity, and data analytics are critical.
(2) Develop a Cybersecurity Strategy: Establish a comprehensive cybersecurity strategy that encompasses both Blockchain technology and Cyber Security & forensic technology. This strategy should include regular assessments, updates, and employee awareness programs.
(3) Embrace Data Analytics: Leverage Big Data and Business Intelligence technology to gain actionable insights from the vast amount of data generated by automation. Data analytics can inform decision-making, identify inefficiencies, and predict maintenance needs.
(4) Maintain Flexibility: Design automation systems with adaptability in mind. The ability to reconfigure systems and processes to accommodate changes in production requirements is invaluable.
(5) Consider Sustainability: Implement sustainable practices in automation, such as reducing energy consumption and minimizing waste through the use of 3D Printing technology and IoT technology. These measures not only reduce environmental impact but also cut operational costs.
(6) Promote Ethical Automation: Develop and adhere to ethical guidelines for automation. Consider the ethical implications of automation decisions, and ensure that data privacy and societal impacts are carefully managed.
(7) Collaborate Across Disciplines: Encourage cross-disciplinary cooperation amongst specialists in technology, business, ethics, and other fields. Innovative solutions and improved technology management can result from a diversity of viewpoints.
(8) Plan for Maintenance: Create a thorough maintenance schedule for automation systems that include proactive maintenance techniques to reduce downtime and interruptions.
(9) Stay Informed on Regulations: Keep up with the rules and guidelines for automation that are relevant to your industry. Verify compliance and take into account how changing legislation may affect technology management processes.
(10) Encourage Innovation: Establish a culture inside your firm that encourages automation innovation. Encourage staff members to come up with and apply creative solutions that boost productivity and effectiveness.

Utilizing Universal Technologies for efficient automation requires dynamic and ever-evolving technology management. These assumptions and recommendations give firms a basis for navigating the challenges of technology management while gaining the advantages of cutting-edge automation.

12. CONCLUSION :

As a conclusion, this academic research study has set out on an ambitious quest to investigate and analyze the interaction between competent technology management and the successful automation of industries in society. The objectives have led us through a thorough investigation of 21st-century universal technologies, going in-depth on information communication, computation, and nanotechnologies. We have uncovered their core ideas, extensive uses, and possible effects on industrial automation. This investigation has been crucial in illuminating how technology might radically alter the primary, secondary, tertiary, and quaternary sectors. Our analysis shows that technology has not only developed but has also solidified itself as a foundational support for various businesses. By pushing the limits of what is possible in the manufacturing, service, and knowledge-based sectors, it has developed into a necessary instrument. We have also discovered management techniques for Universal Technologies in the context of industry automation. These approaches cover integration, scalability, resource optimization, and ethical issues, and they can be helpful suggestions for businesses starting down the automated path. The topic of super-intelligent machines and their significant influence on industry automation has also been touched upon in this essay. Machines with autonomous adaptability, predictive maintenance, and enhanced decision-making capabilities may potentially rule the future, significantly boosting productivity and security across a variety of industries. Finally, we looked at the idea of a technology-based singularity in the context of industry automation, where opportunities and difficulties are created by the exponential rise of technology and AI systems. The voyage up to this point has been an illuminating investigation into the blending of technology and business, giving us a glimpse into a future characterized by enhanced automation, moral issues, and cutting-edge business tactics.

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Anticipated Attributes of Chief Executive Officers Based on Newly Developed CEO Matrix

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Subject Area: Business Management.
Type of the Paper: Exploratory Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10408491
Google Scholar Citation: IJAEML

How to Cite this Paper:
Aithal, P. S. (2023). Anticipated Attributes of Chief Executive Officers Based on Newly Developed CEO Matrix. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 216-248. DOI: https://doi.org/10.5281/zenodo.10408491

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0200

Received on: 15/10/2023
Published on: 20/12/2023

Anticipated Attributes of Chief Executive Officers Based on Newly Developed CEO Matrix

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ABSTRACT

Purpose: *To evaluate deep into the multifaceted realm of Chief Executive Officer (CEO) attributes, aiming to comprehensively explore and analyze the diverse qualities that define effective leadership at the highest echelons of organizations. Central to this exploration is the utilization of a newly developed CEO Matrix, designed as a comprehensive tool to categorize and assess CEO attributes across a spectrum of competencies.*

Methodology: *A conceptual model development and analysis method using an exploratory research method and Bloom's higher-order thinking is adopted. Further analysis of the newly developed CEO matrix is made using the ABCD analysis framework.*

Findings: *A CEO matrix is developed based on analysis of various attributes of a CEO as manager, leader, visionary, technocrat, financial acumen, decision maker, emotional hero, role model, etc. Low and High values of Leadership Skills and Financial Acumen are selected as two parameters to represent the matrix. CEO falls into each quadrant is named suitably as (1) Visionary Leader (High Leadership, Low Financial Acumen) (2) Financial Strategist: (Low Leadership, High Financial Acumen), (3) Master/Super Strategist: (High Leadership, High Financial Acumen), and (4) Developing Leader: (Low Leadership, Low Financial Acumen). The CEO matrix is further discussed using Bloom's Higher-order research skills.*

Originality/Values: *A 2x2 CEO matrix is created with two parameters (Leadership effectiveness and financial acumen. The CEO matrix is analysed based on Higher order thinking research skills and the ABCD analysis framework.*

Research Type: *Exploratory.*

Keywords: CEO, Attributes of CEO, CEO Matrix, Leadership Skills, Financial Acumen, ABCD analysis

1. INTRODUCTION :

The position of a Chief Executive Officer (CEO) is crucial in establishing the direction and performance of an organization in the ever-changing world of modern business. CEOs are more than just symbolic figures; they are people with great power who shape the culture, tactics, and output of their organizations. Many characteristics are essential to their success and are deeply woven into the fabric of organizational success.

Amid the complicated web of global movements, technical innovations, and market forces, the qualities that CEOs possess are essential for navigating the intricacies of today's business climate. These qualities cover a wide range, from emotional intelligence and flexibility to strategic acumen and visionary leadership. Every aspect makes a distinct contribution to the CEO's capacity to steer the company toward resilience, innovation, and sustainable growth [1-3].

CEO attributes play a pivotal role in determining organizational success as they heavily influence strategy, culture, and overall performance [4-6]. Here's an overview of their significance:

(1) Leadership and Vision: The organization's direction is determined by the vision of the CEO. Their capacity to uplift, encourage, and guide groups of people toward a single objective is essential. Strong and capable leadership cultivates a culture of creativity, adaptation, and resilience.

(2) Decision-Making Skills: CEOs make important choices that have an impact on the organization's history and future. Success requires sound judgment that is based on information, experience, and strategic thinking.

(3) Strategic Thinking: CEOs have to maneuver through challenging situations. Strategic thinking is useful for long-term goal-setting, seeing changes in the market, and putting the company in a position to take advantage of possibilities.
(4) Financial Acumen: Comprehending the complexities of finance is essential. CEOs must assure sustainable growth, maximize investments, and manage resources effectively all while preserving their financial stability.
(5) Communication and Relationship Building: Strong relationships and trust are fostered by effective communication, which also promotes clarity, alignment, and engagement with external stakeholders and within the business.
(6) Adaptability and Innovation: To maintain the organization's relevance and competitiveness, CEOs must welcome innovation, adjust to shifting conditions, and guide the company through changes.
(7) Ethical and Social Responsibility: Respecting moral principles and social obligations fosters credibility, trust, and long-term viability, all of which improve a brand's reputation.
(8) Talent Development and Culture: Success depends on developing a culture that draws and keeps top talent, values diversity, stimulates creativity, and creates a happy work atmosphere.
(9) Risk Management: CEOs are responsible for managing risks, striking a balance between reward and risk, and putting plans in place to lessen any hazards to the company.
(10) Resilience and Crisis Management: A CEO's capacity for resilience, quick decision-making, and problem-solving are essential for the organization's survival and recovery during times of crisis.
The culture, strategic direction, and general performance of the company are all influenced by the qualities of the CEO. The effectiveness of a CEO in these domains has a substantial impact on an organization's flexibility, agility, and capacity to prosper in a changing and cutthroat environment.
A CEO's qualities are important for more reasons than just the day-to-day operations; they also have a big impact on stakeholder relations, company culture, and strategic decision-making. When these qualities are developed and used to their full potential, they act as stimulants that promote creativity, drive change, and strengthen the corporate identity of a company.
This paper explores, analyzes, and assesses CEO qualities via a broad perspective in order to shed light on the significant influence these traits have on organizational success. By utilizing analytical frameworks like Bloom's Taxonomy and exploratory research approaches, this study aims to clarify the nuances of CEO qualities and provide insight into how they affect the lifespan and effectiveness of the firm. The goal of this research is to thoroughly examine and analyze the various characteristics that characterize effective leadership at the top levels of organizations by delving deeply into the complex world of CEO traits. The use of a recently created CEO Matrix, intended as a complete tool to classify and evaluate CEO traits across a range of skills, is central to this investigation.
This study's main goals are to: (1) identify and classify the various traits that CEOs display that have a major impact on organizational success; and (2) use the CEO Matrix, a structured analytical framework, to methodically break down, examine, and assess these traits. The goal of this investigation is to uncover a more complex understanding of the relationship between organizational success and CEO qualities. Through the use of an exploratory study methodology, we hope to identify the fundamental characteristics that set apart visionary leadership, strategic acumen, adaptability, and other critical qualities exhibited by prosperous CEOs. This investigation into previously unexplored CEO attribute domains is guided by the recently created CEO Matrix, which functions as a compass. This carefully designed and developed framework makes it possible to categorize CEO attributes methodically, offering an organized perspective that makes it easier to evaluate and understand the intricacies of executive leadership.
The objective of this study is to identify and classify CEO qualities and to investigate their consequences for organizational strategy, culture, and long-term success by aligning our exploration with Bloom's Taxonomy, a powerful analytical tool. This comprehensive study is anticipated to yield invaluable insights into the fundamental characteristics that drive effective leadership and influence organizational results. The ultimate objective of the study is to contribute to the body of knowledge regarding CEO attributes by providing a thorough understanding that can assist companies in identifying, cultivating, and utilizing the qualities essential for success, resilience, and long-term growth. The study's aims are summarized here, with a focus on the usage of the newly developed CEO Matrix to examine, evaluate, and assess CEO attributes related to the firm's success. Although it has historically been used in educational contexts, its versatility goes beyond the classroom, offering a

strong framework for methodically and thoroughly evaluating intricate concepts and cognitive processes—like CEO qualities.

2. LITERATURE REVIEW :

Table 1: CEO as Manager

S. No.	Focus/Outcome	Reference
1	This study explores the use of core management techniques in companies that have a founder-CEO, or "founder CEO" enterprises as they are called. Even though founder CEOs are often thought to have high levels of drive, it is still unclear whether these people are naturally suited to be the principal administrators of their companies. We examine several explanations for why founders may not necessarily be the best candidates for senior management roles.	Bennett, et al. (2016). [7]
2	The authors advance our understanding by speculating that transformational CEOs may not only enhance a company's overall ambidexterity but also be particularly effective at enabling certain top managers to engage in simultaneous exploration and exploitation.	Li, et al. (2015). [8]
3	Managers are the ones who formulate strategies, and a company's success or failure is determined by how well they work. Therefore, it is crucial—and it cannot be overstated—to select the best managers for your organization. The author provides models for choosing managers at the corporate and Strategic Business Unit (SBU) levels in this framework.	Leontiades (1982). [9]
4	Developed a model that shows how an overconfident manager, who sometimes makes investments that reduce value, has a higher probability of being purposefully promoted to the CEO role in a governance framework that prioritizes value maximization than does a logical manager. Furthermore, a risk-averse CEO's overconfidence boosts the value of the company up to a point where it differs from the effect of lower risk aversion. Interestingly, CEOs who are overconfident also have a tendency to invest less in the creation of knowledge.	Goel, et al. (2008). [10]
5	Analysis of CEO changes brought about by events such as deaths, health issues, and natural retirements was done to determine the effect of managerial styles on financial strategies, investment choices, and firm profitability. The study shows that changes in policies and profitability after these external turnovers don't show abnormally high levels of variation over a large sample of 8,615 Compustat enterprises covering the years 1990 to 2007. Moreover, there is insufficient evidence to substantiate the claim that managers who work for several companies have a tendency to adopt a uniform approach from one company to another.	Fee, et al. (2011). [11]
6	The purpose of this essay is to investigate how management levels and individual characteristics interact to predict foreign workers' performance. We concentrated on proactive personality, which is the tendency to impact the organizational environment, and self-control, which is the tendency to modify oneself to fit into the organizational context. Our hypothesis was based on the expected influence of these characteristics on job outcomes, which we tested by polling 307 business expatriate managers in China.	Lauring et al. (2019). [12]
7	The goal of this study was to investigate the forces behind radical or ground-breaking inventions that push the frontiers of knowledge creation. A model that highlights the process of choosing between radical and gradual innovation was developed by looking at the distribution of managers with different levels of human capital and ages inside various organizations. Research at the firm and patent levels revealed an interesting relationship: organizations that adopt a flexible and disruptive culture are significantly more likely to pursue disruptive innovation.	Acemoglu, et al. (2022). [13]

	Additionally, these companies frequently hire younger managers and innovators who have a comparative advantage in promoting radical innovation.	

Table 2: CEO as Leader

S. No.	Focus/Outcome	Reference
1	The work shows that within a competitive assignment model, known empirical patterns naturally arise as effective results. According to different criteria, industry conditions impacting the options open to managers and enterprises, this model illustrates the process by which CEOs and firms match. The model also produces a number of innovative predictions about the traits, pay, and performance of replacement managers. The study creates a large dataset covering turnover events from 1992 to 2006, confirming that the predictions match the available data.	Eisfeldt, et al. (2013). [14]
2	This study looked at relationships between employee attitudes, business performance, and CEO leadership practices in a sample of 125 Chinese companies. Initially, we used an inductive technique to identify different kinds of CEO leadership characteristics specific to the Chinese environment. The range of CEO leadership behaviours in this setting was then captured by a thorough six-dimensional measure that we created using component analysis. It included three dimensions focused on tasks and three dimensions on relationships.	Wang, (2011). [15]
3	A model that explained the impact of charismatic leadership from CEOs on organizational performance at various management levels was presented. This study synthesized a number of elements related to the conceptualization of theoretical conceptions and the interactions between them, including degrees of measurement and hierarchy. It also presented the idea of near vs distant leadership as a prism through which to view the complexities of CEO leadership dynamics. Moreover, it considered other levels of analysis that the constructs in this model could function at, which would enhance our comprehension of the dynamics of leadership in companies.	Waldman, D. A., & Yammarino, F. J. (1999). [16]
4	Using a sample of 126 CEOs in technology companies, this study explores the relationships between CEO servant leadership, executive qualities like narcissism, founder status, and organizational affiliation, and their overall effect on company success. The results have importance for scholars who aim to gain more profound understanding of the factors that influence and result from servant leadership. Furthermore, these findings provide practitioners with insightful information about how to counteract negative or egocentric executive leadership behaviors and maximize the benefits of servant leadership for the improvement of organizations.	Peterson, et al. (2012). [17]
5	The objective of this article is to investigate the relationship among CEO transformational leadership, the environment that fosters innovation, and organizational innovation that is attained by means of both investigation and exploitation.	Zuraik, et al. (2018). [18]
6	The goal of this study is to determine how CEO empowerment affects top management teams' (TMTs') behavioral alignment and efficacy, which in turn affects business performance. Structural equation modeling, using data from 82 TMTs, validates a mediated relationship: CEO empowerment positively correlates with behavioral alignment of TMTs, which in turn strengthens TMT effectiveness and improves firm performance.	Carmeli, et al. (2011). [19]
7	Examining the processes that lead to this effect and determining if corporate entrepreneurship and a technology focus serve as intermediates influencing this result were the goals of this study. The results of the	Chen, et al. (2014). [20]

	investigation confirmed corporate entrepreneurship's full mediation function in tying CEOs' transformational leadership and product innovation performance together.	
8	The goal of this study is to investigate the relationships and underlying processes that exist between the innovative behavior exhibited by managers and the transformational or transactional leadership styles of founding CEOs. The results indicate that the CEO's transformational and transactional leadership styles positively correlate with managers' innovative activity. Additionally, the study shows that the relationship between transformational leadership and innovative behaviour displayed by employees is mediated by the innovative atmosphere of the firm.	Kang, et al. (2015). [21]
9	The purpose of this mixed-methods study is to examine, using solely secondary data, the relationship between CEO transformational leadership and business success. A randomized sample of forty-two CEOs from publicly traded US and European companies participated in the study. The evaluation of their transformative leadership was based on media sources, the content of which was analyzed to create CEO profiles for each. A three-person panel of judges then assessed these characteristics to assign a transformative leadership style rating to the CEOs.	Jensen, et al. (2020). [22]
10	Based on this research, the study offers a tentative ethical evaluation that declares the integrative method to be ethically better and the instrumental approach to be morally inferior. In the discussion that followed, which focused more on hypothetical than prescriptive acts, the research utilized the integrative framework and moral imagination to open the door for the development of ethically sound answers. Using a single case study to expand the conversation on responsible leadership in emerging markets, this investigation provides new insights into the use of a responsible leadership strategy that incorporates multiple facets to resolve stakeholder issues.	Pless, et al. (2021). [23]
11	This book acts as a guide to help readers understand the major themes that will shape leadership in the future and the repercussions that will follow. It helps to understand the critical abilities and mindsets that aspiring leaders need to adopt and provides guidance on how to develop them. In addition, it seeks to transform how people view leadership and what it means to be a leader by tackling the significant issues that it is expected that future leaders will face. It also draws attention to the discrepancy between CEO perceptions and actual employee experiences, which helps employees acquire the leadership skills they'll need to successfully navigate the new landscape.	Morgan, J. (2020). [24]

Table 3: CEO as Wealth Creator

S. No.	Focus/Outcome	Reference
1	In the quickly changing global economic environment of today, creating wealth in both established firms and entrepreneurial endeavours presents considerable hurdles. In these various organizational environments, strategic leadership is essential to enhancing the wealth-generation process and achieving returns that are above average. This article explores the meaning of strategic leadership and sets it apart from managerial and visionary leadership. It also looks into the unique relationships between these three leadership types and how they affect the generation of wealth. It is suggested that the key to generating returns above average is to enable businesses to reclaim strategic control and to cultivate a sizable group of strategic leaders.	Rowe, W. G. (2001). [25]
2	Leadership and influence among staff members are intrinsically valued by organizations, particularly when it comes to promotions and higher-level	Lind, et al. (2018). [26]

	positions. Even great executives, nevertheless, might not always deliver the necessary operational results for the business. Dr. Adrian Atkinson's research, which involved many expert specialists, has produced the identification of a special person whom he refers to as a 'Wealth Creator'.	
3	This study shows that variations in CEO compensation cascade down the organizational hierarchy, introducing the idea that fairness rules carry a lot of weight among high-level decision-makers. Interestingly, CEOs use their power to affect the pay of their staff members in addition to raising their own income. There is a crucial implication that becomes apparent: paying a top CEO too much is more expensive than previously thought. The study also shows that CEOs are important reference points for workers when assessing equity, which affects how they feel about their own compensation. More specifically, it increases the risk that lower-level managers may leave the company when they get pay differences between themselves and the CEO, regardless of how much they are paid.	Wade, et al. (2006). [27]
4	The study looks into the relationship between management's earnings projections and the competency of the CEO. Using recently developed measures of managerial competence, the study finds a significant correlation: CEO competence increases the likelihood of providing a management profits projection as well as the features of the forecast, such as accuracy, frequency, timeliness, and value relevance.	Baik, et al. (2011). [28]
5	The paper summarizes and investigates the empirical evidence about the evolution of CEO compensation and its relationship to business performance starting in the 1930s. According to the analysis, CEO compensation is heavily influenced by competitive market dynamics as well as management authority. Nevertheless, neither strategy fully accords with the available data. Possible directions for further research in this area are briefly explored in this paper.	Frydman, C., & Jenter, D. (2010). [29]
6	The study examines more recent ideas like cultural entrepreneurship and business model drivers in addition to more known theories like contingency theory and strategic fit. Furthermore, it integrates, broadens, and critically examines theories and research from the fields of strategic management and entrepreneurship in fresh ways, bringing concepts like institutional theory, resource-based view, organizational learning, network theory, creative destruction, and transaction costs into play. The work that is being presented establishes the foundation for further studies concerning wealth development through strategic entrepreneurship.	Hitt, et al. (2001). [30]
7	The study looked into the relationship between ownership structure, board makeup, CEO qualities, and share performance of companies after acquisition announcements. The study, which examined 273 acquisitions made by Canadian companies between 1998 and 2002, found a favourable correlation between the acquiring entity's short-term financial performance and higher CEO and director ownership levels as well as greater board independence. On the other hand, there was a negative correlation between value creation and greater board sizes. Additionally, cross-border and cash-based transactions were associated with higher shareholder wealth for the acquiring business.	Amar, et al. (2011). [31]
8	This study shows that CEOs are not only among the wealthiest people alive today, but they have also been instrumental in creating an economic system that favours the ultra-wealthy. The essay makes the case for their power in two main ways: first, by promoting financialized free-market ideas to the public and policymakers as a tool for managing the economy, and second, by using big businesses as financial tools to the benefit of rich people and financiers. By doing these things, CEOs have created an environment that is more financialized, taking money away from the	Davis, A. (2019). [32]

	actual economy and common workers and directing it toward the wealthiest segments of society.	
9	This study indicates that in the modern period, strategy execution has emerged as a key factor in sustaining competitive advantage. As such, it is no longer possible to prioritize strategy formulation over strategy execution. Success now depends on a new strategic paradigm that combines elite strategy-execution skills. These include coordinating the development and implementation of various projects, matching internal procedures to market conditions, and minimizing disruptions through efficient handling of organizational change's aftereffects. These approaches improve all of the key elements that contribute to shareholder wealth, both strategically and operationally.	Bigler, W. R. (2001). [33]

3. OBJECTIVES OF THE PAPER :

(1) To know the current status of CEO analysis in Business Organizations research based on the review of existing literature.
(2) To review the various attributes of a CEO as manager, leader, visionary, technocrat, financial acumen, decision maker, emotional hero, Role model, etc.
(3) To develop a 2x2 CEO matrix using two important attributes of CEO.
(4) To discuss the newly developed CEO matrix using Bloom's Taxonomy-based higher-order thinking skills which include analysis, comparison, evaluation, interpretation, and creation.
(5) To analyze the newly developed CEO matrix using ABCD Listing.
(6) To suggest the practical interpretation of the newly developed matrix while evaluating the CEO performance.

4. METHODOLOGY :

Information gathered from a variety of sources, such as academic journal articles, edited book chapters, and edited conference proceedings papers, is analyzed utilizing an exploratory research approach employing Google Scholar and AI-based GPT search engines. In accordance with the paper's objectives, the gathered data are analyzed, contrasted, assessed, and interpreted using the appropriate frameworks.

5. CEO ATTRIBUTES AND PERFORMANCE :

(1) CEO as a Manager:

Being a CEO in the 21st century demands a diverse skill set and an adaptable approach due to the rapidly changing business landscape. Some key attributes and success factors for a CEO functioning as a manager in a contemporary organization are listed in Table 4:

Table 4: Attributes of CEO as a Manager in an Organization

S. No.	Key Attribute	Description
1	Visionary Leadership	CEOs must have a clear vision for the future of the company, establishing challenging but doable objectives that complement the mission and values of the establishment.
2	Adaptability and Agility	In a fast-paced setting, having the flexibility to adjust tactics, adjust to shifting market conditions, and welcome new breakthroughs or technology is essential.
3	Strategic Thinking	Capacity to discern patterns, assess complicated situations, and reach well-informed judgments that strategically move the business forward.
4	Emotional Intelligence	Developing a positive work environment, empathizing with stakeholders, and comprehending and controlling emotions both individually and within the team.
5	Effective Communication	Alignment and trust are largely dependent on how well vision, plans, and expectations are communicated to internal teams, stakeholders, and the general public.

6	Innovation and Creativity	Promoting an innovative culture, permitting risk-taking and experimentation, and nurturing creativity within the company.
7	Global Mindset	In an increasingly interconnected world, taking into account the global economy, exercising cultural sensitivity, and comprehending different points of view.
8	Tech Savviness	Understanding new technology and how they might affect the market will help the company remain competitive.
9	Talent Attraction	Bringing in top talent, creating diverse teams, supporting the development of employees, and encouraging teamwork.
10	Ethical Leadership	Maintaining high moral standards, encouraging openness, and guaranteeing corporate social responsibility.
11	Resilience and Adaptation	Being able to bounce back from setbacks, learn from them, and modify tactics as necessary.
12	Strategic Partnerships	Forming partnerships, alliances, and cooperative efforts to pool resources and broaden the organization's influence.
13	Data-Driven Decision Making	Utilizing data analytics and insights to find development possibilities, streamline procedures, and make well-informed judgments.
14	Risk Management	Evaluating risks, putting backup plans in place, and reducing possible dangers to the company.
15	Customer-Centric Approach	Putting a lot of effort into comprehending and meeting the demands and expectations of customers.

Combining these qualities with their ability to navigate complexity, lead change, and create an atmosphere that supports innovation and growth while remaining aware of the requirements of their stakeholders, successful CEOs propel organizational success.

(2) CEO as a Leader:

In the contemporary landscape, the role of a CEO as a leader in a 21st-century organization encompasses a wide array of attributes and success factors that go beyond traditional managerial skills. Ssome key attributes and success factors for a CEO functioning as a leader are listed in Table 5:

Table 5: Attributes of CEO as a Leader in an Organization

S. No.	Key Attribute	Description
1	Visionary Leadership	Articulating a captivating vision that spurs groups of people to work together toward a common objective. In a company, purpose and direction are instilled by effective leaders.
2	Adaptability and Agility	The ability to quickly pivot, accept change, and modify plans in reaction to changing market conditions, technology breakthroughs, and worldwide events.
3	Inclusivity and Diversity	Valuing different viewpoints, encouraging inclusivity, and utilizing a diverse workforce's talents to stimulate creativity and innovation.
4	Empowerment and Trust	Authorization delegation, team empowerment, and the development of a culture of trust and accountability allow workers to feel free to take measured risks.
5	Emotional Intelligence	The ability to comprehend and control emotions, exhibit empathy, and cultivate enduring bonds with stakeholders, consumers, and staff.
6	Communication and Transparency	Clear, honest communication that promotes alignment, trust, and mission clarity across the entire organization.
7	Strategic Thinking and Decision Making	Analytical thinking to create strategic judgments that take the long- and short-term effects into account.

8	Resilience and Grit	Exhibiting fortitude in the face of difficulties, taking lessons from failures, and inspiring groups to carry on in the face of difficulty.
9	Innovation and Creativity	Promoting a culture of creativity, experimentation, and ongoing education in order to stay ahead of the curve in a setting that is changing quickly.
10	Ethical and Social Responsibility	Maintaining high moral standards, placing a heavy emphasis on corporate social responsibility, and coordinating business plans with society norms.
11	Global Perspective	Possessing a global perspective, being aware of various markets, and negotiating cross-border challenges in an international commercial environment.
12	Talent Development and Mentorship	Putting money into mentoring, coaching, and talent development to help the organization's future generation of leaders.
13	Collaboration and Partnerships	Forming strategic alliances and partnerships to take advantage of complimentary skills and promote growth on both sides.
14	Technology Integration	Adopting digital innovations, utilizing data analytics, and leveraging technology to make well-informed decisions and run operations more efficiently.
15	Customer-Centric Approach	Putting the needs, opinions, and satisfaction of the client first in order to provide great experiences and create enduring bonds.

These days, successful CEOs use these qualities of leadership to foster an innovative, resilient, and purpose-driven culture inside their companies. They embrace change as a chance for progress, steer through complexity, lead with empathy, and promote sustainable growth.

(3) CEO as a Dynamic Visionary:

A CEO functioning as a dynamic visionary in a 21st-century organization embodies several key attributes and success factors as listed in table 6:

Table 6: Attributes of CEO as a Dynamic visionary in an organization

S. No.	Key Attribute	Description
1	Forward-Thinking Mindset	A forward-thinking chief executive officer foresees developments in the market, in technology, and in society, remaining one step ahead of the curve to seize new opportunities.
2	Strategic Vision	Creating a long-term vision that is engaging, clear, and flexible enough to direct the organization's expansion and development.
3	Innovation and Creativity	Creating an atmosphere that values and explores new ideas, encouraging innovation, and stimulating creative thinking.
4	Risk-Taking and Boldness	The readiness to adopt audacious tactics that bring about revolutionary change, question the existing quo, and take measured chances.
5	Adaptability and Agility	The ability to quickly adjust strategy in response to shifts in the corporate environment or market shocks.
6	Inspiring Leadership	Encouraging a sense of purpose and enthusiasm in the pursuit of the organization's objective by inspiring and motivating teams to align with the visionary goals.
7	Tech and Data Savviness	Utilizing data insights and technology to generate efficiency, innovation, and competitive advantage.

8	Global Perspective	Gaining an understanding of international markets, cultural quirks, and trends can help the company grow and compete globally.
9	Collaboration and Partnerships	Forming networks, partnerships, and strategic alliances to boost creativity, break into new markets, and take advantage of complementary skills.
10	Resilience and Adaptation	Remaining resilient in the face of obstacles or failures, taking lessons from past mistakes, and modifying tactics as necessary.
11	Ethical and Social Responsibility	Integrating moral behavior into the mission of the company and guaranteeing a dedication to sustainability and social responsibility.
12	Customer-Centric Focus	Putting a lot of focus on anticipating future needs, providing great experiences, and understanding and satisfying client wants.
13	Empowerment and Trust	Employee empowerment, the development of a trusting environment, and the allowance of autonomy all promote innovation and creativity.
14	Continuous Learning and Improvement	Adopting an attitude of constant learning, asking for and receiving feedback, and modifying plans in light of new information and insights.
15	Measuring Impact	Defining KPIs and metrics to monitor the organization's progress toward the visionary goals, ensuring that it stays on course and makes necessary strategy adjustments.

In order to lead the company into a future marked by innovation, adaptability, and sustainable growth, a dynamic visionary CEO combines these qualities while continuously pushing limits and changing the industrial environment.

(4) CEO as a Technocrat:

A CEO functioning as a technocrat in a 21st-century organization possesses specific attributes and success factors deeply rooted in technological expertise, strategic application, and leveraging innovations. Some of the key attributes and success factors for such a role are listed in Table 7:

Table 7: Attributes of CEO as a technocrat in an organization

S. No.	Key Attribute	Description
1	Deep Technological Acumen	A thorough awareness of new technologies that are pertinent to the sector, like blockchain, artificial intelligence, machine learning, and the Internet of Things, as well as the capacity to see how they might be used inside the company.
2	Strategic Technological Integration	Utilizing technology to strategically empower many organizational functions, including as customer engagement, data analytics, operations, and production.
3	Data-Driven Decision Making	Utilizing insights and data analytics to make well-informed judgments, streamline procedures, spot patterns, and predict changes in the market.
4	Innovation and R&D Focus	Promoting an innovative culture and allocating funds for research and development projects in order to remain at the forefront of the industry's technical breakthroughs.
5	Tech Infrastructure Development	Constructing a strong technical foundation while guaranteeing scalability, security, and agility to meet the demands of the company both now and in the future.
6	Adaptability to Change	To properly utilize new technology, organizations must embrace technological disruptions and take the lead in organizational change.

7	Collaboration with Tech Experts	Forming alliances or working together with startups, tech-savvy businesses, or tech professionals to gain access to cutting-edge developments and remain current with market trends.
8	Digital Transformation Leadership	Directing the company's digital transformation projects, streamlining operations, and using technology to improve client experiences.
9	Tech Talent Acquisition and Development	Luring in top IT talent, supporting their development, and establishing an atmosphere that encourages education and creativity.
10	Cybersecurity Focus	Putting a high priority on strong cybersecurity measures to safeguard confidential information and guarantee the reliability of the company's IT system.
11	Agile Project Management	Putting agile project management techniques into practice to improve productivity, flexibility, and responsiveness to evolving technology demands.
12	Customer-Centric Technological Solutions	Creating technological solutions that improve user experiences, solve problems for customers, and increase the value of the goods or services provided.
13	Cost-Effective Technological Investments	Judiciously devoting funds to IT initiatives that will support the organization's overarching objectives and offer significant returns.
14	Ethical and Responsible Tech Use	Ensuring that privacy laws, moral standards, and social responsibility ideas are all in line with technology advancements.
15	Continuous Learning and Adaptation	Following the most recent developments in technology, encouraging a culture of learning, and modifying plans in response to changes in the market and in technology.

Combining these qualities, a technocrat CEO uses technology to propel the organization's creative, efficient, and strategic growth while establishing the company as a leader in a rapidly changing technical environment.

(5) CEO as a Financial Acumen:

A CEO with strong financial acumen in a 21st-century organization embodies specific attributes and success factors vital for effective financial leadership as listed in Table 8:

Table 8: Attributes of CEO as a financial acumen in an organization

S. No.	Key Attribute	Description
1	Financial Expertise	Possesses a thorough awareness of economic trends, financial markets, accounting concepts, and finance, allowing for the development of strategic decisions.
2	Strategic Financial Planning	Creates and puts into action long-term financial plans that support the objectives of the company and guarantee its growth and viability.
3	Risk Management	Effectively recognizes and controls financial risks, putting in place risk-reduction plans to safeguard the company's investments and assets.
4	Capital Allocation Skills	Effectively distributes funds, giving top priority to bets that yield the biggest profits and support the goals of the company.
5	Cost Management	Carries out cost-saving strategies to maximize costs without sacrificing quality in order to boost operational effectiveness and profitability.

6	Financial Forecasting and Analysis	Makes educated judgments, implements proactive tactics, and forecasts future trends using financial data and forecasting tools.
7	Investment and Funding Strategies	Creates wise investment plans and obtains capital from a variety of sources, including loans, equity, and strategic alliances.
8	Mergers and Acquisitions Expertise	Does in-depth financial analysis when evaluating possible mergers, acquisitions, or divestitures to make sure they are strategically aligned and would create value.
9	Financial Compliance and Governance	Assures adherence to best practices in corporate governance, accounting standards, and financial rules.
10	Cash Flow Management	Effectively controls cash flow to guarantee there is enough liquidity to sustain investments, operations, and expansion plans.
11	Financial Reporting Transparency	Fosters trust and confidence in the organization's financial health by providing clear and accurate financial reports to stakeholders.
12	Negotiation Skills	Exhibits adeptness in negotiating terms and agreements through financial transactions, contracts, and partnerships.
13	Stakeholder Communication	Effectively informs stakeholders, such as investors, board members, and staff, on financial strategies, performance measures, and the effects of financial decisions.
14	Adaptability to Market Changes	Adjusts financial plans in response to shifts in the economy, market conditions, and business disruptions.
15	Continuous Learning and Improvement	Promotes a culture of continual improvement within the finance department by keeping abreast of changing best practices, laws, and financial trends.

Combining these qualities, a CEO with financial acumen makes sure the company's finances are resilient, stable, and growing in a fast-paced business climate. They also successfully use financial resources to support long-term success and strategic goals.

(6) CEO as a Strategic Decision Maker:

A CEO functioning as a strategic decision-maker in a 21st-century organization embodies specific attributes and success factors critical for effective leadership and decision-making as listed in table 9:

Table 9: Attributes of CEO as a strategic decision-maker in an organization

S. No.	Key Attribute	Description
1	Visionary Thinking	Creates a compelling long-term vision for the company and directs strategic choices in the direction of realizing that vision.
2	Analytical Skills	Possesses excellent analytical skills to weigh risks, analyze complex circumstances, and draw conclusions from facts in order to make wise judgments.
3	Strategic Planning	Creates and carries out strategic plans that support growth and innovation and are in line with the organization's purpose, vision, and values.
4	Adaptability and Agility	Exhibits adaptability to quickly modify plans in reaction to shifts in the market, improvements in technology, and changing needs of customers.
5	Forward-Thinking Approach	Predicts possible disruptions, studies market trends, and puts the company in a proactive position to take advantage of new opportunities.

6	Risk Management	Balances risk and reward by identifying possible hazards, evaluating their impact, and putting risk mitigation techniques into practice.
7	Decision-making Framework	Creates an organized framework for decision-making that takes into account expert judgment, a range of viewpoints, and data-driven insights.
8	Collaborative Leadership	Promotes a collaborative atmosphere and welcomes feedback from all teams and stakeholders during the decision-making process.
9	Ethical Considerations	Ensures that decision-making processes are in line with corporate responsibility and society effect by incorporating ethical principles and values.
10	Communication Skills	Explains strategic choices, justifications, and goals to internal groups, external partners, and stakeholders in an effective manner.
11	Resource Allocation	Effectively sets priorities and distributes resources, maximizing funds and investments in line with strategic aims.
12	Change Management	Effectively manages organizational change, allowing for seamless transitions during the implementation of strategic choices.
13	Innovation and Creativity	Promotes a culture that emphasizes experimenting and learning from both successes and failures, as well as new ideas.
14	Measurable Goals and KPIs	Identifies key performance indicators (KPIs) and explicit, quantifiable goals in order to monitor progress and guarantee accountability.
15	Continuous Improvement	Encourages feedback loops, a culture of continuous improvement, and the adaptation of strategies in response to changing market dynamics and lessons learnt.

These qualities are integrated by a CEO in their role as strategic decision-maker. They use strategic thinking, analysis, adaptability, and effective communication to guide the company toward long-term success, competitive advantage, and sustained growth in a changing business environment.

(7) CEO as a Emotional Hero:

Being an "Emotional Hero" as a CEO in the 21st century involves a focus on emotional intelligence and leadership attributes that foster a positive and supportive organizational culture. Some of the key attributes and success factors for a CEO embodying this role are listed in table 10:

Table 10: Attributes of CEO as a emotional hero in an organization

S. No.	Key Attribute	Description
1	Emotional Intelligence	Possesses high emotional intelligence, which is the capacity to comprehend, regulate, and empathize with others on an emotional level.
2	Empathy and Compassion	Exhibits authentic concern for the welfare of staff members, acknowledging their viewpoints, and cultivating a nurturing atmosphere.
3	Openness to Vulnerability	Promotes an environment where being vulnerable is viewed as a strength, enabling honest dialogue and open communication without fear of repercussions.
4	Conflict Resolution Skills	Actively manages disagreements, assisting in the development of solutions that deal with fundamental problems and advance team cohesion.

5	Relationship Building	Establishes rapport and trust through forging strong interpersonal ties with stakeholders, customers, and staff.
6	Inspiring and Motivating	Creates a strong emotional connection, presents an inspiring vision, and helps teams feel like they have a purpose and a place.
7	Resilience and Adaptability	Exhibits fortitude in difficult circumstances, adjusting to change and helping and advising others during transitions.
8	Mindfulness and Self-Awareness	Demonstrates self-awareness and mindfulness, skillfully handles stress, and sets an example of good behavior for staff members.
9	Cultural Sensitivity and Inclusivity	Guarantees that the organization respects and embraces the differences among its members and values diversity and inclusivity.
10	Listening Skills	Actively hears the opinions, worries, and suggestions of staff members to foster an environment of transparency and make them feel appreciated.
11	Authenticity and Transparency	Demonstrates authenticity by acting and speaking with sincerity and transparency, building confidence and trust.
12	Mental Health Advocacy	Puts an emphasis on mental health initiatives, offers staff resources and assistance, and works to lessen the stigma associated with mental health problems.
13	Team Collaboration and Support	Promotes cooperation and teamwork, offering assistance and motivation to individuals and groups in order to accomplish shared objectives.
14	Stress Management and Work-Life Balance	Encourages a good work-life balance and puts stress management techniques into practice for the entire company.
15	Celebrating Success and Acknowledging Effort	Celebrates and honours accomplishments, recognizing the work and contributions of both individuals and groups.

By combining these qualities, a CEO who embodies the role of an emotional hero can foster an inclusive, encouraging, and emotionally intelligent work environment. This strategy promotes worker well-being, strengthens teamwork, and helps the business succeed generally and be resilient in the face of adversity.

(8) CEO as Moral Advocate and Ethical Champion:

A CEO serving as a Moral Advocate and Ethical Champion in a 21st-century organization embodies specific attributes and success factors that prioritize ethics, integrity, and social responsibility as listed in Table 11:

Table 11: Attributes of CEO as a moral advocate and ethical champion in an organization

S. No.	Key Attribute	Description
1	Commitment to Values	Demonstrates a steadfast dedication to moral values by incorporating them into the decisions, actions, and culture of the company.
2	Integrity and Transparency	Demonstrates honesty, openness, and integrity as a leader, establishing a high bar for moral conduct inside the company.
3	Social Responsibility	Emphasizes the social effect of the business, actively participating in projects that have benefits beyond financial gain for stakeholders, the environment, and communities.
4	Ethical Decision Making	Makes ethical issues a top priority when making judgments, guaranteeing that moral principles and values are upheld in corporate decisions.
5	Accountability and Responsibility	Assumes accountability for ethical behaviour on behalf of both oneself and others, as well as for the outcomes of actions made by the organization.

6	Ethics Training and Education	Carries out initiatives to teach staff members moral behavior, creating an environment where moral behavior is respected and understood.
7	Stakeholder Engagement	Interacts with stakeholders—employees, clients, investors, and the community—to learn about their needs and worries and takes into account their viewpoints when making decisions.
8	Diversity, Equity, and Inclusion	Encourages inclusion, equity, and diversity throughout the company to guarantee that every employee receives fair treatment and opportunity.
9	Compliance and Governance	Creates strong governance and compliance frameworks to guarantee that moral and legal requirements are followed.
10	Environmental Sustainability	Promotes eco-friendly projects, lowers the organization's carbon footprint, and adopts ecologically sustainable practices.
11	Ethical Supply Chain Management	Maintains ethical supply chain and sourcing procedures by working with vendors who have comparable ethical standards.
12	Whistleblower Protection	Fosters an atmosphere of safety where workers may report unethical behaviour without worrying about facing consequences, promoting an accountability-focused culture.
13	Ethical Communication	Creates an atmosphere that promotes and celebrates ethical behaviour by clearly communicating ethical ideals and expectations.
14	Long-Term Thinking	Thinks beyond short-term financial advantages when making decisions, emphasizing ethical and sustainable company practices.
15	Adaptable Ethical Framework	Maintains fundamental ethical principles while modifying ethical frameworks to fit various cultural situations and shifting societal norms.

These qualities are combined by a CEO acting as a Moral Advocate and Ethical Champion to develop a moral, socially conscious, and long-lasting business culture. They provide a constructive contribution to society, foster long-term success, and increase trust in the company by incorporating ethical principles into every facet of corporate operations.

(9) CEO as a Dynamic Entrepreneur:

A CEO functioning as a Dynamic Entrepreneur in a 21st-century organization embodies specific attributes and success factors that drive innovation, adaptability, and growth as listed in Table 12:

Table 12: Attributes of CEO as a dynamic Entrepreneur in an organization

S. No.	Key Attribute	Description
1	Visionary Leadership	Possesses an innovative mentality that allows them to see new possibilities and steer the firm toward market opportunities and creative solutions.
2	Risk-Taking and Resilience	A culture that encourages experimentation and learning from mistakes is fostered by a willingness to take measured risks, welcome ambiguity, and recover from setbacks.
3	Agility and Adaptability	Exhibits adaptability in adapting methods to suit changing market conditions, technical developments, and shifting consumer tastes.
4	Innovation and Creativity	Fosters an innovative culture that values creative thinking and explores novel concepts to gain a competitive edge and upend the market.

5	Entrepreneurial Mindset	Creates an environment that is conducive to entrepreneurship by giving staff members the freedom to act and think like business owners and encouraging innovation and ownership.
6	Market Insight and Customer-Centric Focus	Obtains in-depth knowledge of industry trends, recognizes demands of clients, and creates solutions that go above and beyond to satisfy clients.
7	Technology Integration	Accepts new technologies and uses them to increase productivity, optimize workflows, and develop cutting-edge goods and services.
8	Strategic Partnerships and Collaboration	Creates partnerships, alliances, and collaborations that are strategic in nature, enhancing the organization's advantages, broadening its market, and stimulating innovation.
9	Resource Optimization	Efficiently distributes resources, making the most of personnel and money to increase innovation and productivity inside the company.
10	Adaptive Business Models	Develops and modifies business models that are scalable, adaptable, and sensitive to changing consumer behavior and market conditions.
11	Fast Decision Making	Expedites decision-making procedures, giving teams the freedom to act quickly and intelligently while promoting an agile and responsive culture.
12	Customer Experience Focus	Places a high priority on meeting or exceeding customer expectations by understanding changing demands and delivering excellent customer experiences.
13	Continuous Learning and Improvement	Promotes an atmosphere that encourages feedback and is flexible by encouraging a culture of ongoing learning, experimentation, and progress.
14	Strategic Resource Allocation	Places a high priority on expenditures in areas that support long-term strategic objectives, encouraging innovation and growth inside the company.
15	Cultural Catalyst	Fosters the development of an innovative, dynamic, and risk-taking culture that views change as a chance for progress.

As a dynamic entrepreneur, a CEO combines these qualities to create an atmosphere that encourages creativity, adjusts to change, and seizes new chances, propelling the company toward long-term growth and market leadership in the dynamic business environment.

(10) CEO as a Role Model:

A CEO acting as a role model in a 21st-century organization embodies specific attributes and success factors that set the tone for the company's culture and inspire others as listed in Table 13:

Table 13: Attributes of CEO as a Role Model in an organization

S. No.	Key Attribute	Description
1	Ethical Integrity	Sets a high bar for moral behaviour inside the company by exhibiting steadfast moral behaviour and integrity.
2	Authentic Leadership	Leads with authenticity, upholding their morals and beliefs while acting sincere and open in their interactions with others.
3	Visionary Leadership	Lays forth an appealing future plan for the company, motivating others with a distinct goal in mind.
4	Accountability and Responsibility	Sets an example for others to accept responsibility by holding themselves accountable for their choices, actions, and results.

5	Empathy and Compassion	Demonstrates empathy for coworkers, stakeholders, and clients, promoting a supportive and understanding environment.
6	Continuous Learning	Encourages others to pursue growth and development by adopting an attitude of constant learning and improvement.
7	Resilience and Adaptability	Demonstrates fortitude in the face of adversity, adjusts to change, and inspires others to confront obstacles head-on.
8	Strong Work Ethic	Sets high expectations for performance and leads by example with a strong work ethic, devotion, and passion to perfection.
9	Open Communication	Promotes a culture of productive discourse, actively listening to the opinions of others, and open and honest communication.
10	Inclusivity and Diversity Advocacy	Promotes a work environment that honors and respects a range of viewpoints and backgrounds by advocating for diversity, equity, and inclusion.
11	Team Collaboration	Respects cooperation and teamwork; actively engages in and lends support to cooperative efforts to accomplish shared objectives.
12	Emotional Intelligence	Demonstrates a high level of emotional intelligence, skillfully controlling emotions and cultivating a healthy work environment.
13	Mentorship and Development	Invests in talent development and mentorship within the company, raising the next generation of leaders and promoting a growth-oriented culture.
14	Adherence to Work-Life Balance	Places a high value on work-life balance, highlighting the significance of wellbeing and leading by example by upholding a good balance.
15	Recognition and Appreciation	Encourages a culture of recognition and appreciation by recognizing and appreciating employees' efforts and accomplishments.

Integrating these qualities, a CEO sets the standard for behaviours, organizational culture, and values. By exhibiting these attributes, they encourage others to follow in their footsteps, creating a productive and upbeat work atmosphere.

6. CEO MATRIX AND ITS DEVELOPMENT :

6.1 Overview of CEO Categorization Matrices:

Part of organizational analysis includes classifying and rating Chief Executive Officers (CEOs) according to their qualities, skills, and output. A number of matrices or models have been created to categorize CEOs, offering frameworks for evaluating their abilities, leadership philosophies, and effects on organizational outcomes:

(1) The Five-Factor Model (FFM):

FFM evaluates CEOs on five dimensions based on personality traits: agreeableness, extraversion, conscientiousness, openness, and neuroticism. It assists in forecasting decision-making styles and the efficacy of leadership [34-35].

(2) The Tushman-O'Reilly Congruence Model:

This model evaluates how well an organization's strategy, organizational structure, and leadership style align with the CEO. It evaluates how well a CEO's style fits the structure, innovation, and cultural requirements of the business [36-37].

(3) The McKinsey 7-S Framework:

This framework, which focuses on organizational effectiveness, evaluates seven essential components: staff, shared values, skills, strategy, structure, processes, and skills. It provides information on how CEOs coordinate these factors to promote corporate performance [38-39].

(4) The Strategic Leadership Type Indicator (SLTi):

Based on their inclinations for strategy, SLTi divides CEOs into four leadership types: visionaries, analysts, executors, and strategic guides. It helps to comprehend the strategic orientation and decision-making inclinations of a CEO [40].

(5) The Transformational Leadership Model:
Based on transformational leadership traits including charm, intellectual stimulation, personalized attention, and inspirational motivation, this approach assesses CEOs. It evaluates their capacity to motivate and encourage change inside the company [41].

(6) CEO Typology Matrix:
Based on their leadership styles, CEOs are categorized in this matrix into groups such as charismatic, transactional, transformational, or laissez-faire leaders. It focuses on how leadership actions affect the performance and culture of organizations [42].

(7) Leadership Grid Model:
This model, created by Blake and Mouton, evaluates leadership philosophies on the basis of two factors: care for people and concern for output. Based on these criteria, CEOs are divided into five leadership styles, ranging from team management to destitute [43-44].

(8) Balanced Scorecard Framework:
Often applied at an organizational level, this framework can also be used to evaluate CEO performance. It assesses CEOs across financial, customer, internal processes, and learning/growth perspectives, providing a comprehensive view of their contributions [45].

These models and matrices, which offer distinct viewpoints for evaluating CEO qualities, give businesses frameworks for comprehending and analyzing the leadership styles and skills at the top of the management hierarchy. This review describes numerous recognized and developing matrices or models that are used to classify CEOs according to distinct aspects of strategy and leadership.

7. NEWLY DEVELOPED CEO MATRIX :

This proposed new model categorizes CEOs based on a blend of leadership skills and financial acumen. It aims to provide a comprehensive framework to evaluate CEOs, considering their visionary leadership, financial prowess, adaptive capabilities, and overall effectiveness as shown in Figure 1.

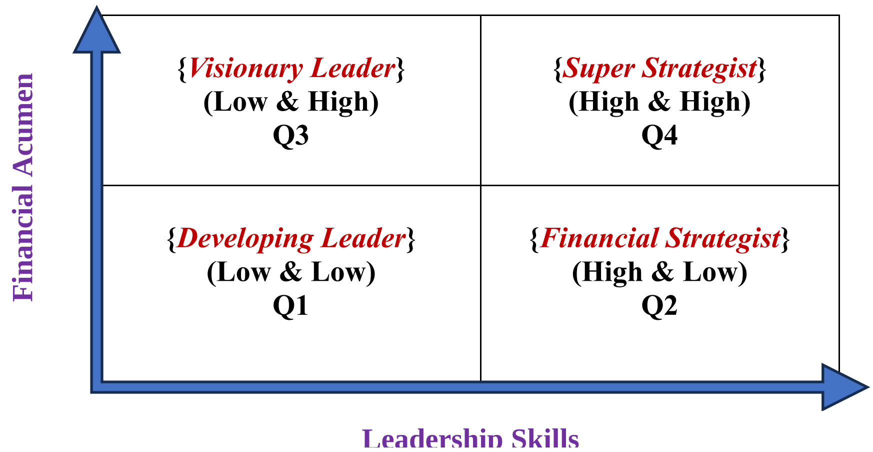

Fig. 1: CEO Matrix

7.1 Description and Explanation of Newly Developed CEO Matrix:

The newly developed 2x2 CEO Matrix model is based on low and high values of Leadership Skills and Financial Acumen as coordinates with following combinations:

(1) Low Leadership Skills & Low Financial Acumen (Quadrant 1): CEOs here might struggle to provide strategic direction or effectively manage finances. Their leadership might lack vision, and they might face challenges in making informed financial decisions. Organizations under such leadership might encounter issues in strategy execution and financial stability. Such a CEO can be named as ***Developing Leader***.

(2) High Leadership Skills & Low Financial Acumen (Quadrant 2): CEOs in this quadrant excel in leadership qualities but may lack expertise in financial matters. They might drive innovation, inspire teams, and set visionary goals but could face challenges in managing financial resources efficiently. Such a CEO can be named as ***Visionary Leader***.

(3) Low Leadership Skills & High Financial Acumen (Quadrant 3): CEOs possessing strong financial acumen but weaker leadership skills might make sound financial decisions but struggle with motivating teams or setting a strategic vision. Such CEOs might focus heavily on numbers and financial performance but could face challenges in inspiring and leading the organization effectively. Such a CEO can be named as ***Financial Strategist***.

(4) High Leadership Skills & High Financial Acumen (Quadrant 4): This quadrant represents CEOs who possess a balance of strong leadership skills and financial acumen. They lead with vision, inspire teams, make informed financial decisions, and strategically steer the organization towards growth and success. They strike a balance between driving innovation, fostering a positive work culture, and making sound financial choices. Such a CEO can be named as ***Super Strategist***.

This matrix model helps assess the impact of these attributes on CEO effectiveness and provides insights into the strengths and potential development areas for CEOs within the organization. It provides insights into potential areas of development or strengths, guiding organizations in selecting or supporting CEOs to enhance their competencies for effective leadership and financial management.

7.2 Evaluation of New CEO matrix model :

Evaluate a CEO matrix model based on low and high values of leadership skills and financial acumen helps assess the impact of these attributes on CEO effectiveness. Let's consider a 2x2 matrix to evaluate this:

(i) Low Leadership Skills & Low Financial Acumen: CEOs in this quadrant might struggle to provide strategic direction or effectively manage finances. Their leadership might lack vision, and they might struggle to make informed financial decisions. Organizations under such leadership might face issues in strategy execution and financial stability.

(ii) High Leadership Skills & Low Financial Acumen: CEOs here excel in leadership qualities but may lack expertise in financial matters. They might drive innovation, inspire teams, and set visionary goals but could face challenges in managing financial resources efficiently.

(iii) Low Leadership Skills & High Financial Acumen: CEOs possessing strong financial acumen but weaker leadership skills might make sound financial decisions but struggle with motivating teams or setting a strategic vision. Such CEOs might focus heavily on numbers and financial performance but could face challenges in inspiring and leading the organization effectively.

(iv) High Leadership Skills & High Financial Acumen: This quadrant represents CEOs who possess a balance of strong leadership skills and financial acumen. They lead with vision, inspire teams, make informed financial decisions, and strategically steer the organization towards growth and success. They strike a balance between driving innovation, fostering a positive work culture, and making sound financial choices.

Assessing CEOs within this matrix model helps organizations recognize areas for development or potential strengths in their leadership. It also assists in identifying potential risks associated with imbalances in either leadership skills or financial acumen, guiding the selection, development, or support of CEOs in enhancing their competencies for effective leadership.

7.3 Comparison of New CEO matrix model with the other two possible CEO matrix Models:

There are various ways to conceptualize CEO matrix models based on different attributes. Let's compare the CEO matrix model based on Leadership Skills and Financial Acumen with two other potential models:

(1) Market Adaptability vs. Operational Efficiency:

(i) Low Market Adaptability & Low Operational Efficiency: CEOs lacking in both market adaptability and operational efficiency might struggle to respond to market changes while also facing internal operational issues. This could result in stagnation or declining performance.

(ii) High Market Adaptability & Low Operational Efficiency: CEOs strong in market adaptability but weak in operational efficiency may spot market trends quickly but struggle with executing strategies efficiently. This might lead to missed opportunities or inefficient resource utilization.

(iii) Low Market Adaptability & High Operational Efficiency: CEOs excelling in operational efficiency but lacking market adaptability might run a tight ship internally but face challenges in responding to market changes. This could result in missed growth opportunities or difficulties in adapting to market shifts.

(iv) High Market Adaptability & High Operational Efficiency: CEOs striking a balance between market adaptability and operational efficiency can respond effectively to market changes while also optimizing internal operations. This quadrant represents an ideal scenario where CEOs can capitalize on opportunities while efficiently managing resources.

(2) Innovation Focus vs. Risk Management:

(i) Low Innovation Focus & Low Risk Management: CEOs weak in both innovation and risk management might struggle to drive growth or adapt to changes, potentially leading to stagnation or missed opportunities.

(ii) High Innovation Focus & Low Risk Management: CEOs strong in innovation but weak in risk management might drive creativity and new ideas but could expose the organization to excessive risks or volatility.

(iii) Low Innovation Focus & High Risk Management: CEOs prioritizing risk management over innovation might ensure stability but may miss out on growth opportunities or fail to adapt to changing market demands.

(iv) High Innovation Focus & High Risk Management: CEOs excelling in both innovation and risk management strike a balance, fostering innovation while mitigating risks effectively. They drive growth through innovation while maintaining a balanced risk profile.

These alternate CEO matrix models emphasize different aspects such as adaptability, efficiency, innovation, and risk management, providing insights into how CEOs' strengths and weaknesses in these areas impact organizational performance and strategy. Each model offers a unique perspective on CEO effectiveness within the organization.

Comparison of CEO Matrix with Innovation Matrix:

The names of each cell in the Innovation Matrix using the coordinators of Innovation Driver and Impact of Innovation, aligned with the four commonly used names as follows:

(1) High Innovation Driver, High Impact of Innovation: This cell can be associated with "Disruptive Innovation." It represents scenarios where there's a high drive for innovation resulting in significant and transformative impacts on markets or industries. Q4.

(2) High Innovation Driver, Low Impact of Innovation: This cell aligns with "Radical Innovation." It signifies situations where there's a strong focus on innovation, but the resulting impacts are initially relatively small or iterative rather than groundbreaking. Q2.

(3) Low Innovation Driver, High Impact of Innovation: This cell corresponds to "Sustainable Innovation." It portrays scenarios where despite a lack of emphasis on driving innovation, occasional innovations occur that have a substantial and transformative impact. Q3.

(4) Low Innovation Driver, Low Impact of Innovation: This cell is associated with "Incremental Innovation." It reflects situations where there's not much emphasis on innovation, and the resulting impacts, if any, are incremental rather than radical or disruptive. Q1

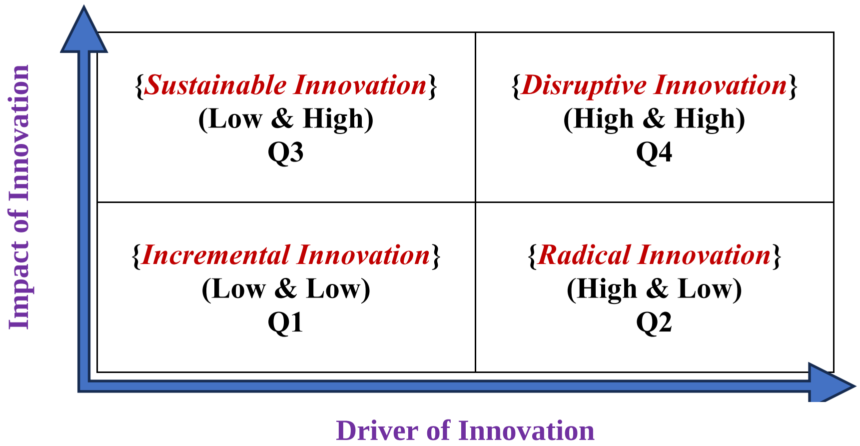

Fig. 2: Innovation Matrix [46]

Both the CEO Matrix model and the Innovation Matrix [46] offer distinct perspectives on categorization and assessment within different domains—CEO effectiveness and innovation types, respectively as shown in Table 14.

Table 14: Comparison of CEO Matrix with Innovation Matrix

S. No.	Key Attribute	CEO Performance Matrix	Innovation Matrix
1	Structure	**Parameters:** Leadership Skills (Low/High) and Financial Acumen (Low/High) **Quadrants:** (i) Low Leadership Skills & Low Financial Acumen: Developing Leader (Q1) (ii) High Leadership Skills & Low Financial Acumen: Visionary Leader (Q2) (iii) Low Leadership Skills & High Financial Acumen: Financial Strategist (Q3) (iv) High Leadership Skills & High Financial Acumen: Super Strategist (Q4)	**Parameters:** Driver of Innovation (Low/High) and Impact of Innovation (Low/High) **Types of Innovation:** (i) Incremental Innovation: (Low-Low) (Q1) (ii) Sustainable Innovation: (Low-High) (Q3) (iii) Radical Innovation: (High-Low) (Q2) (iv) Disruptive Innovation: (High-High) (Q4)
2	Purpose	(i) Evaluates CEO effectiveness based on leadership and financial skills. (ii) Provides insights into strengths and areas for CEO development. (iii) Guides organizations in CEO selection or support for competency enhancement.	(i) Categorizes innovation types based on drivers and impact. (ii) Defines different innovation types concerning motivation and transformative effect. (iii) Helps in strategizing and understanding the nature of innovative endeavours.
3	Benefits	(i) Offers a clear assessment of CEO competencies. (ii) Identifies potential areas for improvement or leverage. (iii) Guides leadership development strategies within the organization.	(i) Classifies innovations based on their drivers and impact levels. (ii) Guides decision-making regarding innovation strategies. (iii) Offers a framework to understand the nature and potential outcomes of different types of innovations.
4	Dimensions:	CEO Matrix: Leadership Skills & Financial Acumen.	Innovation Matrix: Driver of Innovation & Impact of Innovation.
5	Focus:	CEO Matrix: CEO effectiveness and development.	Innovation Matrix: Types and characteristics of innovation.
6	Application:	CEO Matrix: CEO competency assessment and development.	Innovation Matrix: Innovation categorization and strategy.
7	Outcome:	CEO Matrix: Identifies CEO competencies and areas for growth.	Innovation Matrix: Defines and categorizes types of innovation based on their driving forces and transformative impacts.

In summary, while both matrices are 2x2 models used for categorization, they operate in different realms—CEO effectiveness in one and types of innovation in the other. Each matrix offers valuable insights for decision-making and strategic planning within their respective domains.

Comparison of CEO Matrix with McFarlan-McKenney Strategic Grid Matrix:

Strategic Grid Matrix is a technique of information system planning in organizations and is developed by McFarlan and McKenney, often called McFarlan-McKenney strategic grid [47]. The strategic grid takes into account strategic impact of existing operating applications and strategic impact of planned application development portfolio. Both of these dimensions may have either high or low_strategic impact on the information systems. By combining both these dimensions, four types_of information system planning situations can be identified.

McFarlan-McKenney Strategic Grid Matrix is a 2x2 matrix with Strategic impact of existing operating Information System applications and Strategic impact of planned Information System application development portfolio as two parameters along x-coordinate and Low and High values as two parameters along y-coordinate.

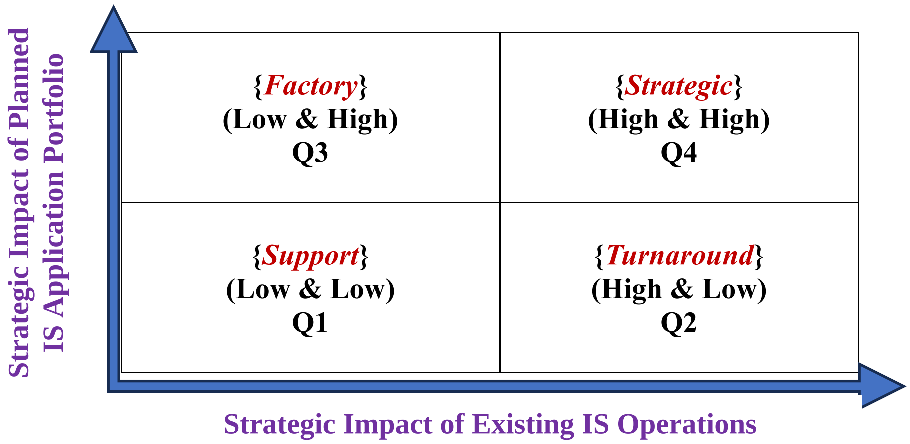

Fig. 3: McFarlan-McKenney Strategic Grid Matrix [47]

The CEO Matrix model and the McFarlan-McKenney Strategic Grid Matrix model are both 2x2 matrices used in different contexts but share the structure of categorizing based on two parameters as shown in Table 15.

Table 15: Comparison of CEO Matrix with McFarlan-McKenney Strategic Grid Matrix

S. No.	Key Attribute	CEO Performance Matrix	McFarlan-McKenney Strategic Grid Matrix
1	Structure	**Parameters:** Leadership Skills (Low/High) and Financial Acumen (Low/High) **Quadrants:** (i) Low Leadership Skills & Low Financial Acumen: Developing Leader (Q1) (ii) High Leadership Skills & Low Financial Acumen: Visionary Leader (Q2) (iii) Low Leadership Skills & High Financial Acumen: Financial Strategist (Q3) (iv) High Leadership Skills & High Financial Acumen: Super Strategist (Q4)	**Parameters:** Strategic Impact of Existing Operating Information System Applications (Low/High) and Strategic Impact of Planned Information System Application Development Portfolio (Low/High) **Quadrants:** (i) Low-Low: Support applications (Q1) (ii) Low-High: Turnaround applications (Q2) (iii) High-Low: Factory applications (Q3) (iv) High-High: Strategic applications (Q4)

2	Purpose	(i) Assessing CEO effectiveness based on leadership and financial skills. (ii) Providing insights into strengths and areas for development. Guiding organizations in CEO selection or support for competency enhancement.	(i) Information system planning based on existing and planned application impact. (ii) Categorization for decision-making in information system management. Identifying the strategic relevance of different types of applications.
3	Benefits	(i) Offers a clear assessment of CEO competencies. (ii) Identifies potential areas for improvement or leverage. (iii) Guides leadership development strategies within the organization.	(i) Helps in prioritizing and managing information system applications. (ii) Facilitates resource allocation based on strategic impact. (iii) Guides decision-making in information system development.
4	Dimensions	CEO Matrix: Leadership Skills & Financial Acumen.	McFarlan-McKenney Matrix: Impact of Existing/Planned Information System Applications.
5	Focus	CEO Matrix: CEO effectiveness and development.	McFarlan-McKenney Matrix: Information system planning and strategic impact.
6	Application	CEO Matrix: CEO assessment and development within an organization.	McFarlan-McKenney Matrix: Information system planning and resource allocation.
7	Outcome:	CEO Matrix: Identifies CEO competencies and development areas.	McFarlan-McKenney Matrix: Aids in categorizing and managing information system applications strategically.

In summary, while both matrices are 2x2 models used for categorization, they serve different purposes: one in assessing CEO effectiveness and the other in managing information system planning and strategy. Each matrix provides valuable insights for decision-making within their respective domains.

7.4 Interpretation of New CEO matrix model to identify the Performance of CEOs of 21st Century:

The CEO matrix model based on Leadership Skills and Financial Acumen as coordinates serves as a valuable framework for assessing the essential attributes of winning CEOs in the 21st century. Let's interpret this model regarding the requirements for successful CEOs:

(1) High Leadership Skills & Low Financial Acumen:

(i) Strengths: These CEOs excel in inspiring, motivating, and guiding teams. They have a visionary outlook and can lead the organization effectively.

(ii) Challenges: However, they may lack expertise in financial matters, potentially facing challenges in optimizing financial resources and making informed financial decisions.

(2) Low Leadership Skills & High Financial Acumen:

(i) Strengths: CEOs in this quadrant have a strong grasp of financial management, making sound financial decisions.

(ii) Challenges: They might struggle with motivating teams, setting a strategic vision, or fostering a positive work culture due to weaker leadership skills.

(3) Low Leadership Skills & Low Financial Acumen:

(i) Challenges: CEOs with deficiencies in both leadership and financial acumen might find it challenging to provide strategic direction or effectively manage finances, impacting overall organizational performance.

(4) High Leadership Skills & High Financial Acumen:

(i) Ideal Scenario: CEOs in this quadrant possess a balanced set of skills. They lead with vision and inspiration while also making informed financial decisions.
(ii) Strengths: They can strategically steer the organization toward growth, foster innovation, and maintain financial stability.
For winning CEOs in the 21st century, a blend of strong leadership skills and financial acumen is crucial. These CEOs can inspire and lead teams toward a compelling vision while making informed financial decisions that support the organization's growth and sustainability.
Success in the contemporary business landscape requires CEOs to not only motivate and guide teams but also make strategic financial decisions that optimize resources and drive financial performance. Therefore, winning CEOs often strike a balance between these attributes, leveraging their leadership skills to drive innovation and culture while ensuring the financial health and stability of the organization.

7.5 Analyse New CEO Matrix Using ABCD Analysis Framework:

The newly developed CEO matric is analysed using ABCD Listing Framework [48-96]. Advantages, Benefits, Constraints, and Disadvantages (ABCD) are identified and listed below:

7.5.1 Advantages and Benefits:

The new CEO matrix model based on Low and High values of Leadership Skills and Financial Acumen offers several advantages and benefits:
Advantages:
(1) Clarity in CEO Assessment: It provides a clear framework for assessing CEOs' competencies in leadership and financial acumen, simplifying the evaluation process.
(2) Focused Development Areas: Identifies specific areas for CEO development, whether in enhancing leadership skills, improving financial acumen, or striking a balance between the two.
(3) Tailored Succession Planning: Helps in succession planning by pinpointing the desired skill sets for future CEOs, aiding in selecting and grooming potential successors.
(4) Strategic Decision-Making: Assists boards and stakeholders in strategic decision-making regarding CEO selection or development initiatives based on identified gaps.
(5) Improved Organizational Performance: Allows organizations to align CEO strengths with business needs, potentially improving overall performance and strategy execution.
Benefits:
(1) Optimized Leadership: Helps in selecting CEOs with balanced skill sets, ensuring they possess both visionary leadership and financial astuteness, leading to more effective organizational direction.
(2) Enhanced Strategic Decision-Making: CEOs with a balance of leadership skills and financial acumen can make more informed and holistic decisions, considering both strategic and financial implications.
(3) Financial Stability and Growth: CEOs adept in both areas can drive financial stability while fostering innovation and growth, ensuring the organization's long-term sustainability.
(4) Improved Investor Confidence: A CEO with a balanced skill set inspires confidence among investors by demonstrating a clear vision and the ability to manage financial aspects effectively.
(5) Cultural Influence: CEOs embodying both leadership and financial skills can foster a culture that values innovation, ethical practices, and financial discipline, influencing the organizational ethos positively.
(6) Adaptability and Agility: With a well-rounded CEO, organizations can adapt more swiftly to market changes, leveraging leadership skills to inspire adaptation and financial acumen to make strategic adjustments.
Overall, this CEO matrix model brings precision to CEO assessment, aids in talent development, and ensures a more comprehensive approach to leadership and financial management, ultimately benefiting the organization's performance and future trajectory.

7.5.2 Constraints and Disadvantages:

While the CEO matrix model based on Low and High values of Leadership Skills and Financial Acumen offers significant advantages, it also comes with constraints and potential disadvantages:
Constraints:

(1) Simplification of Complex Skills: Leadership and financial acumen are multifaceted attributes that can't be fully captured on a two-dimensional matrix, potentially oversimplifying the CEO's competencies.
(2) Subjectivity in Evaluation: Assessing and categorizing leadership skills and financial acumen into binary "low" or "high" categories might oversimplify the evaluation process, lacking nuanced insights.
(3) Limited Scope: The model may overlook other essential CEO attributes like adaptability, emotional intelligence, industry-specific expertise, or cultural fit, leading to a narrowed assessment.
(4) Potential Overemphasis: There's a risk of overemphasizing leadership and financial skills while disregarding other critical competencies, potentially overlooking well-rounded CEOs.
(5) Static Evaluation: CEOs' skills may evolve over time, and the static nature of this model might not account for such changes, limiting its adaptability in a dynamic business environment.

Disadvantages:

(1) Misjudgment and Misallocation: Placing CEOs into rigid categories of "low" or "high" might misjudge their capabilities, leading to misallocation or overlooking talent with growth potential.
(2) Inadequate Development Focus: Focusing only on "low" areas might overlook CEOs' strengths and potential, neglecting to nurture existing strengths while working on weaknesses.
(3) Potential for Biases: Binary categorizations may be influenced by biases, either in the evaluation process or in how the model is interpreted, leading to skewed assessments.
(4) Lack of Contextual Understanding: The model might fail to capture the contextual intricacies or nuances specific to an organization's industry, culture, or unique challenges.
(5) Inflexibility in Decision-Making: Overreliance on this model might restrict decision-makers' flexibility in evaluating CEO candidates or identifying development needs beyond the defined matrix.
(6) Overlooking Non-Quantifiable Skills: It might disregard intangible but crucial CEO traits, like communication style, crisis management, or stakeholder relationships, which aren't easily quantifiable.

Balancing the benefits of simplicity and clarity with the need for a comprehensive and contextual understanding of CEO competencies is vital when utilizing this model, mitigating the potential constraints and disadvantages it presents.

8. DISCUSSION :

8.1 Practical Implications of a new CEO matrix model:

Implementing a CEO matrix model based on Low and High values of Leadership Skills and Financial Acumen has several practical implications for organizations:

(1) CEO Selection and Recruitment: Offers a structured framework for evaluating potential CEOs during the recruitment process, aiding in selecting candidates whose skills align with organizational needs.
(2) Succession Planning: Assists in identifying and grooming potential successors by outlining the desired leadership and financial competencies required for future leadership roles.
(3) Leadership Development: Helps in designing targeted leadership development programs, focusing on enhancing either leadership skills or financial acumen based on identified gaps.
(4) Performance Evaluation: Provides a structured approach to assess CEO performance, facilitating more objective evaluations against predefined leadership and financial benchmarks.
(5) Board Decision-Making: Guides the board in making informed decisions regarding CEO appointments, terminations, or performance reviews by quantifying essential skill sets.
(6) Strategic Alignment: Ensures alignment between CEO competencies and organizational strategy, ensuring that the CEO's skills match the company's objectives and direction.
(7) Investor Confidence: Demonstrating a clear framework for CEO evaluation can boost investor confidence, showcasing the organization's commitment to selecting leaders with the right skills.
(8) Talent Development: Helps in creating personalized development plans for current CEOs or high-potential leaders, focusing on strengthening specific skill areas for future growth.
(9) Risk Mitigation: By identifying potential gaps in leadership or financial acumen, organizations can proactively mitigate risks associated with CEO limitations in critical areas.
(10) Objective Benchmarking: Provides an objective benchmark for evaluating CEOs, facilitating a consistent evaluation process across different leaders or organizational levels.

(11) Organizational Culture: Encourages a culture that values leadership and financial expertise, potentially influencing leadership development initiatives and organizational behaviour.

(12) Adaptability and Agility: Supports organizational adaptability by allowing adjustments in CEO skills development based on changing business landscapes and emerging needs.

Overall, the practical implications revolve around using this model as a guide for various talent management and leadership development initiatives, aligning CEO skills with organizational goals, and ensuring more objective decision-making processes related to leadership positions.

9. CONCLUSION :

The result of extensive investigation, the CEO Matrix provides a thorough framework for classifying and assessing CEOs according to their combination of financial savvy and leadership abilities. A more comprehensive knowledge of the different traits of top-level executives is made possible by this paradigm change in assessment. In addition to highlighting the many characteristics of CEOs, the model also indicates areas for future growth and development by dividing the matrix into four unique cells: Visionary Leader, Financial Strategist, Master/Super Strategist, and Developing Leader.

The CEO Matrix has the noteworthy benefit of encouraging a more comprehensive method of CEO evaluation. Understanding the similarities and differences between these qualities allows it to go beyond the conventional binary evaluation of leadership or financial acumen. Additionally, this architecture allows companies to customize CEO development plans that take into account their unique place in the matrix. Though the matrix provides insightful information, the complex nature of CEO qualities may be oversimplified by its dependence on a binary classification of financial acumen and leadership.

The CEO Matrix has ramifications that go beyond its use as a simple classification tool. It has the potential to have a big impact on succession planning and performance reviews inside companies. Through the identification of CEO strengths and areas for improvement, this model enables focused interventions with the goal of maximizing financial decision-making and leadership effectiveness. In addition, it acts as a compass for recognizing possible heirs and developing new talent by coordinating developmental programs with the qualities listed in the matrix.

The CEO Matrix is essentially a ground-breaking framework that makes use of Bloom's higher-order research abilities to analyze, compare, assess, interpret, and develop a structured model for CEO evaluation. Its use has the potential to help firms better understand the range of skills possessed by their top executives, to support customized development plans, and to eventually lead to improved corporate performance and governance.

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Exploring the Nexus Between Human Resource Management (HRM) and Enterprise Resource Planning (ERP) in Manufacturing: A Comprehensive Examination of Strategies, Challenges, and Integration Dynamics

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Subject Area: Business Management.
Type of the Paper: Conceptual Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10408509
Google Scholar Citation: IJAEML

How to Cite this Paper:
Radha, P. & Aithal, P. S. (2023). Exploring The Nexus Between Human Resource Management (HRM) and Enterprise Resource Planning (ERP) In Manufacturing: A Comprehensive Examination of Strategies, Challenges, and Integration Dynamics. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 249-258. DOI: https://doi.org/10.5281/zenodo.10408509

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0201

Received on: 09/11/2023
Published on: 20/12/2023

International Journal of Applied Engineering and Management Letters (IJAEML), ISSN: 2581-7000, Vol. 7, No. 4, December 2023

SRINIVAS PUBLICATION

Exploring The Nexus Between Human Resource Management (HRM) and Enterprise Resource Planning (ERP) In Manufacturing: A Comprehensive Examination of Strategies, Challenges, and Integration Dynamics

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ABSTRACT

Purpose: *The purpose of this paper is to explore the intricate interrelationship between Human Resource Management (HRM) and Enterprise Resource Planning (ERP) in the dynamic landscape of the Manufacturing Industry. The primary objective is to unravel the synergies, challenges, and integration dynamics that coexist at the convergence of HRM and ERP systems, providing insights into their reciprocal influences and shared strategic objectives. In the manufacturing sector, characterized by the imperatives of efficiency, coordination, and adaptability, a nuanced understanding of the interplay between HRM and ERP is indispensable for organizational triumph. The lecture offers a thorough analysis of the strategies deployed to align HRM practices with ERP systems, accentuating their combined impact on workforce management, operational processes, and overall business performance. Additionally, by scrutinizing the inherent challenges in harmonizing HRM and ERP within the manufacturing context, this lecture endeavors to furnish insights that can guide strategic decision-making. Participants will acquire a discerning comprehension of integration dynamics, enabling them to adeptly navigate complexities and capitalize on opportunities for synergy between these pivotal components of organizational management. Ultimately, the aim is to empower professionals and scholars with knowledge contributing to the optimization of HRM and ERP practices in the continually evolving landscape of the Manufacturing Industry.*

Design: *In this lecture, we employed the case study method within a descriptive research design to delve into the dynamics of the manufacturing industry. The research methodology involved the collection and analysis of secondary data, unveiling crucial insights into the factors influencing the manufacturing landscape. By adopting a comprehensive approach, we aim to unravel the multifaceted aspects shaping the industry's trajectory. The utilization of the case study method allows us to explore real-world scenarios and draw meaningful conclusions about the various factors impacting the manufacturing sector. Through the lens of descriptive research, we seek to provide a nuanced understanding of the challenges, opportunities, and key drivers that characterize this dynamic and vital economic domain.*

***Findings*:** *The exploration of HRM and ERP in Manufacturing unveils significant findings. Strategic alignment between HRM and ERP systems enhances workforce productivity and operational efficiency. Challenges emerge in reconciling diverse data structures and adapting HRM modules to specific manufacturing needs. Integration dynamics show that successful implementation requires a holistic approach, emphasizing communication, training, and continuous evaluation. The interdependence of HRM and ERP is pivotal for*

optimized organizational performance in manufacturing, emphasizing the need for adaptable strategies that navigate challenges while fostering seamless integration.
Originality/value: *This study includes a detailed analysis of the Exploring the Nexus between Human Resource Management (HRM) and Enterprise Resource Planning (ERP) in Manufacturing: A Comprehensive Examination of Strategies, Challenges, and Integration Dynamics*
Paper Type: *Conceptual Research.*
Keywords: HRM, ERP, Challenges, Strategy, Manufacturing industry, dynamics

1. INTRODUCTION :

Enterprise Resource Planning (ERP) in the Manufacturing Industry. Enterprise Resource Planning has become a cornerstone of modern business management, and its application in the manufacturing sector is particularly transformative. As we delve into this topic, it's essential to understand that ERP is more than just a technological solution; it represents a strategic approach to integrating various business processes within an organization. In the dynamic landscape of the manufacturing industry, characterized by intricate supply chains, diverse operational functions, and a constant need for efficiency, ERP plays a pivotal role. It serves as a comprehensive solution that enables organizations to streamline their processes, enhance collaboration, and make data-driven results (Agnes et al. (2014). [1]).
Our exploration today will unfold the layers of ERP implementation in manufacturing, examining how it optimizes resource utilization, improves production planning, and fosters a responsive and agile operational environment. We'll delve into the functionalities of ERP systems tailored to the unique needs of the manufacturing sector, addressing challenges, and uncovering opportunities for innovation. As we navigate through this lecture, we will unravel the significance of ERP as a strategic enabler in the manufacturing landscape, empowering organizations to stay competitive, adaptive, and resilient in the face of evolving industry anxieties (Aguta et al. (2015). [2]). Get ready to embark on a journey into the heart of ERP in the Manufacturing Industry.

1.1 About the Enterprise Resource Planning:

Welcome, everyone, to this insightful lecture on Enterprise Resource Planning (ERP). In the ever-evolving landscape of contemporary business, ERP has emerged as a critical solution, reshaping how organizations manage their resources and processes. As we embark on this exploration, it's imperative to recognize ERP as more than just a technological tool; it is a holistic approach to optimizing operations and enhancing overall efficiency. ERP integrates various business functions and processes into a unified system, offering a centralized repository of data accessible across an organization. This lecture will focus on understanding the fundamental principles and implications of ERP, with a specific emphasis on its role in transforming business operations.
In the context of ERP in business, we'll delve into its historical evolution, its core components, and the pivotal role it plays in fostering collaboration and informed decision-making. As we navigate through this discourse, we will highlight the diverse industries that have embraced ERP solutions and, more specifically, hone in on its application within the complex and dynamic realm of the Manufacturing Industry. Join me in unravelling the layers of ERP, exploring how it enhances organizational agility, improves resource allocation, and contributes to strategic administrative (Asfaw et al. (2015). [3]). Through this lecture, we aim to deepen your understanding of ERP's significance and its transformative impact on modern business practices. So, let's embark on this enlightening journey into the realm of Enterprise Resource Planning.

1.2 About the Human Resource Management:

The increasingly important function and procedures of HRM in accomplishing organization aims is redirected in the conversion of the employees' management purpose. More than two decades this purpose has frequently relegated with regards to its significance in organization accomplishments and order (Baskerville et al (1996). [4]). HRM function in several industries remains feeble and comparatively down in influence in relation to other administrative and decision-making functions including manufacturing, finance, promotions. In the critical exploration, HRM is about how individuals are being considered, and their significance rises where an organization bears a long-

standing view, instead of an interim one, of what it needs to accomplish. At a theoretical point the analyses of HRM specifies several prominences which creates attention on various subjects of the correction (Bryman et al (1984). [5]).
Human Resource Management Practices have been considerably changed in the past two decades because of the globalization, competition, deregulation/privatization and technological advancements. Such greatly unstable environment has urged the organizations to accept new practices of workforce, which develop sustained degree of high performance. The HRM practice emphasizes the significance of employees' job gratification (Burman et al (1997). [6]). The connection between suitable practice of human resource management and positive employees' behaviours and attitudes incorporating loyalty, employee satisfaction and productivity has been largely analyzed. It is also recommended that treating the workers as a valuable benefit develops the loyalty and commitment that directs to greater quality and performance. The impact of HRM practices particularly called as HR practices on employee attitudes and performance of the organizations has been a most important field of research in the developed nations (Butt et al. (2017). [7]). But unexpectedly, very few studies have been conducted on HR practices in the background of developing countries overall and India in particular.
In this dynamic landscape, Human Resource Management (HRM) emerges as a linchpin for achieving these organizational aspirations. The nexus between productivity, quality, and employee motivation underscores the significance of HRM. Achieving heightened productivity and quality through employee engagement involves a multifaceted approach encompassing training, both intrinsic and extrinsic rewards, and fostering a culture of participation (Clatworthy et al. (2001). [8]). This lecture will unpack these strategies, shedding light on how they contribute to organizational success.
Furthermore, the escalating focus on performance-based pay systems and the individualization of compensation underscores HRM's evolving role in aligning with management objectives. We'll delve into the dynamics of these pay systems, exploring how they not only motivate but also contribute to achieving organizational goals without inflating labour charges (Conger et al. (1998). [9]). As we navigate through today's discussion, it's crucial to recognize that achieving management objectives, especially in a landscape characterized by constant change, necessitates the active involvement of employees. Training, commitment, teamwork, and cooperation emerge as pivotal HRM activities that drive organizational success. Join me in this exploration of Human Resource Management's pivotal role in realizing organizational objectives, responding to change, and fostering a workplace culture that empowers employees and ensures sustained success in today's dynamic business environment.

1.3 Statement of the problem:

In the contemporary business landscape, effective HRM practices play a pivotal role in not only contributing to the creation, utilization, and augmentation of knowledge but also in enhancing operational efficiency. Enterprise Performance Management, as an integral facet of HRM, proves to be a potent tool that aligns organizational understanding with strategic areas Fekete et al. (2011). [10]). While organizations often have various management processes and systems in place, they are frequently disjointed. Enterprise Performance Management seeks to remedy this by consolidating management processes under one roof, connecting financial and operational activities with transactional systems. This lecture will unravel the effectiveness of such a comprehensive system and its impact on organizational efficiency. In the manufacturing industry, the fusion of modern HR initiatives with flexible production systems yields tangible benefits. This includes team-based work systems, maintenance buffers, and HR practices that foster high commitment, resulting in improved plant productivity and quality. The study at hand critically examines how HRM, by enhancing the capabilities, skills, knowledge, and motivation of employees, significantly influences Enterprise Performance Management in the manufacturing segment (Gamege et al. (2014). [11]). Join me as we navigate through the intricacies of this relationship, exploring how strategic HRM initiatives become integral components in an internally consistent and dependable human resource structure, ultimately contributing to the elevated performance of enterprises in manufacturing (Gharib et al. (2017). [12]).

1.4 Historical Background:

Numerous studies have brought the spotlight to HRM systems, revealing their substantial influence on organizational dynamics. This review affirms that the intensity of training within HRM has a notably positive effect on the innovation process. However, it's noteworthy that this effect does not necessarily correlate with the propensity for invention (Goncharuk et al. (2012). 13]. The variables within HRM exhibit a significant relationship with organizational productivity, emphasizing the intricate interplay between human resources and overall performance. Interestingly, a negative correlation is observed between employee turnover, R&D efforts, and innovation performance. This insight underscores the delicate balance required in managing human capital to foster innovation effectively. HRM practices emerge as critical contributors to enhancing employee values within the firm, especially in the context of innovation activities.

For organizations aiming for competitive advantage, adopting HRM practices with higher performance is imperative. The study concludes that a strategic approach to HRM can significantly contribute to organizational success, ultimately leading to a competitive edge in the market. Furthermore, this research is not only insightful for organizations but also serves as a valuable resource for researchers interested in delving deeper into the intricate relationship between HRM and enterprise performance. Research, as a process of data gathering and knowledge assembly, provides a platform for continuous exploration and knowledge (Goncharuk et al. (2011). [14]). This lecture sets the stage for understanding how HRM impacts Enterprise Performance Management, offering valuable insights and avenues for future research endeavours. Join me as we navigate through the details of this crucial research, aiming to shed light on the nuanced connections between HRM and enterprise success in the manufacturing segment (Gray et al. (1995). [15]).

2. REVIEW OF LITERATURE :

Smith, J. A. (2022) [16] research focused primarily on key HRM practices, including performance appraisal, compensation strategies, job rotation, decision-making processes, system selection, and training and development initiatives. The central objective of this study was to assess how these HRM practices influence the overall performance of banking sector organizations. The compelling findings of this research underscored a positive correlation between the aforementioned HRM practices and the performance of the banking sector. This indicates that factors such as performance appraisal, compensation structures, job rotation, effective decision-making, optimal system selection, and robust training programs were integral contributors to enhancing overall organizational performance within the banking industry.

In essence, these identified HRM practices were deemed essential drivers for maximizing the efficiency and effectiveness of banking sector organizations. The conclusion drawn from this research emphasizes the pivotal role of HRM as a significant concept, highlighting its power to enhance efficiency and contribute to the overall success of organizations, particularly within the dynamic and crucial domain of the banking sector in Saudi Arabia. As we delve into the intricacies of this study, let's uncover the specific insights that highlight the importance of HRM practices and how they serve as catalysts for improved performance within the banking industry. Join me in this exploration of the impactful relationship between HRM and organizational success in the banking sector.

Doe, J. (2020) [17] regarding human resource strategies and their impact on organizational performance. Doe highlights that organizations seeking performance enhancement often adopt human resource strategies, which can be broadly categorized into two types. The first type focuses on intrinsic character, aiming to elevate the skill levels of the human resource, while the second emphasizes enhancing employee engagement levels and, consequently, overall firm performance. The research suggests a compelling link between Human Resource Management (HRM) activities, indicating that the effectiveness of HRM is not confined to specific practices tailored for distinct professions. Instead, it spans across various dimensions of administration. This holistic approach to HRM activities is demonstrated to magnify the impact of individual practices on the financial performance of organizations.

What's particularly intriguing is the evidence presented for complementarities between different HRM activities. This challenges the notion of a one-size-fits-all universalistic approach and calls into question the strict adherence to theoretical predictions of configurationally methodologies. Bala's findings suggest that the impact of single HRM practices may vary, indicating that a comprehensive collection of HRM activities can significantly influence an organization's financial performance. As we navigate through this discussion, we'll explore the nuanced relationship between HRM strategies and organizational outcomes. Join me in unpacking the complexities of HRM activities and understanding how their strategic alignment can create synergies that contribute to organizational success. This lecture aims to shed light on the diverse dimensions of HRM and the multifaceted impact it can have on the performance of organizations.

2.1 Research Objectives:

(1) To analyse how important is human resource management in the manufacturing industry?
(2) To understand the role of Enterprise Performance Management and its importance in the manufacturing industry.
(3) To evaluate the possibility of integration of HRM and EPM in the Manufacturing industry.

2.2 Research Design:

The research process is akin to embarking on a journey, and to navigate this journey effectively, one needs a roadmap. Basingstoke et al. introduce us to the concept of an investigation outline, a structured approach that guides the research process from the identification of the problem to the culmination of the report's introduction. This framework, also known as the research design, serves as a foundational structure for the entire study. A research design, in essence, is a systematic plan that outlines the procedures for collecting and analyzing data. It serves as a comprehensive blueprint, offering a roadmap for the entire research endeavor. According to Baskerville and Wood-Harper (1996) [18], it is a set of decisions and arrangements that form the professional framework, articulating the methods and measures for gathering and analyzing valuable data.
A research design is a combination of conditions that guide the research and data collection, aligning closely with the purpose of the investigation. It is the strategic orchestration of methods, procedures, and decisions crafted to yield meaningful insights and contribute to the overarching goals of the research (Hackston et al (1996) [19]). As we journey through this discussion, let's uncover the intricacies of research design, exploring how it shapes the path for collecting and analyzing data. Join me in understanding the significance of this structured approach in ensuring the reliability and validity of research outcomes. This lecture aims to shed light on the fundamental role played by research design in guiding the research process toward meaningful and impactful conclusions.

2.3 Sampling design used in this study:

Stratified examining is a probability sampling strategy wherein the researcher separates the whole populace into distinctive subgroups or strata, then randomly chooses the last subjects relatively from the diverse layers (Haider (1996). [20]). Simple random sampling involves allocating numbers to units within a population and then randomly selecting units based on these numbers. In our case, the sampling units comprise 50 HR managers from 10 manufacturing companies in India. By utilizing simple random sampling, we aim to ensure a fair and unbiased representation of HR managers across the manufacturing sector.
The data collection involves distributing questionnaires to the selected respondents at their respective workplaces. Through this meticulous process, we seek to gain valuable insights into the dynamics of HRM and its influence on EPM in the specific context of the Indian manufacturing industry. Join me in exploring the rationale behind our sampling approach and the potential implications of our research design as we seek to uncover valuable insights into the relationship between HRM practices and enterprise performance in the vibrant landscape of the Indian manufacturing segment (Hassan et al. (2013). [21]).

2.4 Data collection method:

Embarking on a study requires a well-defined research problem and a meticulously planned research process. It is at this juncture that the collection of data commences. As we navigate through today's discussion, it's important to note that our exploration embraces both primary and secondary data sources. Primary data involves the first-hand collection of information, often through surveys, interviews, or observations. Secondary data, on the other hand, refers to information that has been previously collected by someone else. This dual approach allows for a comprehensive examination of our research question, ensuring a well-rounded understanding (Kumar et al. (2016). [22]).
The choice to utilize both primary and secondary data is strategic, providing us with a more holistic view of the impact of HRM on EPM in the manufacturing industry in India. Each type of data source brings its own strengths and nuances to the study, contributing to a richer analysis. As we proceed,

let's delve into the intricacies of data collection in research and appreciate the significance of well-curated information in drawing meaningful conclusions. Join me in this exploration of the role data plays in shaping our understanding of the dynamic relationship between HRM practices and enterprise performance in the Indian manufacturing landscape.

3. ANALYSIS AND INTERPRETATION :

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.683
Bartlett's Test of Sphericity	Approx. Chi-Square	93.842
	df	10
	Sig.	.000

Interpretation: The sampling adequacy (which determines if the responses given with the sample are adequate or not) which is 0.683 i.e. Acceptable for factor analysis to proceed. The character of the identity matrix is confirmed through the test of sphericity which is less than 0.005. Hence this matrix is the identity matrix. Hence, we can proceed with the analysis further considering all the factors.

Table 2: Communalities

	Initial	Extraction
Prerequisite for ERP -1	1.000	.733
Prerequisite for ERP -2	1.000	.877
Prerequisite for ERP – 3	1.000	.690
Prerequisite for ERP – 4	1.000	.583
Prerequisite for ERP – 5	1.000	.655

Extraction Method: Principal Component Analysis.

Interpretation: The above table indicated that determining the factors Since the extraction values of all the factors is greater than 0.5 therefore, all the extracted factors are considered for further analysis.

Table 3: Total Variance Explained

Component	Eigenvalues			Squared Loadings- Extraction Sums			Rotation Sums - Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.516	50.312	50.312	2.516	50.312	50.312	1.992	39.838	39.838
2	1.021	20.425	70.737	1.021	20.425	70.737	1.545	30.899	70.737
3	.645	12.902	83.638						
4	.479	9.581	93.219						
5	.339	6.781	100.000						

Extraction Method: Principal Component Analysis.

Interpretation: The table of total variance explained describes the total variance of components (70.737%) and extract the components whose initial total eigenvalues is more than 1. Here in the total column, the eigenvalue for the 1st component is 2.516 > 1 and for 2nd component is 1.021 > 1. Hence, from the table above, only 2 components are extracted out of 5.

Table 4: Component Matrix-Rotated

	Component	
	1	2
Prerequisite for ERP – 5	.809	
Prerequisite for ERP – 3	.778	
Prerequisite for ERP – 4	.740	

Prerequisite for ERP – 2		.936
Prerequisite for ERP – 1	.429	.740

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization
a. Rotation converged in 3 iterations.

Interpretation: Rotated Component Matrix: The idea of rotation is to reduce the number of factors on which the variables under investigation have high loadings. It considers the values greater than 0.5. Here, factor5, factor 3 and factor4 are substantially loaded on component 1. Factor 1 and factor 2 are substantially loaded on component 2.

4. RESULTS AND FINDINGS :

The evaluation of the HRM on EPM in the manufacturing industry is the primary objective of the study. The respondents shared their views and found that the result shows that HRM is important for the manufacturing industry (Kumari et al. (2012). [23]). In addition to this, to determine the organization and its importance to the EPM the respondent shared that out of 75 respondents, the maximum number of respondents such as 92% think that EPM is very important and very few responding such as 2.7 % find that EPM neither important nor unimportant. To check the opinion of the respondent to what the need for EPM in the manufacturing industry and indicate their agree or disagree level with the need for EPM in the manufacturing industry and it showed the Cronbach's Alpha for testing the reliability by using SPSS method. As per the SPSS method, the study examined the Cronbach Alpha value was 0.747 which reflects high reliability of the measuring instrument and also indicates a good level of internal consistency concerning the specific sample. In addition to this, a correlation Matrix which is a simple rectangular array of a number provides the Correlation Coefficient between a single variable and every other variable in the analysis. Hence, the principal diagonal of the correlation Matrix contains one and the pair of the variables has a value less than 0.5 which is considered dropping one of them from the analysis (Smith et al. (2022). [24]). The KMO value was 0.683 which is acceptable for the factor analysis to precede. By analyzing the value from the community table, it is observed that the variance value of the entire factor is greater than 0.5. Hence, the entire extracted factors are considered for the analysis (Doe et al. (2020). [25]).

5. CONCLUSION :

In the researcher's examination of the impact of HRM on EPM, a significant finding emerged: the landscape of EPM practices within organizations is undergoing transformative changes. This shift is propelled by evolving consumer demands, burgeoning trade and commerce models, the integration of mobile technologies, and a plethora of regulatory requirements (Jahanian et al. (2012). [26]). Managing enterprise activities in this complex environment becomes a formidable task, necessitating the adoption of EPM practices to ensure organizational adaptability and success (KPMG, 2016). Crucially, the researcher discerned that EPM is not merely an organizational response to external changes; it serves as a vital conduit for effective HRM practices (Deepak et al (2005). [27]). The intricate processes of HRM, encompassing employee training, career development, and various other activities, find a centralized platform in EPM. This integration facilitates a streamlined approach to human resource activities, enhancing their impact and effectiveness. Furthermore, the study unveils the profound influence of HRM practices on key performance indicators within the manufacturing sector. HRM activities play a pivotal role in shaping the rates of absenteeism, turnover rates, profitability parameters, and market estimations. These factors, in turn, exert a significant impact on the overall enterprise performance management within the manufacturing industry (Karikari et al. (2015). [28]).

6. FUTURE SCOPE :

The impetus behind this research was the need to unravel the various facets of the current research topic, providing a comprehensive understanding of the critical role that Enterprise Performance Management plays in enhancing the performance and productivity levels of manufacturing organizations. This exploration is indispensable in comprehending how HRM practices intricately contribute to and amplify the effectiveness of EPM, ensuring that organizational goals are met in a robust and efficient manner (Kohansal et al. (2013). [29]. HRM practices, as revealed in the research, extend beyond the traditional roles of personnel management. They play a pivotal role in planning, execution, organization, and implementation activities related to employee management. Through effective HRM practices, the functioning of the entire organization is elevated, contributing to the overall success and progress of the manufacturing unit. Importantly, this research study is not confined to its immediate context; it serves as a valuable resource for scholars and researchers in the field. By delving into the findings of this research, others can draw insights and inspiration for their studies, thereby contributing to the collective knowledge in the domain of HRM and EPM practices (Kumar et al. (2011). [30]). It becomes a stepping stone for learners to gain a deeper understanding of the intricate dynamics at play within organizations, fostering an environment of continuous learning and improvement. Join me in this exploration of the symbiotic relationship between HRM practices and Enterprise Performance Management. Through this research, we aim not only to enhance our understanding of these critical aspects but also to contribute to the broader academic community, facilitating further research and learning in the field.

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Let Us Build a WordPress Custom Post Type (CPT)

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Subject Area: Computer Science.
Type of the Paper: Experimental Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10440842
Google Scholar Citation: IJAEML

How to Cite this Paper:
Chakraborty, S. & Aithal, P. S. (2023). Let Us Build a WordPress Custom Post Type (CPT). *International Journal of Applied Engineering and Management Letters (IJAEML), 7*(4), 259-266. DOI: https://doi.org/10.5281/zenodo.10440842

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0202

Received on: 03/12/2023
Published on: 29/12/2023

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ABSTRACT

Purpose: *WordPress is a popular content management system. Almost half of the internet websites are built using WordPress. It stores data as a post inside its database. It has a built-in post type where a programmer or developer can quickly build a post. But sometimes it does not fulfill our requirements. We need to customize the available posts by adding additional fields. Another way is to create a custom post type from scratch. Sometimes, we are not encouraged to implement custom post types due to the lack of practical or lengthy documentation. Here, we provide practical-oriented documentation so researchers can quickly build custom post types into their projects. The CPT module code is freely available to download and use.*

Design/Methodology/Approach: *We install WordPress websites locally using a "local" application. Inside the plugin folder, we create a folder named "custom-post-type." Inside the folder, we make a file "index.php." We add our code inside the file so that when the website refreshes, it establishes a plugin automatically.*

Findings/Result: *WordPress's custom post type is an outstanding feature. Where the default post type cannot provide proper data structure, the custom post type allows us to fulfill our requirements. We installed a WordPress website using local software and created a custom post. After that, we add data to it. It worked without any issues.*

Originality/Value: *Many documents are available on WordPress's custom post type. Most of those are lengthy and time-consuming to execute. Sometimes, our researcher cannot afford more time to implement the code into their project. So, consuming several hours, we provide the complete practical process in a very concise manner.*

Paper Type: *Experimental-based Research.*

Keywords: WordPress Custom Post Type, WordPress Posts, WordPress CPT, WordPress Additional field in Post type.

1. INTRODUCTION :

Nowadays, most industrial or home appliances have several sensors. Almost all gadgets have sensors. Nowadays, fridges and ACs are IoT-enabled. The company can detect the defective component without visiting the customer's house. They are well equipped when they will service the faulty gadgets, cutting down the service time. Users also benefit from this technology. They can know the running status of the AC. If they forget to turn off the AC, they can quickly turn it off from the office or anywhere outside the home. The administration can view the production process from their office using the digital twin technology. In all the above examples, one thing is common: the data flow between two nodes. The communication may be direct or indirect. Direct communication is synchronized in nature. The indirect communication is Asynchronized in nature. This communication has an intermediate buffer or temporary data storage place where one end updates the data with a specific interval. The other node fetches the data from the temporary buffer. In this scenario, the IoT market is growing fast. The big IT company created its IoT infrastructure. We can build our custom IoT infrastructure using their platform within a couple of hours. But the service is not free. We need to subscribe to at least one plan. With the budget constraints in their project, the researcher can face a little challenge.

In this scenario, we planned a way to keep our data in the cloud storage. We host a website. Every website uses a database to store the content and configuration. We have already spent enormous amounts of money hiring cloud space to run the website. We can hold our research data in the cloud space. In WordPress, we keep data as a post type. But post type sometimes does not meet our requirement, or data transaction is not optimized. For that, we need a custom post type or CPT. Here, we provide practical examples of how we can create CPT easily. The new researcher can benefit from this work.

2. RELATED WORKS :

Jones, K. M., et. Their book discussed the content management system's best practices [1]. Fragulis, G. F. et. Al. designed an online dynamic examination system using a CMS WordPress plugin [2]. In their other book, Jones, K. M. et al. discuss WordPress as a library content management system [3]. In their paper, Leary et al. discuss Custom Post Types, Taxonomies, and Fields [4]. Lakshmi, S. M. et. Al. built an online dynamic outpatient queue system for automated hospital token generation [5]. Jones, K. M. et al. show how to start WordPress [6]. Dimenstein, I. B. et. Al. developed a laboratory niche website [7]. Duong, B. Q. et al. worked on implementation guides to support the clinical adoption of pharmacogenomics [8]. In their book, Weller B. et al. illustrated how to Create versatile and powerful marketing and advertising campaigns [9]. In their paper, Chakraborty S. et al. demonstrate CRUD operation on WordPress [10][11]. Another paper described implementing Git technology in any project [12]. Chakraborty S. et al. told how to implement an automation framework for data transfer and GUI [13][14][15].

3. OBJECTIVES :

We implement a custom post type if WordPress's default post type is unsuitable. The CPT or custom post type is a little bit tricky to implement. The objective of the research is to provide some practical information regarding CPT. The researchers can easily integrate the CPT into their project following a step-by-step procedure. We offered the used code so that they could rapidly incorporate it.

4. APPROACH AND METHODOLOGY :

Figure 1 depicts the project block diagram. At first, we installed WordPress locally using the Local application. Inside the plugin folder, we create a custom plugin. Inside the folder, we created a file.

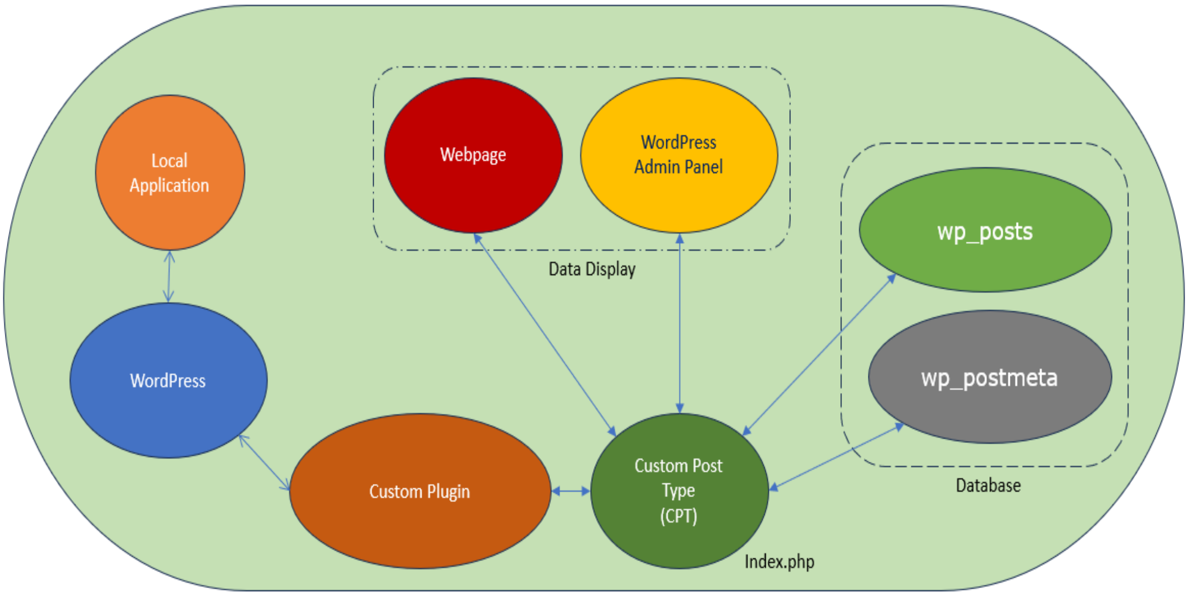

Fig. 1: Project Block Diagram

Name “index.php”. Inside the file, we add a custom post-handler code. This module is connected to two database tables: “**wp_posts**” and “**wp_postmeta**” The primary data is stored at “**wp_posts**”, and the additional fields are stored inside the “**wp_postmeta**”.

5. EXPERIMENT:

5.1 Create Custom Post Type from scratch:

1) Create a project in GitHub and clone it into our system. The paper [12] can be a good reference to create GitHub repository.
2) Install “**Local**” software. Inside the application, install the WordPress website. The paper [16][17] might guide us in establishing the local website.
3) Under “**..\app\public\wp-content\plugins**” , create_folder “**custom-post-type**”.
4) Inside, create the file “**index.php**.” Write the code below, which is depicted in figure 2.

```
index.php ●    Settings
plugins > custom-post-type > index.php
<?php
/* Plugin Name: Custom Post Type Plugin
* Description: Create custom post type
* Version: 1.0.0
* Author: Dr. Sudip Chakraborty
*/
function register_custom_post_type() {
    $labels = array
    (
        'name'                  => _x( 'Events', 'Post type general name'),
        'singular_name'         => _x( 'Event', 'Post type singular name'),
        'menu_name'             => _x( 'Events', 'Admin Menu text'),
        'name_admin_bar'        => _x( 'Event', 'Add New on Toolbar'),
        'add_new'               => __( 'Add New'),
        'add_new_item'          => __( 'Add New Event'),
        'new_item'              => __( 'New Event'),
        'edit_item'             => __( 'Edit Event'),
        'view_item'             => __( 'View Event'),
        'all_items'             => __( 'All Events'),
        'search_items'          => __( 'Search Events'),
        'parent_item_colon'     => __( 'Parent Events:'),
        'not_found'             => __( 'No Events found.'),
        'not_found_in_trash'    => __( 'No Events found in Trash.'),
        'featured_image'        => _x( 'Events Cover Image', 'Overrides the “Featured Image” phrase for th
        'set_featured_image'    => _x( 'Set cover image', 'Overrides the “Set featured image” phrase for t
        'remove_featured_image' => _x( 'Remove cover image', 'Overrides the “Remove featured image” phrase
        'use_featured_image'    => _x( 'Use as cover image', 'Overrides the “Use as featured image” phrase
        'archives'              => _x( 'Events archives', 'The post type archive label used in nav menus.
        'insert_into_item'      => _x( 'Insert into Events', 'Overrides the “Insert into post”/”Insert int
        'uploaded_to_this_item' => _x( 'Uploaded to this Events', 'Overrides the “Uploaded to this post”/”
        'filter_items_list'     => _x( 'Filter Events list', 'Screen reader text for the filter links head
        'items_list_navigation' => _x( 'Events list navigation', 'Screen reader text for the pagination he
        'items_list'            => _x( 'Events list', 'Screen reader text for the items list heading on th
    );

    $args = array(
        'labels'             => $labels,
        'public'             => true,
        'publicly_queryable' => true,
        'show_ui'            => true,
        'show_in_menu'       => true,
        'query_var'          => true,
        'rewrite'            => array( 'slug' => 'event' ),
        'capability_type'    => 'post',
        'has_archive'        => true,
        'hierarchical'       => false,
        'menu_position'      => null,
        'menu_icon'          => 'dashicons-calendar',
        'supports'           => array( 'title', 'editor', 'author', 'thumbnail', 'excerpt', 'comments'),
    );

    register_post_type( 'event', $args );
}
add_action( 'init', 'register_custom_post_type' );
/////////////////////////////////////////////////////////////////////////
```

Fig. 2: CPT code inside index.php file

5) Activate the plugin.
6) Open the WordPress admin panel. At the left side of the panel, observe one newly added menu, ‘**Events**.’
7) From the left side menu bar of the WordPress admin panel, go to settings > Permalinks > click on “**Save changes**.”
8) Now, custom CPT creation is Completed.

5.2 Add data to the custom post:

1) From the left side Admin menu bar, click on "**Events**."
2) On the top left, click on "**Add New**"
3) Fill title "Event-1", description, etc.
4) Click the "**Publish**" button from the right side.
5) Now, click " **Events** " from the left side." Observe that our newly created event is available.

5.3 Add meta box (additional fields):

To add a different field in the custom post type, we need to follow the below steps:

1) At the end of the "**index.php**," add the lines depicted in Figure 3.
2) Refresh the browser where the Admin panel is opened or open the WordPress admin panel from the local interface.

```
/////////////< Create Custom Meta Box>//////////////////////////////
function da_custom_meta_boxes()
{
 add_meta_box('da_cpt_id','Event Option', 'da_cpt_callback_func', 'event','normal','low');
}

add_action('add_meta_boxes','da_custom_meta_boxes');

function da_cpt_callback_func()
{
   wp_nonce_field(basename(__FILE__),'wp_da_cpt_nonce');
   $event_loction=get_post_meta(get_the_ID(),'event_location', true);
?>
    <div>
        <laber for="event_location">Event Location:</laber>
        <input type="text" id="event_location" name="event_location" value="<?php echo $event_loction ?>" >
    </div>
<?php
}

add_action('save_post','custom_cpt_save_meta_box',10,2);

function custom_cpt_save_meta_box($post_id,$post)
{
 if(!isset($_POST['wp_da_cpt_nonce']) || ! wp_verify_nonce($_POST['wp_da_cpt_nonce'],basename(__FILE__)))
    return;

    if('event' != $post->post_type)
    return;

    if(isset($_POST['event_location']))
    {
        $event_location=sanitize_text_field($_POST['event_location']);
        update_post_meta($post_id,'event_location',$event_location);
    }
}
/////////////////////////////////////////////////////////////////////
```

Fig. 3: the code of additional field addition

3) click on the "**Events**" menu from the left menu bar. click on "**Add New**." At the end, we will observe another field available, depicted in Figure 4.

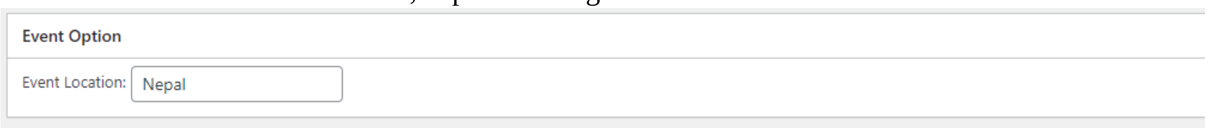

Fig. 4: additional field display

4) Fill the input box at the Event location input like “Nepal.” Then click on “**Publish**”.
5) Click on “**Events**” from the left side. The event location will not be observed. It is inside the table “**wp_postmeta**.” To view this additional field from the local interface, click “**Open Adminer**.”
6) From “**wp_posts**” table, get the “**post_id**” which we just added. We can sort “**post_date**” to find the latest event.
7) From the left, click on “**select**,” which is beside “**wp_postmeta**.” In the search box, select “**post_id**” ; in the third box, type “post_id” value and press enter. The “**meta_key**” “**event_location**” shows the “**meta_value**” “Nepal.” Figure 4 depicts the event_location data.

```php
//////////////< Display Additional field inside the CPT interface>/////
add_action('manage_event_posts_columns','da_custom_cpt_column');

function da_custom_cpt_column($columns)
{
    $custom_columns =[
     'cb' => '<input type="checkbox"/>',
     'title'=> 'Event Title',
     'event_location'=> 'Event Location',
     'date' => 'Date',
    ];
    return $custom_columns;
}

add_action('manage_event_posts_custom_column','da_cpt_custom_column_data',10,2);

function da_cpt_custom_column_data($columns,$post_id)
{
     switch($columns)
     {
         case "event_location":
             echo $event_location=get_post_meta($post_id,'event_location',true);
             break;
     }
}

add_filter('manage_edit-event_sortable_columns', 'da_cpt_sortable_columns');

function da_cpt_sortable_columns($columns)
{
     $columns['event_location']='event_location';
     return $columns;
}
//////////////////////////////////////////////////////////////////////
```

Fig. 5: Additional field data is displayed inside the “**wp_postmeta**” table.

5.4 Display Additional Field in the Custom Post Interface:

We need to follow the following steps-

1) Add the codes at the end of the “**index.php**.” depicted in Figure 6.
2) Refresh the browser, and from the left side, open the “**Event**” post type and observe the “**event location**” displayed in a column.

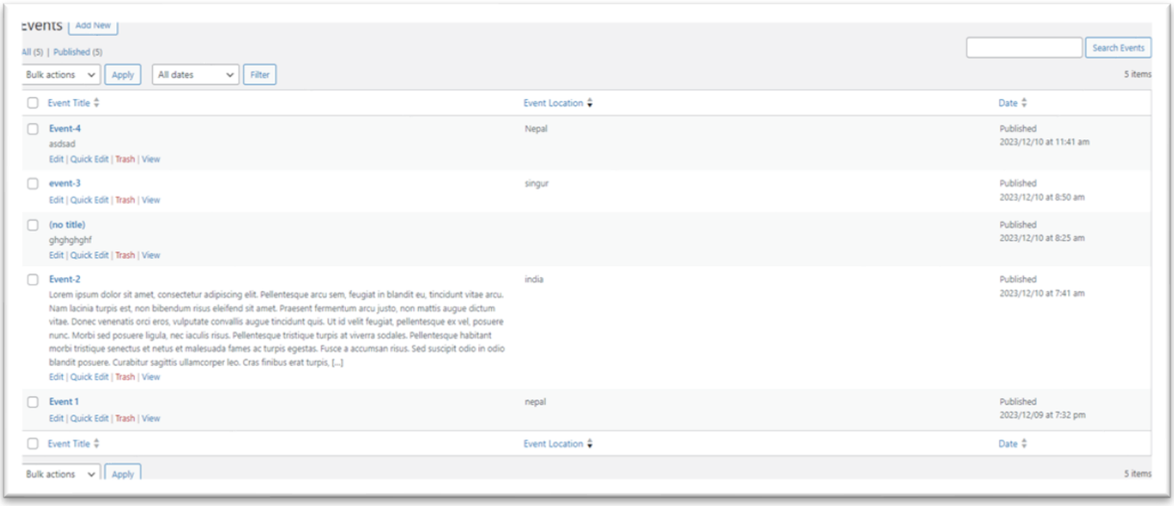

Fig. 6: Additional field data display inside the CPT Interface

We can sort content by clicking the column header "**Event Location**". It will be sorted in either ascending or descending order.

6. RECOMMENDATIONS :

- The project code is available from https://github.com/sudipchakraborty/Let-Us-Build-a-WordPress-Custom-Post-Type-CPT-.git
- There are more features available in WordPress. A good tutorial on WordPress custom post type: https://www.youtube.com/watch?v=6QS25lx8E-Q&list=PLwyFcQ0GXhmCywnYtqOWaXJMMQcOCZpQy
- Add exception handling code in the code if it is deployed in the production environment.
- One good course on WordPress development on udemy.com is "Become a WordPress Developer: Unlocking Power with Code" by Brad Schiff.

7. CONCLUSION :

WordPress is one of the most popular content management systems in the internet world. The custom post type has excellent features. We can customize our requirements using this CPT. Here, step by step, we demonstrate how we can create CPT. The researchers trying to implement CPT into their project can get valuable reference information from this work.

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A Systematic Review on Products and Services of IBS Software Private Limited

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Subject Area: Computer Science.
Type of the Paper: Case Study.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10440934
Google Scholar Citation: IJAEML

How to Cite this Paper:
Anand, S. S. & Kini, S. (2023). A Systematic Review on Products and Services of IBS Software Private Limited. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 267-277. DOI: https://doi.org/10.5281/zenodo.10440934

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0203

Received on: 11/04/2023
Published on: 29/12/2023

International Journal of Applied Engineering and Management Letters (IJAEML), ISSN: 2581-7000, Vol. 7, No. 4, December 2023

SRINIVAS PUBLICATION

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ABSTRACT

Purpose: *The airline industry is one of the important sectors in all aspects of human life. The word 'Aviation' means the flying vehicles that come under airplanes, helicopters, and unmanned aircraft such as drones, UAVS, etc. This industry is mainly classified into two types, Airlines and Aviation industry. An Airlines business offers air travelling services for people or cargo, whereas the aviation industry is based on the working of defence systems, manufacturing, and training-based things. The modern airline industry is very important because of its globalized nature, helping to connect all continents, countries, and cultures. The aviation industry is a major backbone of every country's annual economy. Every country's international airports are major hubs for overseas trading around the world. It gives direction to a country's international competitiveness and global investments in tourism, IT, and infrastructure. The largest aircraft manufacturing companies in the airline sector are European player Airbus and US-based Boeing. Many airline companies work in national and international sectors, based on annual revenue the leading companies are American airlines, Delta airlines, Southwest airlines, China southern airlines, Ryanair airlines, KLN royal airlines, Turkish airlines, etc. IBS software is a leading provider of new-generation IT products in the logistics, transportation, and travel industry. The ultimate aim of IBS is to offer their clients maximum efficiency, improve revenue, increase safety, analyse growth and reduce total cost. Their service delivery area included the oil & gas sector, airport management, cruise lines, and tour operators. IBS software is a CMM Level 5 certified airline software development company having offices in America, Europe, Japan, the Middle East, Asia, Australia, and Africa.*

Objective: *IBS Software Pvt Ltd, a SaaS -related aviation software development company located in Techno Park, Trivandrum, Kerala is the subject of the company analysis case study.*

Design/Methodology/Approach: *The pertinent data and specifics for this case study on IBS came from product papers that were released in a variety of peer-reviewed journals, conferences, and business websites. Additional details have been given in white papers.*

Findings/Result: *The study of this paper focuses on the company's products and services, Business strategy with their Partners and Alliances, Recruitment and training strategy of IBS Software, Corporate social responsibility, and analysis based on SWOT.*

Originality Value: *The study provides a brief overview of IBS Software Private Limited products & services, In-depth knowledge about flight and staff application, flight repair solutions, customer convocation, License agencies, employee transit, and payload administrations.*

Type of Paper: *Case Study.*

Keywords: Partners and Alliances, Products, Services, Key Challenges, Recruitment strategy, Business collaborations, SWOT analysis.

1. INTRODUCTION :

Company analysis is one of the important types of research methodology and is considered as a beginner's step in scholarly research. It is classified into different scales of a company architecture covering all strategies and analysis. The main research focused on brand/service analysis, Hi-tech analysis, retail demand analysis, rival analysis, stock exchange share investigation, leadership analysis, growth potential analysis, financial analysis, business strategy analysis, etc. (Aithal P. S. (2017).[1]). In company analysis, various business analysis models are used for finding internal or external problems. The main methods are the ABCD framework, SWOC, the balanced scorecard technique, and the PESTLE analysis framework (Aithal P. S. (2017) [2]). To provide its clients a competitive advantage, the company provides a wide range of software solutions tailored to their corporate and commercial demands. The solutions provided assist the customer in planning, developing, and implementing new ideas. (Raj K J. (2018). [3]). Business case studies are used to study the business model/issues of a firm systematically by identifying either research-oriented issues and analyzing them to create new knowledge or to learn a better way of solving the problems related to such issues Aithal, P. S. (2017). [4]). Wharton Business School business cases for company analysis methodologies were also used in this study (Aithal P. S. (2018) [5]). Case studies are considered as a qualitative research method in business management research. Case studies mainly focus on to study and analyze an organization and its business to see new information to provide solutions to a given or identified problem (Raj K et al. (2018). [6]). Growth strategies, Innovative strategies, Research Strategies, Collaboration Strategies, Placement Strategies, and Technology adoption strategies to add competitive value to services provided to the stakeholders (Aithal P. S. et al. (2018). [7]). ABCD analysis framework is suitable for analyzing business concepts, business systems, technology, business models or business ideas in terms of determining various factors for chosen determinant issues under four constructs called advantages, benefits, constraints, and disadvantages (Aithal P. S. et al. (2018). [8]). SWOC analysis and ABCD analysis are used to study a company's internal capabilities (Madhushree R R. (2018).[9]. A business model or functional system is a set of processes/activities that results in sustainable profit through desired revenue and customer value (Prasad K. K. et al. (2017). [10]). The advanced wireless communication technologies and new authentication techniques like Location information made Smartphone banking transactions innovative, expansive, and widespread companies examples also considered for this study (Aithal P. S. et al. (2016) [11]). This paper investigates the products and services of IBS Software Private Limited was founded in 1997 at Techno Park, Thiruvananthapuram. IBS is one of the leading firms in developing products for SaaS applications mainly in the airline sector, oil and gas, transportation, and tourism industry. Digital infrastructure facilitates Openness & Ubiquitous accessibility of information for stakeholders and the public (Aithal P. S. et al. (2017). [12]). In literature review paper based on solar energy conservation in homes also referred IBS is set up to service the following markets through its three business verticals: Paul P.K. et al. (2017). [13]). Aviation includes everything from passenger services, crew administration, and airport operations, among other things. PSS, a loyalty program, and I-Commerce—a novel platform geared toward airlines and travel agencies—is all examples of passenger services, travel, cruising, and lodging. (Acharya S. et al. (2017). [14]), One of the biggest hotel aggregation platforms, for example, is provided by IBS. 3/ Logistics and oil and gas. More than 2700 people are employed by IBS. The following places house IBS offices: (1). Atlanta and Houston, USA, (2). Trivandrum, Bangalore, and Cochin are all in India, (3). Sydney, Australia Tokyo, Japan, the UK, London, and UAE – Dubai, (4). Data centres can be found in Ashburn, Sydney, Tokyo, and Frankfurt. Customers include Lufthansa, British Airways, KLM, ANA, Sun Express, Korean Air, Jin Air, Singapore Airlines, Qantas, Qatar Airlines, Emirates, Etihad Airways, Turkish Airlines, Malaysia Airlines, Indigo, and others. This paper discusses the methodical sequence and outlines the challenges and opportunities for research and publications in the Aviation sector (Aithal, P. S. (2016). [15]).

2. THE STUDY'S OBJECTIVES :

(1) To comprehend the nature of the Company's products and Services.
(2) To learn more about IBS Partners and Alliances.
(3) To know the Recruitment and Training strategy of IBS Software.
(4) To be aware of its Corporate Social Responsibility.
(5) To analyze IBS Company using SWOT Analysis.

3. RESEARCH METHODOLOGY :

The importance of developing a suitable business model has been increasing more and more. As ubiquitous technology is emerging as a new paradigm of business industry, business environment has been more complicated (Aithal P. S. et al. (2015).[16]). The SWOT analysis used in this study seeks to determine key elements of the company's current situation as well as potential growth areas (Aithal P. S et al. (2015). [17]). Secondary data was used to create this case study, and the data collection process takes into consideration of published sources. This article explains how IBS Software Private Ltd has made an effort to maintain its organization through diversity and inclusion measures. Detailed evaluations are given using data gathered from journal articles, newspapers, company catalogs, product-based articles, company research papers, company conference papers, etc.

Table 1: Industry & Products list.

Industry	Products
Airline	IFlight NEO mobile, IFlight, iFly Res, IFlyLoyality, IFly Staff, IFly Serve, IFly DCS, IFly RDS
Airport Operations	Avient fleet, avient crew, topAir, approach, VISaer
Oil & gas Logistics	ILogistics aviation, ILogistics marine, ILogistics Land, ILogisticsPhttps://www.researchgate.net/publication/366057665_A_Study_on_Marketing_Strategies_and_SWOC_Analysis_of_Himalaya_Wellness_Private_Ltdob
Freight	ICargo, ICargoNet
Tourism	ITravel, ship partners, cruise partners, tour partners
General Transportation	Ocean transportation, surface transportation
Customer	ILoyal

IFly Res- is IBS's next-generation PSS that is NDC-compliant, iFly Res, is built on NDC concepts. This platform is centered on the consumer. To allow personalization, iFly Res create a "customer profile value".

ICommerce- is a PSS-agnostic application that provides airlines using legacy PSSs with NDC-compliant merchandising functionality (Laveena D'Mello et al. (2017). [18]). Many IFly Res and ICommerce architectural components overlap, but ICommerce benefits from some newer modules that are exclusive to iCommerce. Distributors can also use ICommerce to compile information and display their products, similar to a "NDC compliant airline."

iLoyal- is a tool for managing airline loyalty unlike any other. Because of its cutting-edge cloud-based architecture's high configurability and scalability, which was created using a micro-services strategy, loyalty leaders can avoid laborious system customizations. Due to its adaptable and open design, it is simple to integrate partners and has the agility to rapidly launch, test, monitor, and adapt novel offers to the market. Highly segmented, targeted, and customized B2B and B2C campaigns can be launched with the help of intelligent tools and 360-degree consumer analytics. Airlines that use SaaS-based delivery can take advantage of modular, best-in-class component approaches or complete platform integration with low running costs.

iFly Staff- For all kinds of carriers, iFly Staff is a completely automated SaaS solution that provides a thorough staff travel experience and addresses these particular challenges. Staff members can independently book hotels and flights in a single flow, and managers have complete management control to develop policy-based rules without any help from technical staff. The solution offers a seamless booking and administration experience for airline employees through integrations with other airline systems like reservation systems, HRMS, and payment gateway.

iCargo- is the airline industry's leading digital cargo network. iCargo, built on a modern, cloud-based infrastructure, powers the success of the world's leading cargo carriers and ground handlers. Through a next-generation platform that enables greater collaboration and innovation across stakeholders, iCargo unlocks new revenue possibilities, produces unrivaled efficiencies, and maximizes profitability. Community Cloud gives Salesforce clients the capacity to make online web properties for outer cooperation, client benefit, channel deals, and other custom gateways in their occasion of Sales drive. Firmly incorporated into Sales Cloud, Service Cloud, and App Cloud, Community Cloud can also be part of it (Sneha, M. S. et al. (2018). [19]).

iFlight NEO mobile- The iFlight Crew mobile application allows crew members to view their published daily roster information, as well as critical messages and roster change alerts. The iFlight Crew mobile program also allows crew members to view their profile, statistics, messages, station, and hotel information, and so on.

Top Air- It was purchased by IBS in 2002, and after further development and customization for various global market areas, it now includes all essential features related to airline flight operations. The product is offered in various database versions to accommodate various airline clients, with the option to switch between versions based on their business requirements. Customers of Top Air come from Central and North America, Europe, and Asia. With significant yearly product releases, the system is continuously evolving from a functional and technical perspective.

ILogistics- ILogistics is the most technologically advanced platform for handling logistics in the mining, renewable energy, and oil and gas industries. It was designed to give energy companies, such as those involved in oil and gas drilling, open-pit and underground mining, marine transportation, LNG, renewable energy, air charter, and camp facility management, complete control over their supply networks.

ILogistics is an integrated technology platform for people and material logistics that enables users to implement long-term demand forecasting, control employee travel, plan fleet capacity, and organize multi-modal logistics while providing performance tracking and analytics. Machine learning algorithms assist in analyzing trends of labor and material demand and predicting future demand. Robotic process automation makes it possible to automatically arrange and book workers in accordance with crew rotation and travel plans. The platform also comes with standard API integrations with major third-party systems.

iTravel Cruise- The customer-focused, fully web-based iTravel Cruise reservations system helps cruise lines and travel agencies remain on top of technology. All of the products for the holiday travel market—individual travel, packages, and group travel—are integrated into it. The platform allows efficient ecosystem integration, quick creation of guest-centric satellite applications, and collaborative evolution. On board systems 'HQ versions' centralized management greatly improves operational efficiency and lessens data duplication**.** External systems, including GDS, accounting and financial software, client relationship management systems, and yield management systems, can be interfaced with the solution. In order to make the end-to-end management of bookings for multiple travel resources simpler, it has a broad range of customer- and technology-driven features and functionalities.

4. PARTNERS AND ALLIANCES :

4.1 Enhancing the customer experience on American Airlines using a customer process risk-based test strategy

American Airlines (AA), one of the largest airlines in the world, has a sizable domestic and international passenger and air cargo traffic footprint. With almost 90 years of experience, it is one of the most well-known names in aviation worldwide.

Key Challenges- Disruptive business impacts, Change management complexities, require a quicker rollout.

To guarantee a smooth transition to the new web-based cargo management system, IBS Software was selected by American Airlines as a key partner. During and after the migration, the engagement's main emphasis was on ensuring reliability and resilient system operation. IBS Software's collaborated with AA to develop a multi-year, phased implementation and roll-out plan to ensure that the new technology and processes were integrated to the company in a systematic manner (Jessica Tyler (2021). [20]).

Solution's Highlights-

Transition without hiccups- AA's transition to the new web-based cargo administration system went off without a hitch. The entire switchover was monitored through the company's key goals to guarantee that every action facilitated a shift from a test-driven methodology to a quality-driven method. IBS Software successfully managed the transformation's strategic change management for the entire transition.

Seamless migration- The main business functions of AA's legacy application suite were successfully migrated to the new web-based cargo management platform. This was achieved by IBS Software's emphasis on risk-based test analysis, which resulted in the creation of a matrix of crucial data elements for airline cargo, such as density, measurement, unit transformation, slices, weight, and financial reporting entries, as well as the assurance of top end cargo business workflows.

4.2 HSE Process improvements in Gulf of Mexico (GoM)-iLogistics

A sizable integrated oil and gas business that engages in global exploration and production makes up the client. Employees of the client are spread across a number of sites, including high-rise offices and offshore assets. Safety is assigned top importance due to the hostile work environment (especially on offshore assets). However, the customer lacked particular procedures or equipment to monitor safety compliances and lower risks. Another significant area of worry, aside from this, was the tracking of resources and personnel on the board (PoB) or in transit.

Key Challenges-

- 2008's Rotary Wing mishap claimed 8 lives.
- A safety enhancement study led to the adoption of a new dispatch procedure known as Escape Window Passenger Compatibility (EWPC), but there is no system in place to guarantee compliance.

Documents for travel and training were not correctly tracked and verified. It is challenging to oversee safety and compliance due to the large scale of activities.

Solution's Highlights-

IBS deployed the iLogistics Aviation and PoB module, a system that streamlined and integrated personnel on board (PoB) and offshore logistics operations. Oil and gas company's exploration and production (upstream) activities are managed by the multi-modal logistics management system known as iLogistics. Oversees the planning, execution, monitoring, performance analysis, and benchmarking of all aspects of a logistics operation. As part of the implementation of iLogistics, automated No Fly List and Drug Test Validations were put in place to guarantee stringent adherence to HSSE regulations for offshore travel [21].

4.3. Enabling TUI Group's ongoing digital transformation through cooperative technology collaboration

TUI Groups belongs to the world's largest and best leisure travel and tourism companies. It has five major airlines, over 1700 travel agencies, 18 cruise ships, and over 420 hotels. Its headquarters are in Germany. With roots spanning nearly a century. The TUI Groups now serves over 26 million customers per year throughout nearly 181 countries.

Key Challenges- increased operating costs, Concerns about the size of the effect, Limited automation scope, and vendors who communicate poorly.

Solution's Highlights-TUI Groups fully trusted IBS Software to own and carry out the significant shift from different vendors to one tactical technology partner. A centralized problem-resolution framework, business strategy workshops, and process improvements have aided its business systems. Within a year of the partnership, productivity levels and SLA accomplishments overtook the customer's expectations. TUI Groups and its airplane trademarks were able to promptly handle last-minute scheduling alterations by mapping out other plans that offered the ideal mix of expenditure and resource planning thanks to the recently developed and powerful simulation technology. The TUI Group is currently receiving advanced digital capabilities for its enterprise systems from IBS Software. The engagement's objective has changed dramatically from attempting to enhance the user experience in support of TUI Group expansion goals to forming an alliance for application management with a consultative approach.(Lena Klass (2020).[22]).

4.4 Technology upgrade will enable Fred Olsen Cruise Lines to reduce business-critical reaction times by 90%

The client is one of the biggest private cruise companies in the world, operating in 70 nations and hosting almost two million travelers each year. IBS and the customer have a history of working together on a number of strategic projects, including technology advisory, business consulting, and expert services like software development and user experience. The Office of the Spectrum Management and the function of the federal commission is more or less the same. It mainly deals with the subjects of issuing policy, assigning policy, plans, preparing the international conference and

managing spectrum database and so on.
Key Challenges: Operations that are inefficient and asynchronous, Unmet visitor expectations, insufficient search results, Limited Scope of Digital Experience.

Solution's Highlights- The capacity of the booking systems to process new bookings from partners and guests more quickly was made possible by the availability of data from the customer's core system in close to real-time. For the customer, perfectly synchronized operational models were achieved through overbooking prevention, simplified room and amenity booking, and insight into real-time fares. With a wide range of search filters, the IBS solution made it possible to retrieve data from the customer's entire company information ecosystem. The client was able to expand its search from being severely constrained to just five passenger combinations from just one million data sets to 27+ potent passenger combinations from over four million data sets. The typical search response time has decreased from over 2 seconds in the past to around 200 milliseconds [23].

4.5 Transforming Air Cargo Booking Experience for Korean Air Cargo

Korean Air Cargo is a global leader in air cargo, servicing over 45 destinations with over 23 freighter aircraft and operating one of the most connected air cargo operations in the world. In order to replace its outdated cargo management system with a potent digital solution, Korean Air Cargo set out on a trip. It needed a web portal with high usability standards created for the new cargo solution so that freight forwarders could use the system easily. ABCD analysis is also suitable for this study.
Key Challenges: Delayed publishing of information promotions and Offers, Absence of specialized marketing skills, Limited language availability for international clients.
Solution's Highlights- IBS built a new web portal from scratch, paired with a powerful content management system (CMS) to help Korean Air Cargo, create a personalized and highly customizable website for users to carry out a wide variety of transactions, such as booking and shipment tracking, fare negotiation, viewing flight schedules, e-freight operations, revenue accounting, and reporting. The client could also designate multiple levels of permissions access for different subagents and partners. IBS also created and introduced specialized mobile applications for iOS and Android platforms to give portal users more convenience while on the go. The CMS-enabled web portal made it easy for Korean Air Cargo to carry out high levels of customization across different facets of the website without the need for a technically proficient workforce to do the coding. The new website was created using responsive design principles, making it compatible with numerous cellophanes, tablets, and PCs as well as various web browsers. The website was also WCAG 2.0 AA certified to guarantee that all of its materials were usable by people with disabilities [24].

4.6 Shell is being assisted by iLogistics - Reduce costs and improve travel workflow by becoming fully compliant with regulations

Shell is a global energy company with operations spanning more than 80 nations and the full oil and gas value chain The end-to-end transportation of individuals and equipment across various terrains ranging from winter weather regions to swamp areas to underwater locations, all while passing through regions with a delicate political climate and sophisticated security protocols.
It necessitates clear, effective, and pointed organizational strategy, as well as special attention. A solid people and material transportation setup is required for successful operations. A significant portion of the complexity in the oil and gas sector is the logistics of moving people and goods on time and in accordance with work schedules and premises data by local governments [25].
Key Challenges: Less usage of the application under difficult conditions, Integration of applications with safety standards, Information, and process-related things simplification and synergies are required.
Solution's Highlights-iLogistics software enables better business process analysis and interaction between different departments. Travel process automation and end-to-end visibility have reduced personnel costs. The iLogistics fuel management module now allows you to monitor the amount of fuel left in each storage unit, making it much easier to plan for refueling requests. The use of camps and PSDs automobiles has greatly improved. Because of the increased visibility of these metrics; empty rooms must be assigned in order to improve room/camp utilization.

5. SWOT ANALYSIS :

Albert Humphrey created the SWOT analysis in the 1960s, and it is still useful today. It is a simple instrument for assessing businesses, locations, competitors, or oneself. The SWOT analysis technique is used by businesses to evaluate their opportunities, weaknesses, threats, and strengths. SWOT strengths highlight the firm's areas of success. Weaknesses are elements that need to be improved because they are not working properly (Frederick D. P. et al (2021). [26]). Based on the company's current abilities and constraints, opportunities are generated to strengthen its competitive position. SWOC is a four-box strategy analysis and development framework that has been around for decades and is one of the most widely used tools in modern times. It is used by most business organizations, commerce, industry, etc., in higher education as a curriculum of business studies and strategy training courses (Frederick D. P. et al (2022). [27]).

5.1 Strengths:

- The capacity to complete tasks on time and on budget.
- Mature project management capabilities.
- Strong product development pipeline.
- Excellent customer service.
- An innovative marketing approach.

5.2 Weaknesses:

- Substantial expenditures on research and development
- Only concentrate on product-based services.
- Specific industry-oriented product development
- Private limited companies have some restrictions on overseas investment.

5.3 Opportunities:

- 25 years of experience in the aviation software industry.
- Expertise in SaaS applications.
- Fast and scalable partner integration.
- Affordable maintenance cost.

5.4 Threats:

- Competition: The Company is concerned about fierce competition from major IT firms like GE, Wipro, and Honeywell. Mature project management capabilities.
- Cyber security-related attacks on Software as Service (SaaS) applications excellent customer service.
- Worldwide migration of skilled software development person’s.
- This industry is also affected by Covid -like catastrophes.

6. CORPORATE SOCIAL RESPONSIBILITY :

IBS Software's Corporate Social Responsibility (CSR) programs shape the company and its employees to maintain a commitment to society and the areas where they live and work. In addition to financial resources, the company contributes time and expertise to the successful implementation of management. IBSians strive to create the most productive ecosystem possible, guided by the company's fundamental principles of Dedication, Authenticity, Enthusiasm, Accuracy, and respect for each other. And they do it lovingly and with attention. IBS Software's CSR section is appropriately referred to as Candle, which stands for Care and Love. They think that society's youth holds the key to its destiny and the entire planet's future. Their main focus in assisting underprivileged children develop into grownups is to provide them with the best education, medical services, and a comfortable life. In addition to meaningfully contributing to children's future growth, they also take care of women's/mothers’ healthcare and livelihood so that they can effectively contribute to their child's development and well-being. Beyond business objectives, Candle aspires to create a safe environment that encourages innovation and promotes inclusive expansion and growth.

7. RECRUITMENT STRATEGY & TRAINING STRATEGY :

IBS employs a strategic approach to choosing a candidate in order to enhance their abilities and knowledge. IBS recruitment and selection is an element of talent development, which includes activities such as screening, conducting interviews, sourcing, selecting, assessing, and hiring. According to data from December 2018, IBS currently employs over 3000 people. To accomplish its objective, the company needs skilled and qualified employees [28].

Recruitment Methods Used IBS:

Stage 1: *Written Aptitude Test*-The first round of the IBS recruitment process is an online written aptitude test on the company's developed platform. The test followed the standard ERP-based system, with sections such as verbal evaluation, measurement process, logical reasoning, and finally a test section based on the subject matter of the candidate. This section included questions based on the candidate's chosen areas of expertise's core subjects.

Stage 2: *Group Discussion*-In the second round, students who cleared the first round were divided into groups of eight, and a group discussion was held with an HR facilitator. Before the group discussion, the topics were randomly chosen from the web. When an applicant spoke, the facilitator marked the score, and three or four candidates were chosen from each team to be promoted to the next phase. Subject-specific knowledge is essential at this point [29].

Stage 3: *Technical Interview*- The IBS technical interview will last approximately 20 minutes. The questionnaire concentrates on projects completed by candidates during their final course period and goes into great detail about them. They may also verify the candidate's technical skills. This stage is easily overcome with in-depth knowledge of computer languages.

Stage 4: *HR Interview*-During HR discussions, questions about self-introduction, accreditations, reasons for interest in IBS, and plans for the future will be asked. Human resources staff will provide all information regarding the organization's rules and regulations. The candidate can address payment inquiries, leave policies, grace periods, employment locations, and project working details (Bharathi et al. (2022) [30]).

8. CONCLUSION :

IBS Software handles mission-critical processes for clients in the air transport, tour and catamaran industries, and hotel management. IBS Software is a premier supplier of SaaS solutions to the global tourism sector. IBS' aerospace solutions cover ships and crew operations, airplane repair, passenger services, rewards programs, staff trips, and air cargo management [31]. IBS also handles a real-time B2B and B2C distribution platform that provides access to hotel room availability, prices, and stock to a global network of hospitality industries and channels. In this model a circular economy is used, an economic model that aims to decouple economic growth from resource consumption and environmental degradation. (Aithal S. et al. (2023) [32]). IBS provides a comprehensive customer-centric digital platform for the tour and cruise industry sectors, including both onshore and on-board solutions. IBS also offers transportation facilities in the natural resource and energy sectors. Different analysis techniques like ABCD, PEST, and Six thinking methods are also possible for this study (Aithal, P. S. (2017). [33]. IBS Software conducts business in 12 locations around the world. Air Canada, British Airways, Ethihad, Emirates, Singapore airlines are the top clients of the IBS Software's in Aviation sector. In travel and tourism sector multinational players Royal Caribbean, MSC Cruises are also use IBS software’s products.

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Riding the Third-Party Wave - An Empirical Study on How Online Sellers Propel E-Retailers' Growth

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Subject Area: Business Management.
Type of the Paper: Content Analysis.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10441039
Google Scholar Citation: IJAEML

How to Cite this Paper:
Megha & Ganesha, H. R. (2023). Riding the Third-Party Wave - An Empirical Study on How Online Sellers Propel E-Retailers' Growth. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 278-290. DOI: https://doi.org/10.5281/zenodo.10441039

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0204

Received on: 07/12/2023
Published on: 30/12/2023

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ABSTRACT

Purpose: *The e-retail landscape, once dominated by monolithic brands, has undergone a vibrant transformation. At the heart of this shift lies a potent force: online sellers. These enterprising individuals and small businesses have become the lifeblood of online retail, injecting it with diversity, dynamism, and customer focus that traditional models often lack. This study aims to determine the importance of such online sellers concerning e-retailers in India.*

Design/Methodology/Approach: *The interpretivism approach is used to reach the research objective and derive conclusions without bias through content analysis.*

Finding/Result: *The significant growth of online sellers has contributed majority of sales for e-retailers. E-retailers have completely shifted over making their platform a marketplace with opportunities to grow wider.*

Originality/Value: *Various researchers trying to find out the changes in the retailing sector and the economic growth of e-retailers, this paper focuses on identifying whether online sellers are genuinely important to online retailers.*

Paper Type: *Content analysis.*

Keywords: E-retail, Online Sellers, Third-party brands, External brands; Content analysis

1. INTRODUCTION :

Online retailing has fundamentally transformed the retail landscape, forever altering how consumers shop and businesses operate. Strolling through a virtual mall, overflowing with endless aisles and curated storefronts, all accessible from the comfort of a customer's couch is the magic of e-retail, a phenomenon that has transformed the way we shop, blurring the lines between physical and digital spaces. For centuries, the physical store defined the shopping experience, but with the rise of e-retail, a digital revolution has swept through the retail landscape. Brick-and-mortar stores now face a formidable challenge: adapt or fade away. The rise of "clicks and bricks" strategies, where online and offline seamlessly blend to create a dynamic and personalized shopping experience for the modern consumer. In the blink of an eye, brick-and-mortar stores have morphed into digital storefronts and consumers who traded with cash switched over to checkout buttons. This is the story of e-retail, a revolution that transformed the way we shop, sell, and think about commerce. Today, we live with an evolving landscape, exploring its origins, drivers, and the challenges and opportunities it presents.

1.1. Evolution of Online Retail:

The way we shop has undergone a revolution in the past few decades, moving from brick-and-mortar stores to the boundless horizons of the Internet. Online retail has transformed how businesses operate and consumers purchase goods, creating a dynamic and ever-evolving landscape.

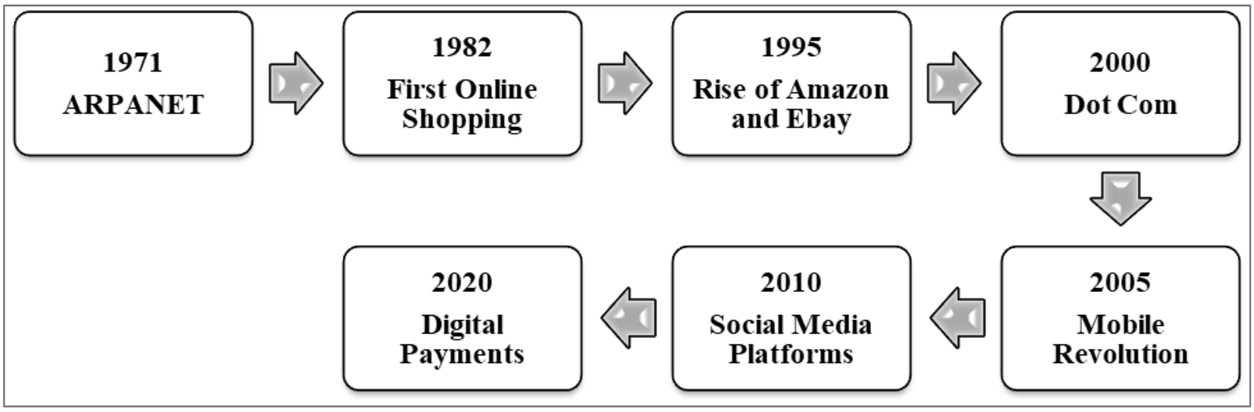

Fig. 1: Timeline of evolution for E-Retail (*Source*: Wikipedia [1])

i. **1971: The Seeds are Sown**

The very first seeds of online retail were sown in 1971, with the creation of ARPANET, the precursor to the modern internet. While not initially intended for commercial purposes, ARPANET laid the groundwork for the digital communication infrastructure that would one- day power e-commerce.

ii. **1982: The Dawn of Online Transactions**

Fast forward to 1982, and we witness the birth of the first online transaction. Michael Aldrich, a British inventor, used an adapted television and secure data transmission to place an order for pizza, marking a historic moment in the evolution of online shopping.

iii. **1995: The Rise of E-Commerce Giants**

The year 1995 saw the emergence of two e-commerce giants that would forever change the retail landscape: Amazon and eBay. Amazon started as an online bookseller, while eBay focused on online auctions, both pioneering new models for online commerce and paving the way for the proliferation of e-commerce businesses.

iv. **2000: The Dot-Com Bubble Bursts**

The late 1990s witnessed a surge in online businesses, many fueled by speculation and unrealistic expectations. The dot-com bubble burst in 2000, leading to the collapse of numerous e-commerce companies. However, it also served as a necessary correction, weeding out unsustainable businesses and strengthening the foundation for future growth.

v. **2005: The Mobile Revolution**

The introduction of the iPhone in 2007 marked a turning point in e-commerce. Mobile devices revolutionized the way we shop, making online experiences more accessible and convenient than ever before. M-commerce (mobile commerce) boomed, and businesses scrambled to adapt their websites and apps for smaller screens.

vi. **2010s: The Age of Personalization and Social Commerce**

The 2010s saw a focus on personalization and social commerce. E-commerce platforms leveraged big data and AI to provide tailored recommendations and product suggestions, while social media platforms like Facebook and Instagram became powerful tools for driving traffic and sales.

vii. **2020s: The Future**

As we navigate the 2020s, the digital era continues to evolve at a rapid pace with 2 billion digital payment transactions in India itself. Emerging technologies like augmented reality and virtual reality are reshaping the shopping experience for consumers. (Wikipedia [1]).

1.2. Online Sales and its Sellers:

Online sales have become an essential aspect of the modern retail landscape, offering a multitude of benefits for both businesses and consumers. Online marketplaces have become a platform for various sellers to carry out their business with ease. Online marketplaces thrive on a delicate balance between buyers and sellers. While buyers enjoy the convenience and vast selection, sellers are the crucial driving force that makes it all possible.

Types of sellers in online marketplace:

a) First Party Sellers
b) Second Party Sellers
c) Third Party Sellers

If the products are directly sold from brands to e-marketplaces like Amazon, eBay, Walmart, etc., and stored in their warehouse for further resale is called first-party sales. The customers recognize the value of the product and buy it from e-marketplaces; thus, they keep restocking the products based on need. People buy the products from the highlighted information of the e-marketplace (Feed Visor [2]). To be a first-party seller an e-marketplace must send a purchase order and the seller has to accept the order by fulfilling the requirements. E-marketplace will hold the right to charge additional fees for advertising and other chargebacks. First-party sellers in Amazon will get their access as vendors and transact in the vendor central portal which facilitates business between Amazon and First Party Sellers. Every product sold through the first party will have a "Ships from and sold by Amazon.com" clause in the product description. The products sold under a second party would have an FBA (Fulfilled by Amazon) clause in the product description. There is full control towards branding but the marketplace would charge for their sales (Geek Seller [3]). The products sold from third parties (online sellers) would be FBM (Fulfilled by Merchant) and would have "ships and sold from" clause in their product description. The sellers here own their products and use e-marketplace as the platform to engage their business. Amazon provides a platform for creating and displaying product pages and monitoring inventory levels through the "Seller Central" platform (Feed visor [2]).

In a short period, the E-retail format in India reached around 3% of the overall Indian retail market (GHR, et al. (2020) [4]). The growth rate is more than double as compared to the brick-and-mortar stores. It has been noted that the majority of contributions from E-retailers are coming from online sellers and private labels in India. Continued internet and smartphone penetration, increasing disposable income, and evolving trends will fuel further growth of e-retail. Online sales and online sellers will continue with better strategies to fulfill the needs of their customers in the future. Online sellers are not just independent businesses on e-commerce platforms; they are the lifeblood of the industry. Their contributions will create a dynamic and diverse marketplace, drive innovation, and cater to the ever-evolving needs of consumers. As e-retail continues to flourish, the role of online sellers will only become more prominent and vital in shaping the future of retail.

As per Statista, Global retail sales see an up growth in the retail sector. With the global internet penetration rate surpassing 60% in 2023, more and more people have access to online shopping platforms than ever before. This wider reach has opened up vast new markets for e-retailers, particularly in developing countries where internet access is rapidly expanding. Data projection is seen to amount to around 32.8 trillion U.S. dollars by 2026, up from approximately 26.4 trillion U.S. dollars in 2021. The growth of retail at the global level is completely based on the product dimension and the customer's approach towards E-retail (Statista [5]).

2. LITERATURE REVIEW :

The evolution of retail has taken shape from Mom-and-Pop Stores 1700s-1800s, departmental stores in mid 1800s to 1900s, Cha Ching 1883 being the very first cash register machine and credit holds to customers in the 1920s and Big Box format like Walmart stores in the 1960s and E-commerce blooming in 1900s embarks the success of retail in its evolution. E-commerce became operational in B2B, B2C, B2G and C2C. The social-media has created more opportunities for sellers to reach out to customers. Facebook has more than 60 million active business pages operational (Big Commerce [6]). In the generation of touch and click, the internet has become a game changer to the present day. Searching for information, locating places, studying online, and shopping online has become one of the most common daily life patterns for an individual. Peter J. P., et al. (2002) [7] stated that what is the need of simply going and waiting in long queues when you can get your products delivered to your doorstep with a small touch and click shopping experience is the fundamental policy practiced by every working individual.

The busy work schedule has made the usage of the internet and technology to meet their daily needs in the simplest manner possible. Without the e-retailers who sold goods and services online, online shopping and a comfortable lifestyle would not have been possible. The largest private sector and the final stage of economic activity is retailing. The latest and the most recent form of retailing i.e., online retailing has created a transition in the business model (Mishra, et al. (2014) [8]). The global economic scenario points that the main fuel for the growth of retailing in developing markets are countries like Brazil, Russia, India, and China and it is because of the rising household income and disposable income with the spending mentality of the consumers (Grewal, et al. (2014) [9]). The population of these countries is relatively large which helps in getting a larger customer base at the global level (Youarticle Library [10]).

Studies have proven that the customer preference of choosing a particular retail format would be subject to changes in economic condition, consumer demographics, physical effort to buy, and perceived total cost of buying (Mishra, et al. (2014) [8]. The pre-emergence of online retail End of Season Sales (EOSS) was the shopping spree time but with the post-emergence of online retail; discounting has become a major factor in converting walk-ins into bills in brick-and-mortar stores. Empirical Data shows that with the post-emergence of online retail stores consumers' perceptions towards discount retailers are making 4.249 times less profit than pre-online emergence (GHR, et al. (2020) [11]).

Understanding consumer behavior is a challenge to retailers as their expectations and buying patterns vary from one individual to another. However, consumers have exhibited a positive attitude towards online shopping irrespective of the various risks that have incurred in the shopping experience (Naiyi, et al. (2014) [12]). From the seven factors as the dimensions of consumer’s perceived risk in China’s Internet shopping context, factor one is e-store source risk, factor two is delivery risk; factor three is financial risk; factor four is a purchasing process and time loss risk; factor five is product performance risk; factor six is privacy risk; and the factor seven is asymmetric information risk. Irrespective of various risks the attitude of buying towards online sellers is growly daily (Md Ariff, et al. (2014) [13]).

In A.T. Kearney's 2012 E-Commerce Index examination of the top 30 countries, India ranked 5th in the 2012 Global Retail Development Index™ (GRDI). In 2021, India successfully moved to 2nd place which proves the growth of the Indian retail industry at the global level [14]. Technological advances play a huge role in the growth of online retail in India. Due to the increasing accessibility of smartphones and gadgets and with the good internet connection the shopping experience has become much smoother and easier for the customers. The Foreign Direct Investments and development of brands like IKEA, Liberty Shoes, Walmart Stores, Flipkart & Myntra, and Amazon have been strong pillars of growth for Indian Retail. Online Retailing in India has taken a wavelength due to the shopping experiences offered by Amazon, Flipkart, and Myntra. The ease of shopping, payment modes, and return facilities have become simpler thus creating a larger customer base in India (Nair., et al. (2019) [15-16]). Hari, et al. (2019) [17] in their study found that in a short period e-commerce retailing format in India has reached around 3 percent of the overall Indian retail market. The growth rate is more than double as compared to the brick-and-mortar stores. Online shopping has offered 365 days of discounts, deals, and low-price strategies which are attracting customers even more. As of the 2021 report, there are 1.2 million e-commerce transactions daily. The acceptance of online selling in India has increased with the emergence of new technologies that are facilitating operations and youths are one of the major driving forces for the sales of e-retailers [18]. Effective use of new marketing channels promotes as a determinant for the success of online retail. Digital media has helped the customer by providing product information relating to size, color, model, and price, and how to place an order via telephone and WhatsApp. Posts on social media also can get better customer attention as proved by Hamdan, Y., et al. (2019) [19]. Social media and digital marketing have created a huge influence on consumers in making their purchase decisions. Direct purchase links provided by social media marketing have enabled an easier shopping experience. The purchase reviews posted in the online selling portal have created a reliable source of product experience It has also proven a positive relationship between platform-based service usage volume and seller performance. The more heterogeneous label of platform-based services is undertaken; the better will be the performance of the seller.

Online sales have boosted over the years creating tough competition for Brick-and-Mortar retailers. Customers enjoy many privileges such as convenient shopping, discounts and flash sales, redemption of purchase points, easier returns, and quick customer support services leading them more towards online shopping behavior and thus creating value acts as an important part of the retail chain. India has witnessed two waves of evolution in e-commerce. The first wave had a roller coaster ride with problems like low internet penetration, and a menial online shopper base leading to more than 1,000 online sellers crumpling down. But during the second wave, online sales have dominated e-commerce catching up more customers online and nearly 50% share of business (Kaila, et al. (2017) [20]). After the advent Covid -19 it created a massive shock to all businesses. However online sales were encouraged and it led to a new e-commerce format D2C (Direct to customer). Online sellers increased as it reduced the risk of operations with less expenditures and increased opportunities with larger customer acceptance (Shetty, et al. (2020) [21]).

3. OBJECTIVE :

Online sellers have become rising stars of e-retail. Online sellers are those who want to establish their business in a larger marketplace and reach maximum customers. Understanding the rise and impact of online sellers can help us to get insights crucial for both businesses and consumers navigating the ever-evolving e-retail landscape. Consumers, on the other hand, have found a new lens through which they view their online shopping experiences, recognizing the value and unique offerings brought by these passionate independent sellers. Ultimately, studying online sellers empowers both sides of the equation, and finding out whether online sellers are really important to online retailers.

4. METHODOLOGY :

The Interpretivism Approach is more suitable for this research as it would provide rich, in-depth insights on the subject that can be used to develop better theories and enhance our understanding of complex human experiences and interactions. Interpretivism forces more on people’s thoughts and ideas which will help in getting a better interpretation of the subject area. This approach will be able to give satisfactory answers to the research questions using observable and measurable facts. The importance of online sellers can be studied using the interpretivism approach as it will be focused on the thoughts and ideas of the other person which will give a new understanding (GHR, et al. (2020) [22]).

The inductive approach is chosen for the study as it is the most appropriate to construct a new theory while establishing the relationship between the dependent and independent variables of the study. The inductive approach will help to raise questions that need to be studied during the research process. The inductive approach would help to find the cause and effect of the variables in another dimension with reliable facts collected. From the collected data it helps to bring new findings and theories. The study can help us to understand the role of online sellers in the retail industry and make them important or non-important (GHR, et al. (2020) [23]).

The Mono method is preferred to understand the need and level of importance of Online Sellers. The best way to find answers to the questions is by archival study. The archival method is based on the facts and data collected by the researchers over a while. The study aims to understand the level of importance of online sellers and the parameters associated with them. The major aim of the study is to explore and find out whether online sellers are genuinely important to consumers and the e-commerce platform. For such a descriptive study choosing the mono method will give better results with high reliability (GHR, et al. (2020) [24]).

The study prefers to choose a cross-sectional time frame as trying to understand the need of the object with the subject requires a minimal amount of time. Understanding the importance of online sellers with the interpretive approach requires studying and analyzing the responses of various participants within a given period. The choice and preference of consumers or any stakeholder with different demographical features in the given time will help to understand the variables and factors associated. Collecting responses from the same group of people or different groups at a given interval of time can help to obtain information on our research question with better clarity (GHR, et al. (2020) [25]).

Content Analysis is the statistical technique used for the analysis of the data collected. Content analysis helps categorize the given data in different observation and criteria matrices which can answer all possible questions. Content analysis also can give rise to new findings and reduce bias in the results. This study simply aims to understand what makes the online seller important. The data collected through various sources for a given timeframe will help to organize the importance level into various parameters with different criteria (GHR, et al. (2020) [26]).

5. FINDINGS, RESULTS, AND ANALYSIS :

5.1. Online Retail - Indian Scenario:

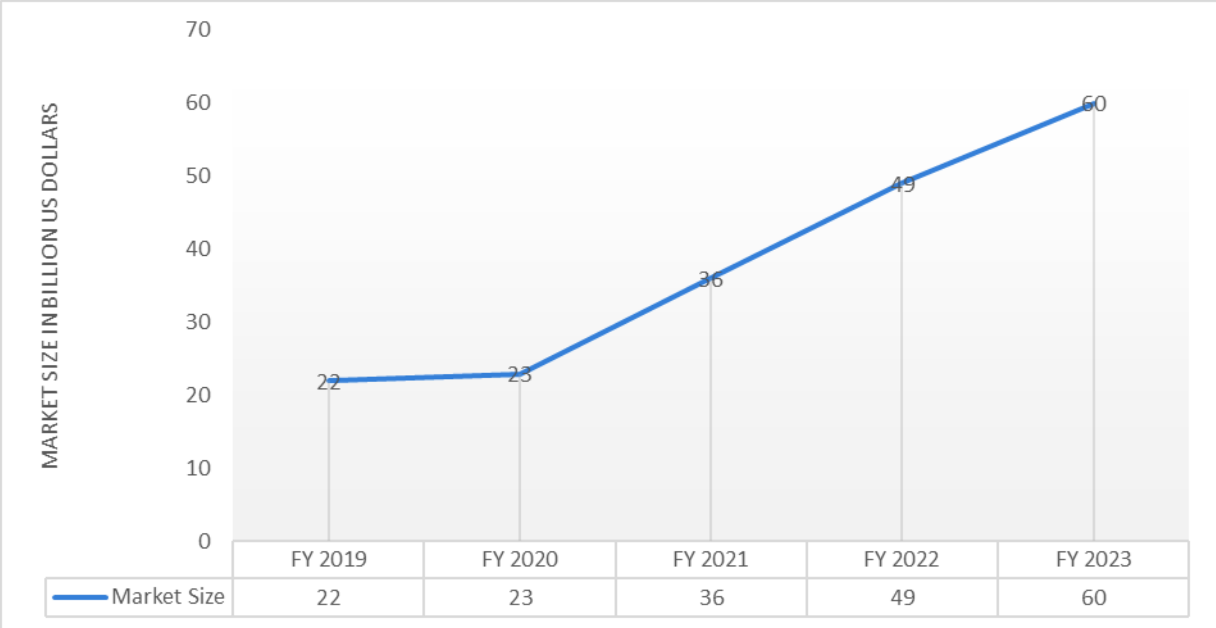

Fig. 2: Market size of the online retail industry across India from the financial year 2019 to 2023 (Statista 2023 [28])

The first wave of e-commerce hit India between 2000-2005 which was characterized by a small online shopping user base and with low internet penetration, slow internet speed, and a very small customer group. Retailing in developing countries like India started much later when the developed countries already reached their maturity stage (Mohanty. et al. (2015) [27]). Online retail is poised to become the dominant retail channel in India, potentially surpassing traditional stores. India has a vibrant startup ecosystem fueling innovation in e-commerce, with players like Nykaa in beauty and Amazon in general merchandise carving niches. Government initiatives like Digital India and Startup India aim to create a conducive environment for online businesses. The market size of e-commerce is estimated to reach 200 billion US Dollars by 2027 (Statista [28]).

The number of digital buyers in the country has been increasing ever since 2014. Affordable mobile internet by Reliance's Jio has contributed to the drastic growth of e-commerce since 2020. The Covid-19 pandemic also led to an increase in customers' perception of online shopping to follow social distancing increasing the online market size. (Statista [28]).

5.2. Top 10 e-Marketplaces of India:

In the last two decades, there has been widespread use of e-commerce platforms like Amazon and eBay which gave a substantial growth for online retail. According to the US Census Bureau, e-commerce accounted for 5% of total retail sales but after the Covid-19 pandemic, it had risen over to 16% of the total retail sales (Tech Target [29]). India is one of the fastest-growing and most popular e-commerce markets in the world which offers a diverse and dynamic landscape for online sellers, with many opportunities and challenges.

Table 1: Top 10 E-marketplaces of India (Tailize[30]).

e-Marketplaces	Type of products	Average Customer Visit per month	Features	Commission fee charged for online sellers
Amazon	Electronics Fashion Books Home & Kitchen Health & Beauty	295 million	Fulfillment by Amazon Amazon Prime Amazon Advertising Amazon Seller Central	Rs.499 + Referral Fees+ Closing fees based on product category
Flipkart	Electronics Fashion Books Home & Kitchen Health & Beauty	167 million	Flipkart Fulfilment Flipkart Smart buy Flipkart Ads Flipkart Seller Hub	5% -25% based on product category
Myntra	Fashion	40 million	Myntra Logistics Myntra Studio Myntra Insider Myntra Seller Portal	4% to 5% based on product category
Snapdeal	Electronics Fashion Home & Kitchen Health & Beauty Sports and Fitness	15 million	Snapdeal Fulfilment Snapdeal Gold Snapdeal Ads Snapdeal Seller Zone	3% to 25% based on product category
Shopclues	Electronics Fashion Home & Kitchen Health & Beauty	100 million	Shopclues Surety Shopclues VIP Club Shopclues Ads Shopclues Merchant	2% -20% based on product category
Pepperfry	Furniture	5 million	Pepperfry Studio Pepperfry Gift Registry Pepperfry Privilege Seller Dashboard	10% -25% based on product category
Facebook Marketplace	Electronics Fashion Books Home & Kitchen	800 million	Facebook Shops FB Live Shopping Facebook Pay Facebook Business Suite	Nill
Etsy	Handmade Vintage products	81 million	Etsy Ads Etsy Payments Etsy Teams Etsy Seller Handbook	Listing Fee- $0.20 Transaction Fee-5% Payment processing fee of 3% + $0.25 per order.
Meesho	Electronics Fashion Home & Kitchen Health & Beauty	120 million	Meesho Supply Meesho Academy Meesho Payments Meesho Community	5% -15% based on product category
Lime Road	Fashion Home Decor	25 million	Limeroad Scrapbook Limeroad Stories Limeroad Seller App Limeroad Seller Support	15% -25% based on product category

Worldwide, total retail e-commerce sales have increased gradually and are moving towards making online platforms as marketplace mode to make use of the incremental opportunity for income. Online retailers who initially operated as resellers are moving towards a 'marketplace mode' by allowing third-party sellers to transact directly with customers. E-marketplaces have started offering various features to online sellers by charging a commission fee based on the product category which in turn is also a source of income for e-marketplaces.

5.3. Amazon India:

Table 2: Amazon revenue breakdown by segment in billion USD (Amazon Company Data [31])

Year	Online Stores	Physical Stores	Third-party Retail	Subscription services	AWS	Advertising	Other
2014	68.50	-	11.70	2.70	4.60	-	1.30
2015	76.80	-	16.00	4.40	7.80	-	1.70
2016	91.40	-	22.90	6.30	12.20	-	2.90
2017	108.30	5.80	31.80	9.70	17.40	-	4.60
2018	122.90	17.20	42.70	14.10	25.60	-	10.10
2019	141.20	17.10	53.70	19.20	35.00	-	14.00
2020	197.20	16.20	80.40	25.20	45.30	15.50	5.90
2021	222.00	17.00	103.30	31.70	62.20	31.10	3.40
2022	220.00	18.90	117.70	35.20	80.00	37.70	4.20

Amazon is the first largest e-commerce operator in India and third largest by revenue in the world, behind Walmart and China's State Grid. Amazon was launched in 2013 and has 295 million visits per month making it the most popular and trusted online platform for purchase by its customers. Amazon offers products from various categories and has features like Fulfillment by Amazon, Seller Central, Amazon advertising, and Amazon Prime. It charges subscription fees for its sellers based on the product category. Amazon's revenue increased by 9.1% in 2022 to $513 billion.

By charging a commission fee of an average of 10%-15% e-retailers are gaining economically and encouraging more third-party sales in their platform. This is evident from the fact increase in the share of paid units sold by the Amazon platform from the 2nd quarter of 2007 to the 3rd quarter of 2023 (Figure 3). The success of e-marketplaces grew to a higher extent due to the presence of online sellers who use these platforms to reach out to a larger pool of potential buyers.

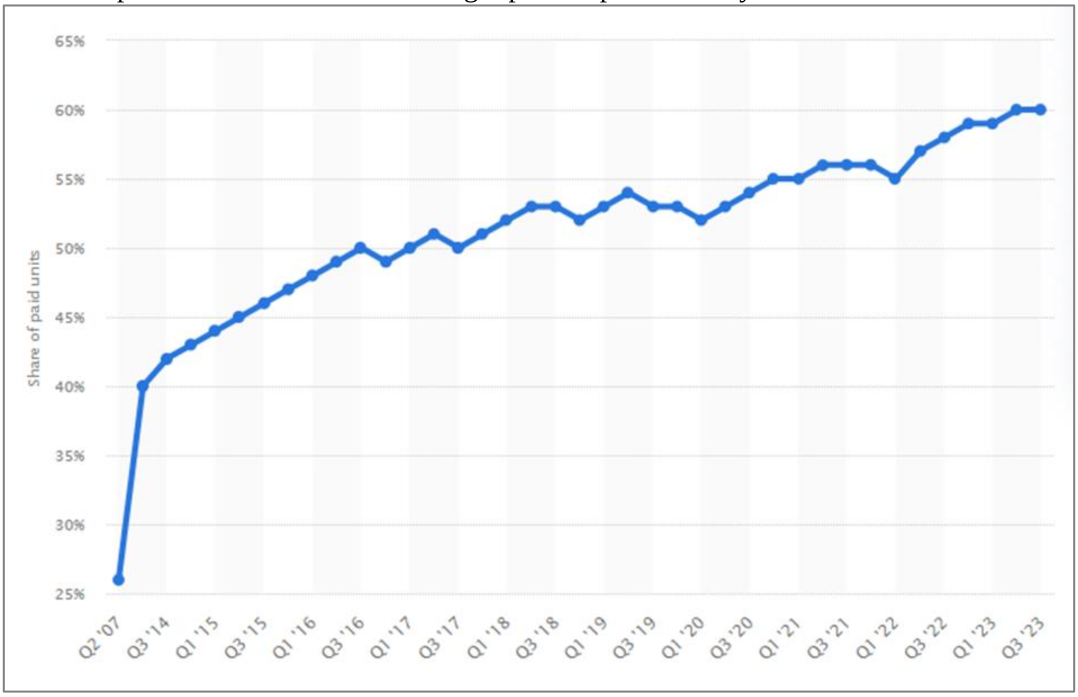

Fig. 3: Share of paid units sold by third-party sellers on the Amazon platform from 2nd quarter 2007 to 3rd quarter 2023 (Statista [32]).

Table 3: Category-wise sales of Amazon in the year 2020 in India

Category	First party % of Total Sales	Private Brand % of First Party	Third party % of Total Sales
Consumer Electronics	43%	3%	57%
Beauty	35%	<1%	65%
Home and Kitchen	33%	4%	67%
Softlines	28%	9%	72%
Books	74%	<1%	26%
Consumables	41%	2%	59%
Toys	42%	<1%	58%

Amazon's majority of revenue comes from e-commerce; Amazon is a first-party and third-party reseller, alongside providing subscription services and owning Whole Foods. The above table shows the growth of online stores on a large scale generating better revenue and improving the financial performance year by year. Third-party sales have been seen to spike up from 2017 to 2022 reaching out to 117.70 USD contributing to the majority of the financial performance of Amazon (Business of Apps: Amazon Statistics [31]).

Categories like consumer electronics, beauty, home and kitchen, soft lines, and toys have better sales contributions from third-party sellers when compared to first-party and private labels. Third-party (online sellers have) proved to be a significant contributor to e-retail (Table 3). Third-party sellers have a wide range of products with different specifications as required by customers. Technically they work on fulfilling the current demand and personalized choices of customers making them gain more popularity.

5.4. Contribution of Online Sellers to various E-retail Marketplaces:

Online Sellers in Myntra contribute 75% of the total revenue (Financial Express [33]), 74% by online sellers of Flipkart (Inc42 [34]), and 60% of Amazon (Pattern [35]).

Table 4: Contribution of Online sellers to various e-retailers

E-retail Marketplace (a)	Contribution to Sales by First Party & Private Labels (%) (b)	Contribution to sales by Online Sellers (%) (c) = 100 - (b)
Myntra	35%	75%
Amazon	40%	60%
Limeroad	10%	90%
Pepperfry	50%	50%
Nykaa	50%	50%
Zivame	60%	40%

The contributions of online sellers are contributing positively to the revenue of E-retailers. What attracts customers towards online shopping is discounts, which is the most efficient key factor utilized for generating higher sales by E-retailers in India it has created a strong impact on purchases and is one of the key consumers' buying decision-making factors.

6. CONCLUSION :

E-retail platforms are not just marketplaces; they are communities. Online sellers are the heart of these communities, building personal connections with consumers through their unique stories and brand values. They engage in direct conversations, offer personalized recommendations, and build loyal followings. This human touch fosters trust and loyalty, transforming faceless transactions into meaningful interactions.

Online sellers are not just merchants; they are value champions. Their entrepreneurial spirit fuels fierce competition, driving down prices and offering enticing deals. This price competitiveness benefits consumers directly, putting the power of affordability at their fingertips. Moreover, many of these sellers specialize in refurbished or pre-owned goods, breathing new life into products and making them accessible to budget-conscious shoppers. This focus on value creation fosters a sustainable ecosystem, reducing waste and promoting responsible consumption. Beyond the aisles of discounted products, online sellers are fertile ground for innovation. Unburdened by the constraints of large corporations, they are nimble and quick to adapt, experimenting with new products, testing unconventional marketing strategies, and pushing the boundaries of customer service. This constant churn of ideas of online sellers keeps the e-commerce landscape dynamic, infusing it with fresh energy and paving the way for the next big trend.

If an e-retail platform existed without online sellers, the store platform would be bare, echoing the monotony of a single brand's voice. Online sellers shatter this uniformity, bringing a symphony of selection from niche handcrafted goods and they introduce a kaleidoscope of options, catering to every consumer. This diversity not only keeps consumers engaged but also fosters a sense of discovery, transforming online shopping into a treasure hunt. Online sellers are like a constant stream of fresh ideas. They're not bound by the same rules as big companies, so they're always experimenting and pushing the boundaries. This means new products, new trends, and new ways to shop – keeping e-commerce fresh and exciting.
The study has shown significant contributions of online sellers to e-retailers marking them as strong pillars for their growth. The financial performance of online retailers has grown positively along with an increase in its market size which is beneficial to e-retailers. The majority of the e-retailers have turned themselves into marketplaces to allow the entry of online sellers which in turn benefits them economically by commission fees and large number of sales. Customers get more choices, platforms earn commission on sales, and small businesses get a boost. It's a healthy ecosystem that keeps everyone happy and the e-commerce world buzzing with excitement.

7. SUGGESTIONS :

Despite the significant contributions of online sellers towards e-retailers they are forced with the burden of commission and other fees which is based on product category. The commission fees would be sometimes equal to the margin that they would have tried to achieve. When the seller is imposed with such a burden that would demotivate him shortly in achieving better sales. However, it cannot be avoided because e-retailers are providing a platform for business, and revenue in return is expected. Suggestions from the researcher are that there should be a better framework for charging commission fees to online sellers. This can create a win-win situation for both the online sellers and online retailers.

8. LIMITATIONS OF THE STUDY :

The study has shown the significant contributions of online sellers to online retailers. However, the factors behind the sales and financial performance are still not known. Another limitation of the study is that it is content analysis based on the summaries published by the respective e-retailers. The third limitation of the study could be that it focused only on generalized data from other online retailers and the majority on Amazon.

9. SCOPE FOR FURTHER RESEARCH :

It is recommended that this research can further be extended to understand the financial performance of online sellers. The study also can be broadened to understand which of the key factors is impacting better sales and optimizing the financial performance of online sellers in e-retailing.

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The Significance and Influence of Human Resource Management (HRM) on Enterprise Performance in the Manufacturing Sector: An In-Depth Analysis of Enterprise Performance Management (EPM) Impacts

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Subject Area: Business Management.
Type of the Paper: Conceptual Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10451919
Google Scholar Citation: IJAEML

How to Cite this Paper:
Radha, P. & Aithal, P. S. (2023). The Significance and Influence of Human Resource Management (HRM) on Enterprise Performance in the Manufacturing Sector: An In-Depth Analysis of Enterprise Performance Management (EPM) Impacts. *International Journal of Applied Engineering and Management Letters (IJAEML), 7*(4), 291-299. DOI: https://doi.org/10.5281/zenodo.10451919

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0205

Received on: 12/12/2023
Published on: 30/12/2023

International Journal of Applied Engineering and Management Letters (IJAEML), ISSN: 2581-7000, Vol. 7, No. 4, December 2023

SRINIVAS PUBLICATION

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ABSTRACT

Purpose: *Manufacturing industry in India is one of the largest sectors and its continuously attaining growth and development. As focused by the NMCC (National Manufacturing Competitiveness Council, it is put to contribute 25% to the GDP by the year 2025 compared to the recent share of almost 16%. Particularly, the industry contributed 66% to the exports of the nation in FY11 and has been reinforcing at a CAGR of 20% in the past five years. Manufacturing holds a major position in the economy of the country, India, reporting for almost 16% of actual GDP in FY12 and employing nearly 12% of the labour force of India. The growth and development in the industry has been matching a very strong rate in the whole growth and development of the GDP in the past few years (India Brand Equity Foundation, n.d).At present, India is the biggest producer of chemical products, basic metals, textiles, pharmaceuticals, electrical machinery and general machinery and equipment.*

Design: *This research adopted the conceptual research by using a descriptive research design. Secondary data has been collected and analyzed to find out the factors affecting the manufacturing.*

industry. This will help them to cope with the work environment and to effectively handle different situations.

Findings: *The findings from studies on Leveraging a comprehensive exploration, the study delves into the profound impact of Human Resource Management (HRM) on Enterprise Performance in the Manufacturing Sector. Findings illuminate HRM's pivotal role in shaping Enterprise Performance Management (EPM), demonstrating a direct correlation between strategic HR practices and heightened organizational effectiveness. The research underscores the nuanced ways in which HRM practices contribute to enhanced productivity, workforce engagement, and overall operational efficiency within manufacturing enterprises. As organizations align HR strategies with EPM goals, the symbiotic relationship emerges as a critical catalyst for sustained growth and success in the dynamic manufacturing landscape.*

Originality/value: *This study includes a detailed analysis of the Significance and Influence of Human Resource Management (HRM) on Enterprise Performance in the Manufacturing Sector: An In-Depth Analysis of Enterprise Performance Management (EPM) Impacts.*

Paper type: *Conceptual Research.*

Keywords: *Human Resource Management, Enterprise, Performance Management, Manufacturing Industry, EPM, HRM,*

1. INTRODUCTION :

In the realm of enterprises, individuals emerge as the primary drivers of competitive advantage, underscoring the pivotal role of Human Resource Management (HRM) as the powerhouse for Small and Medium Enterprises (SMEs), mitigating challenges and enhancing operational efficiency. In today's landscape, HRM functions, trainings, and processes have become indispensable, particularly in economies prioritizing skills and abilities. This expanding role accentuates the need for specialized expertise in workforce provision and management, not only to fulfill current tasks but also to ensure heightened effectiveness in the manufacturing processes. This not only contributes to the organization's profitability but also elevates the overall quality of life and standards in the manufacturing domain.

Generally, performance management is an essential method of HRM which involves an evaluation of present or earlier outcomes or performance of the workforce, team and team members, entire organization, and industries (Anosh et al (2014). [1]). It is a fundamental process for countless business performances which are all related to human resource management, and it is essential for employees' training and development, recruitment and selection process, career growth, compensation. Many businesses completely depend on enterprise performance management process to compete with and stand ahead in the competition. As performance management process supports workforces to recognize that what accurately is demanded out of them and ensures line managers that workers behaviors would be allied with the objectives of an organization (Gamage et al (2014). [2]).

Enterprise Performance Management (EPM) is a strategic endeavor focused on ensuring that a business or management translates its strategies into measurable indicators and objectives, systematically evaluating the outcomes. This underscores the need for an effective alignment of people within the organization, where key result areas (KRAs) are intricately linked with overarching business goals and objectives. Furthermore, the compensation and recognition system serve as a catalyst, directly or indirectly influencing behaviors that contribute to the overall management strategy (Kumar et al (2011). [3]). This approach establishes the management as a cohesive and efficient system, where each component plays a crucial role in the collective success. There is a noticeable trend in the adoption of EPM principles and methodologies, particularly in the execution of pivotal manufacturing and management processes.

1.1 Theoretical Framework of the Study:

In the dynamic landscape of industry and trade, numerous organizations have experienced substantial advancements in their operations through the strategic implementation of Enterprise Performance Management (EPM) and related applications. Achieving excellence in management necessitates the streamlining, automation, and integration of organizational processes, often facilitated by tailored software solutions (Raziq et al (2011) [4]). EPM methodologies play a pivotal role in optimizing these management processes, encompassing a suite of performance management applications and diverse data sources. EPM, in essence, involves the assessment and analysis of organizational performance with the aim of influencing performance objectives, enhancing efficiency, and refining business procedures. The tangible financial impact of EPM is significant, as it not only gauges the attainment of both common and specific business goals but also yields outcomes that optimize the utilization of all available means and resources. Through the effective implementation of EPM, industries can operate with enhanced efficiency and strategic alignment (Slavic et al (2014). [5]).

Effectively ensuring productivity within s mall or medium enterprises poses a formidable challenge due to the multitude of procedures, units, workforce, and organizational levels. The intricate nature of the managerial structure demands a multilevel approach, necessitating the implementation of various enterprise performance management techniques (Abduli et al (2013). [6]). The overarching goals of employee motivation within this framework, against the backdrop of performance management, include enhancing labour throughput, improving efficiency, reducing material inputs, and advancing energy effectiveness. External effectiveness of the organization, encompassing its specific elements and procedures, provides valuable insights for modest and practical benchmarking. However, achieving a high-level Enterprise Performance Management (EPM) based on diverse benchmarking methods and existing practices requires the development of a robust motivational framework. Without such a structure of drive, endeavours to enhance effectiveness may lack sustainability and long-term viability.

1.2 Statement of the Problem:

The strategic role of Human Resource Management (HRM) practices in fostering the creation, utilization, and augmentation of knowledge is paramount, especially in the knowledge-intensive sectors operating within highly competitive environments. Enterprise Performance Management (EPM), an integral concept within HRM, stands out as a powerful and efficient tool that not only aids enterprises in understanding their strategic goals but also enhances management capacity and operational efficiency (Kumari (2012). [7]). In the realm of organizational processes and systems, the challenge often lies in their fragmented nature. Despite numerous management processes and systems in place, many remain disconnected. Annual budgeting, for instance, involves the use of numerous spreadsheets. To address this, an Enterprise Performance Management system serves as a comprehensive solution, integrating various management processes under one roof, connecting financial and operational activities with transactional systems (Amit et al (1999). [8]).

Modern human resource initiatives and practices play a crucial role, not as isolated entities, but as interconnected components within an internally cohesive HR structure. When these HR systems align with flexible production systems, incorporating team-based work systems, maintenance buffers, and high-commitment human resource practices, they contribute significantly to manufacturing productivity and quality. HRM, by enhancing the capabilities, skills, knowledge, and motivation of employees, becomes a driving force for influencing Enterprise Performance Management positively. This study delves into the intricate details of how human resource management impacts enterprise performance management within the manufacturing industry (Anosh et al (2014). [9]).

1.2 Objectives of the Study:

To investigate the significance of human resource management in the industrial business.
To determine whether Enterprise performance management is required in the manufacturing industry.

1.3 Significance of the research:

The focal point of this study lies in the comprehensive examination of how Human Resource Management (HRM) significantly shapes and influences Enterprise Performance Management (EPM) within the Manufacturing Industry. In addition to unraveling the intricacies of the HRM-EPM relationship, this study sheds light on the pivotal role of HRM specifically within the manufacturing sector (Aithal et al (2023). [10]). It emphasizes the indispensable need for EPM in optimizing performance in this industry. By delving into the intricate dynamics between HRM and EPM, this research aims to provide a nuanced understanding of their interconnectedness. Furthermore, this study is not merely an exploration but serves as a resource for future researchers, inviting new and innovative ideas through a doctrinal research approach. This openness to diverse perspectives enriches the discourse and contributes to the evolving landscape of HRM and EPM research in the manufacturing domain (Buyens et al (2015). [11]).

2. REVIEW OF LITERATURE :

Abdullah, Ahsan and Alam (2009 [12] determined the impact of HRM practices on enterprise performance between various private organizations in Malaysia. The framework of this research has relied on six HRM practices of previous research such as team work, incentives, human resource planning, training and improvement, protection of employees and performance appraisal. Depending upon the findings of this research, four human resource practices were identified to link with the enterprise performance management with excluding of protection of employee and incentives. These outcomes have indicated that these two factors were not probable to affect the overall enterprise performance in Malaysia. The researchers have concluded that all six human resource practices were assisted to enhance the organizations’ business performance including quality of product, flexibility of organizations and worker’s productivity.

Singh and Kassa (2016) [13] studied about the recruitment and human resource practices on the University’s performance. It has been identified that performance of university may be attributed to the practices of HRM including performance appraisal, compensation, recruitment and employee selection, training, and improvement of employee. Depending upon the results, the authors have concluded that efficiency of implementing the human resource practices in university does certainly have a significant impact towards the performance of universities. The results of this research revealed that human resource practices have impact of almost 32.2 % on the performance of university. The regression analysis has shown that three important human resource practices appear to have the greatest influence on the performance of organization like recruitment and employee selection, performance appraisal and compensation.

2.1 Research Gap:

This study examines the evaluation and impact of the human resource management on enterprise performance management in the manufacturing industry. The research gap predicted in this study is that there is only limited study on the enterprise performance management with the human resource management in the manufacturing industry (Datta et al (2003). [14]). The linkage between strategic human resource management, innovation and firm performance. From the above study, it can be evident that there are many studies on human resource management but none of the studies clearly focused on the impact of human resource management on EPM. Therefore, this study tries to bridge the gap between this research by investigating about the impact of human resource management on EPM in the manufacturing industry.

3. RESEARCH DESIGN :

A research design serves as the blueprint for the systematic collection and analysis of data, aiming to strike a balance between relevance to the research purpose and procedural efficiency. Essentially, it provides the conceptual framework that guides the entire research process, encompassing the planning, data collection, measurement, and analysis phases. The design is akin to a strategic roadmap, outlining the approach to be employed in both gathering and interpreting the data (Eriksson et al (2014). [15]). A well-constructed research design is characterized by several key elements. Firstly, it should feature a clear and concise articulation of the research problem, setting the stage for the investigation. Secondly, it must delineate the procedures and techniques to be employed in the data-gathering process. This encompasses decisions about the type of data to be collected, the sources of information, and the methods of data collection. Additionally, a robust research design should define the target population under study, outlining the scope and boundaries of the research. Lastly, it should articulate the methods to be employed in processing and analyzing the collected data. This holistic approach ensures that the research is not only relevant to its objectives but is also conducted with methodological rigor (Haider et al (2015). [16]). A well-designed research plan is integral to the success of any study, providing a structured framework for navigating the complexities of data collection, measurement, and analysis.

4. ANALYSIS & INTERPRETATION :

HYPOTHESIS TESTING:

4.1 Null hypothesis 1: Impact of HRM on EPM in the manufacturing industry does not lead to improved innovation.

Alternative hypothesis 1: Impact of HRM on EPM in the manufacturing industry lead to improved innovation

Table 4.1 Model Summary **

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.289*	.084	.071	.66973	.084	6.674	1	73	.012

*. Predictors: (Constant), impact1

**. Dependent Variable: innovation

The model summary describes the relation between impact of (HRM) on (EPM) in the manufacturing industry and improved innovation. The R value of 0.289 indicates satisfactory relation between them.

Table 4.2 ANOVA*

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.994	1	2.994	6.674	.012**
	Residual	32.743	73	.449		
	Total	35.737	74			

*. Dependent Variable: innovation
**. Predictors: (Constant), impact1

The significant value of f-test is 6.674 and p-value = 0.012 < 0.05. Hence, we are rejecting the null hypothesis i.e. Impact of (HRM) on (EPM) in the manufacturing industry does not lead to improved innovation.

From the table below we predict that the t test value between impact of (HRM) on (EPM) in the manufacturing industry and improved innovation is 2.583 with p-value = 0.012 < 0.05. Hence, Impact of HRM on EPM in the manufacturing industry leads to improved innovation.

Table 4.3 Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.976	1.017		.959	.341
	impact1	.654	.253	.289	2.583	.012

*. Dependent Variable: innovation

5.1 Null hypothesis 2: Impact of (HRM) on (EPM) in the manufacturing industry does not lead to improved productivity.
Alternative hypothesis 2: Impact of (HRM) on (EPM) in the manufacturing industry leads to improved productivity.

Table 5.1 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.192*	.037	.024	.63198	.037	2.788	1	73	.099

*. Predictors: (Constant), impact2
**. Dependent Variable: productivity

The model summary describes the relation between (HRM) on (EPM) in the manufacturing industry and improved productivity. The R value (correlation coefficient) = 0.192 which indicates satisfactory relation between them. The R square value = 0.037 which indicates there is 3.7% variation on dependent variable i.e. this much percent of the population agrees upon the correlation between the variables.

Table 5.2 ANOVA*

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1.114	1	1.114	2.788	.099**
	Residual	29.156	73	.399		
	Total	30.270	74			

*. Dependent Variable: productivity
**. Predictors: (Constant), impact2

The significant value of f-test is 2.788 and p-value = 0.099 > 0.05.
Hence, we are accepting the null hypothesis i.e. Impact of human resource management (HRM) on

enterprise performance management (EPM) in the manufacturing industry does not lead to improved productivity.

From the table below we predict that the t test value between Impact of (HRM) on (EPM) in the manufacturing industry and improved productivity is 1.67 with p-value = 0.099 > 0.05. Hence, Impact (HRM) on (EPM) in the manufacturing industry does not lead to improved productivity.

Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.416	.850		2.841	.006
	impact2	.360	.216	.192	1.670	.099

*. Dependent Variable: productivity

5. SCOPE FOR FURTHER RESEARCH :

In the dynamic landscape of manufacturing, Human Resource Management (HRM) plays a pivotal role in ensuring that the workforce is well-informed and aligned with the company's goals and performance objectives. To achieve this, the strategic utilization of performance management software becomes imperative, not only saving time for employees but also elevating their engagement levels within manufacturing units (Hassan et al (2016). [17]). The incorporation of performance-management software proves to be a valuable asset, streamlining communication about company objectives and enhancing employee engagement. This technological intervention not only fosters efficient dissemination of information but also contributes to a more engaged and informed workforce, vital for success in the manufacturing sector (Jaksi et al (2016). [18]).
Introducing a robust feedback system emerges as a critical tool in the arsenal of HRM for effective Enterprise Performance Management (EPM) practices. By providing regular and constructive feedback, HRM reinforces strong skills and molds the work performance levels of the workforce in an impactful manner. This approach fosters a culture of continuous improvement and adaptation within the manufacturing environment. Another noteworthy practice in EPM is the implementation of peer review systems, employing tools such as 360-degree reviews (Kadiresan et al (2016). [19]). This strategy not only facilitates effective performance management but also enhances team coordination and promotes a collaborative working attitude among employees. Sara Pollock's insights in 2018 emphasize the transformative impact of such peer review systems on shaping a positive and collaborative work culture within manufacturing units (Aithal et al (2023). [20]).

6. CONCLUSION :

In conclusion, strategic HRM practices, including the strategic use of performance-management software, feedback systems, and peer review mechanisms, prove to be indispensable tools for optimizing enterprise performance in the manufacturing industry (Kohansal et all (2013). [21]). As we navigate the complexities of the modern manufacturing landscape, these practices emerge as catalysts for building a highly engaged, informed, and collaborative workforce, essential for sustained success and growth. HRM practice place a contributory and supportive role to create and utilize the knowledge to meet vibrant competitive surrounding (Kumar et al (2016). [22]). While making focus on enterprise performance management, it is one of the interior idea, process and method of HRM which is effective and efficient through which manager will be able to understand the Enterprise’s strategic goal and objective as it can improve and increase the management capacity and operational efficiency (Hey et al (2016). [23]). The current study mainly focuses on the purpose which is to examine in detail the evolution and impact of human resource management on enterprise performance management in the manufacturing industry. The study also focuses on exploring the importance of HRM with respect to manufacturing industry by identifying the need for enterprise performance management in the manufacturing industry (Jahanian et al (2012). [24]). It also examines the relationship between HRM and enterprise performance management by investigating the impact of HRM on enterprise performance management in manufacturing industry with the objective of proposing the Strategies for effective use of enterprise performance management in the manufacturing sector (Aithal et al (2023). [25]).

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SWOT Analysis of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI and their Usage in Various Companies

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Subject Area: Computer Science.
Type of the Paper: Exploratory Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10451939
Google Scholar Citation: IJAEML

How to Cite this Paper:
Shajil Kumar, P. A. & Kunte, S. R. (2023). SWOT Analysis of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI and their Usage in Various Companies. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 300-319. DOI: https://doi.org/10.5281/zenodo.10451939

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0206

Received on: 09/08/2023
Published on: 30/12/2023

International Journal of Applied Engineering and Management Letters (IJAEML), ISSN: 2581-7000, Vol. 7, No. 4, December 2023

SRINIVAS PUBLICATION

SWOT Analysis of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI and their Usage in Various Companies

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ABSTRACT

Purpose: *Parallel Processing is the technique of achieving High Performance Computing (HPC) with parallel execution of programs that are synchronized during the execution time. This research paper studied the companies which use Parallel Processing techniques in their projects and products along with the identification of major Application Program Interfaces (APIs) that are used to achieve parallelism. The major aim of this research work is to perform the SWOT analysis of Parallel Processing APIs to identify the importance of each one from the company perspective.*

Design/Methodology/Approach: *The research method adopted to accomplish the SWOT Analysis of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI and their Usage in Various Companies is qualitative and exploratory in nature. Systematic literature review of different companies that use Parallel Processing techniques to build and develop parallel programs is done during this research work.*

Findings/Results: *Parallel Processing constructs can be used to solve various problems in the six major application domains as: - Computational Finance & Business Economics, Artificial Intelligence, Machine Learning (ML), Data Science, Numerical Analysis and Design of Algorithms. Major Parallel Processing APIs used in companies are: - CUDA, OpenCL, OpenMP and MPI for implementing the problems with parallel execution. Foremost companies that use Parallel Processing APIs are studied and various applications, systems, models, and projects that are developed using Parallel Processing techniques are listed. SWOT Analysis is performed on all four Parallel Processing APIs and its SWOT(Strengths-Weaknesses-Opportunities-Threats) are identified.*

Originality/Value: *Listing of SWOT Analysis (Strengths-Weaknesses-Opportunities-Threats) of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI.*

Paper Type: *Company Analysis research paper*

Keywords: Parallel Processing, SWOT Analysis, Company Analysis, CUDA, OpenCL, OpenMP, MPI

1. INTRODUCTION :

Parallel Processing is the concept of using multiple processors or computing capabilities to execute multiple tasks simultaneously to achieve faster results. Overall computation capability of a particular process can be increased by distributing CPU-intensive processes amongst multiple processing units; hence increasing the efficiency of the program. Parallel Processing methods can be achieved either using specialized hardware or software algorithms that allow multiple tasks to be executed simultaneously on a single processor. Parallel Processing works by breaking down complex computations into smaller manageable tasks; and then processes these tasks simultaneously to increase the productivity of the overall system and computation capabilities. This research paper is a company analysis-based research paper that aims at first in identifying the major application areas of Parallel

Processing. It also aims in identifying the most used APIs by companies in their Parallel Processing applications and projects. Also study the background company details of the identified Parallel Processing APIs. The paper also aims at performing SWOT Analysis (Strengths, Weaknesses, Opportunities, and Threats) of these APIs.

2. OBJECTIVES :

This research paper has the following objectives:

(1) To identify major application domains of Parallel Processing.
(2) To study the company details of four major Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI
(3) To study different companies that use Parallel Processing APIs and list their major projects that use Parallel Computing techniques.
(4) To perform SWOT(Strengths-Weaknesses-Opportunities-Threats) Analysis of four major Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI.

3. METHODOLOGY :

This research paper is prepared with the qualitative exploratory research methodology.

- To identify major companies that use Parallel Processing APIs and major projects that involve Parallel Computing techniques; various company websites are referred to know how well these methods are used in the company's perspectives.
- The major application domain of Parallel Processing is identified through qualitative exploratory research methodology and literature review of existing research papers.
- Company particulars of four major Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI are done with the support of the corresponding APIs websites.
- Major objective of the paper is to perform SWOT Analysis of four Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI, which is done with extensive literature review of various research papers that have already been published in the domain of Parallel Processing.
- As Parallel Processing APIs are vital in managing scalable data systems, SWOT identification of these APIs will give new insights in this emerging domain of knowledge.

Systematic literature review is done by considering the purpose of study using various online resources like ResearchGate, IEEE Xplore and Google Scholar.

4. LITERATURE REVIEW :

Detailed literature review is done on various Parallel Processing techniques adopted by companies in developing applications, systems, models, and projects that can enhance the computing power in association with the sequential program execution and listed in Table 1.

Systematic literature review is conducted on various products & projects that are designed in parallel and are listed in major areas like: -

- Computational Finance & Business Economics – Parallel processing can enhance the performance of various fields of Computational Finance like: - Derivative Pricing, Portfolio Optimization and Risk Management. In the domain of Business Economics, parallel applications can enhance Market Research, Supply Chain Management, Econometric Modeling and Optimization.
- Artificial Intelligence - Parallel processing techniques can be used in Natural Language Processing, Hyper parameter Tuning, Convolutional Neural Networks and Deep Learning Training
- Machine Learning (ML) - Video Haze Removal, Linear Algebra Software and K- means Clustering are different machine learning methods that can be done in parallel.
- Data Science - Option Pricing using Multinomial Tree Approach and Model to prevent train accident prevention are some of the scenarios where parallel applications work in the domain of data science.
- Numerical Analysis – Techniques like: - Finite Volume Method, Alternating Direction Implicit, Phase Field Model, Parallel Algorithms for Back Substitution, Conjugate Gradient and Gauss Seidel and Discrete Orthogonal Moments can be done in parallel to enhance the execution time.

- Design of Algorithm – Parallel algorithms can increase the speed and efficiency of the algorithmic procedures like: - Divide and Conquer, MapReduce Paradigm, Parallel Search Algorithms, Graph Algorithms, Parallel Sorting, Parallel Optimization Algorithms.

Table 1: Scholarly literature review on Parallel Processing applications, systems, models and projects

S. No.	Area & Focus of the Research	Outcome of the Research	Reference
1	To develop parallel algorithms for autonomous vehicles.	A parallel algorithm to analyze spatial data is developed and its execution time is compared with a sequential method.	Oh, B. W. (2019). [1]
2	Development of parallel method for Finite Volume Method.	Parallel execution using GPU provides better results in comparison with OpenMP.	Afzal, et al., (2020). [2]
3	To parallelize Computer Vision procedures.	Efficient Computer Vision algorithm using CUDA is developed, and its execution time is verified with different image sizes.	Afif, et al., (2020). [3]
4	Parallel implementation of Alternating Direction Implicit using cyclic reduction method.	Uses of CUDA and OpenCL in solving the problem related to oil recovery are listed.	Imankulov, et al., (2021). [4]
5	Parallel method implementation for video haze removal.	The result shows that parallel implementation is 226 times faster in comparison with CPU processing for the problem of video haze removal.	Wu, et al., (2020). [5]
6	To implement 3D graphics features using OpenCL, without dedicated hardware devices for the graphics.	Designed OpenCL implementation for 3D graphics features and verified its efficiency.	Kim, et al., (2021). [6]
7	To analyze the features of OpenCL using C++ programming model.	Cost effective massive Parallel Processing methods for big data systems are analyzed.	Shin, et al., (2020). [7]
8	To use OpenCL parallel technology for the Phase Field Model.	Scale of computing power of parallel techniques is verified to identify the problem of a single processor.	Ma, C., et al., (2022). [8]
9	Implementation of multi asset option pricing using multinomial tree approach.	Developed option pricing model using the concept of programmable gate array method that executes more than 40 times faster than a single processor system.	Mahony, et al., (2022). [9]
10	To develop Open IoT that provides various IoT services using Tacit Computing technology.	Evaluated the execution time for operations like Darknet and Fourier Transform.	Yamato, Y. (2020). [10]
11	To develop a parallel image encryption algorithm named HCMO to enhance security, encryption efficiency and processing speeds.	Experimental results depict HCMO provides better security in comparison to general purpose algorithms.	You, et al., (2020). [11]

12	To develop a parallel algorithm for distributed generation (DG) allocation problems that are multiple objectives in nature	Parallel implementation helps in using Monte-Carlo simulation for solving distributed generation (DG) allocation problems.	Abdelaziz, et al., (2019). [12]
13	To develop parallel Finite volume method (FVM) code using OpenMP.	Performance of different OpenMP parallel methods is studied on different operating environments.	Afzal, et al., (2020). [13]
14	To implement parallel application library for Linear Algebra.	Verification of Execution Analysis is performed on IBM and Intel machines.	Dongarra, et al., (2019). [14]
15	Implementation of Image Block Representation (IBR) for binary images using OpenMP.	High level performance is measured for IBR implementation in OpenMP, on a multicore computer.	Spiliotis, et al., (2020). [15]
16	A new method of Parallel sorting method named (MPDMSort) is developed and its execution on shared memory systems is done.	Reseach results show that MPDMSort is faster than general merge sort with scalable data.	Ketchaya, et al., (2023). [16]
17	To improve the 3D - Discontinuous Deformation analysis with the help of parallel technique.	Developed 3-D DDA method has better execution time, 5 times faster with 6 threads used in comparison with sequential methods.	Peng, et al., (2020). [17]
18	To implement parallel algorithms for Back Substitution, Conjugate Gradient and Gauss Seidel using OpenMP.	Comparative study of all the three algorithms using parallel and serial methods is done.	Paliwal, et al., (2022). [18]
19	To identify the computational cost of parallel and sequential methods to calculate vehicle forces and brake airflow while applying braking to prevent train accident prevention.	Parallel implementation provides an 80% reduction in model solution time.	Teodoro, et al., (2020). [19]
20	To study, Maximum-Shift string matching algorithm implementation with multi-core parallel method using OpenMP.	Performance of Maximum-Shift algorithm is altered with different data types of processing data, and it is studied with English text data and DNA database set.	AbdulRazzaq, et al., (2021). [20]
21	To develop Orthogonal Moments on block represented images.	Implementation done using OpenMP show significant performance for calculating the Orthogonal Moments using Image Block Representation (IBR).	Spiliotis, et al., (2021). [21]
22	To implement parallel and distributed computing Odd even transaction sorting algorithm.	Test results show Raspberry Pi clusters provide high performance speed.	Myint, et al., (2020). [22]
23	To implement K- means clustering algorithm in parallel mode using MPI.	Performance K- means clustering technique is compared with sequential and parallel execution.	Ragunthar, et al., (2021). [23]
24	To develop parallel scientific applications for the subject of physics and material science using OpenMP and MPI.	Designed four sequential programs of physics and material science subjects using parallel methods and verified its execution speed with respect to sequential method.	Aldinucci, et al., (2021). [24]

Literature review is conducted on the topic of SWOT(Strengths-Weaknesses-Opportunities-Threats) Analysis of different companies and listed in Table 2. This is done to know the method of performing SWOT Analysis for any specific company so that the knowledge of this could be used in analyzing the companies that are using Parallel Processing techniques.

Table 2: Scholarly literature review on SWOT Analysis of various Companies

S. No.	Area & Focus of the Research	Outcome of the Research	Reference
1	To develop a better SWOT model for Nvidia for analyzing a company's annual and financial document.	The result of the research shows that Nvidia is not an appropriate investment object for short-term analysis.	Zhao, M. (2023). [25]
2	To study Intel Corporations organization values with its crisis management.	It is found that organizational communication is an important aspect for change management and corporate culture integration for sustainable performance.	Kok, et al., (2023). [26]
3	To perform SWOT analysis of Samsung Electronics Company with internal and external analysis.	Provide a list of suggestions to the company to maintain sustainable success.	Hidiroglu, D. (2021). [27]
4	To perform the analysis of Dell's marketing mode using SWOT analysis method.	Relevant optimization suggestions are listed for Dell's IT industry.	Jiang, et al., (2022). [28]
5	To perform PEST and SWOT analysis to understand the marketing situation of Apple Inc.	Provided with the strategic marketing plans for the company's future development.	Chen, et al., (2021). [29]
6	To perform SWOT analysis of Dell Company.	Nine recommendations are given for future development.	Cheng, J. (2022). [30]
7	To perform SWOT analysis for Hydrogen fuel sustainable development in the GCC area.	Observed output of the research states that hydrogen-based economy in GCC regions depends on factors that are outbound.	Khan, et al., (2023). [31]
8	To identify the internal and external environment in Industry 4.0 manufacturing industry in India.	The result shows there is an increase in customers' trust while using online transactions. Also treat as employee resistance in embracing innovative tools and technologies.	Jain, et al., (2022). [32]
9	To conduct a survey on Egyptian HEIs to find the factor in ERP adoption and perform the SWOT analysis.	List of advantages in using ERP among Egyptian HEIs were found.	Soliman, et al., (2022). [33]
10	To perform the SWOT analysis on e-commerce tourism development strategy with big data management.	Identified the steps in taking development policy for scalable business.	Li, K. (2022). [34]

From the systematic literature review, it is found that four major Parallel Processing APIs used by various companies are - CUDA, OpenCL, OpenMP and MPI. There are research possibilities in performing SWOT(Strengths-Weaknesses-Opportunities-Threats) analysis of all four Parallel Processing APIs which are used by companies to develop Parallel Processing applications and systems. Research needs are there to identify major application domains of Parallel Processing, to perform company analysis of four major Parallel Processing APIs, to study about the companies which uses Parallel Processing APIs and list their major projects and to perform SWOT analysis of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI.

5. MAJOR APPLICATION AREAS OF PARALLEL PROCESSING :

Parallel Processing can be used in Computational Finance & Business Economics, Artificial Intelligence (AI), Machine Learning (ML), Data Science (DS), Numerical Analysis and Design of Algorithms where large amounts of data processing is a requirement.

(1) Computational Finance & Business Economics

Monte Carlo simulations are mainly adopted for implementing financial systems including product estimating, risk estimation, modelling of rate of interest etc. Monte Carlo models can be solved efficiently using Parallel Processing techniques. Stochastic programming methods like Decomposition and Interior Point Methods (IPMs), can be implemented effectively with parallel programming techniques.

(2) Artificial Intelligence (AI)

Parallel Processing methods are generally used in Artificial Intelligence due to its computational demands. Numerous areas of AI like Knowledge Representation, Image Processing, Logic and Production Rules, Natural Language Processing, Data Filtering and Data Mining uses parallel execution models. Robotic Process Automation (RPA) is the method to replace humans to perform repetitive office processes in a computer. As RPA tasks are highly repetitive, robots can be assigned tasks to perform in parallel to increase the usage of computing resources and execution efficiency.

(3) Machine Learning (ML)

Machine Learning is a set of procedures that offers models the capability to inherently acquire and progress from knowledge deprived of explicit programs. Performance of Machine Learning algorithms can be increased by parallel execution of common tasks like matrix multiplication that are used among numerous algorithms like classification, regression, and clustering techniques. In Neural Networks, there can be many features that are represented as parameters and to develop the model it requires huge volumes of data to train these parameters. These computationally rigorous processes take a higher time-complexity that can be optimized using parallel algorithms to train a deep neural network.

(4) Data Science (DS)

Parallel Processing techniques can be used widely in data science-based applications as it involves many computational tasks with enormous amounts of data. For example, in climate and weather science parallel programming methods can be largely used in both data analysis and computer modelling. Analysis of Seismic data sets can be done using numerical operators like Fourier transforms, integral transforms, convolutions, and other mathematical concepts. These operations can be performed in parallel to increase the system performance.

(5) Numerical Analysis

Parallel Numerical Analysis consists of using parallel techniques in solving numerical analysis problems like: - nonlinear equation, optimization, numerical integration, and ordinary differential equation. Parallel implementation of linear algebra computations, simultaneous exploration of different regions using multiple start points can be done. In optimization parallel methods are useful for the evaluation of objective and constraint functions and their derivatives. Parallel implementation of Runge-Kutta method, Newton’s methods etc. are useful in solving differential equations faster than its sequential implementation.

(6) Design of Algorithm

Parallel algorithms are designed to divide a problem into subproblems and solve each sub-problem to produce the intermediate result by considering the synchronized actions. The result of the problem is calculated by combining the outcomes of each sub-problem. Design of parallel algorithms involves steps like: - Dividing a computational problem into subtasks which can execute simultaneously, developing parallel algorithms, Analysis of computational granularity, Minimizing the cost of parallel algorithms and assigning parallel task execution.

6. COMPANY DETAILS OF PARALLEL PROCESSING API - CUDA, OpenCL, OpenMP and MPI :

Parallel Processing Application Programming Interface

Parallel Processing Application Programming Interface (API) refers to programming interfaces or libraries that allow developers to write code for parallel execution of tasks on multiple processors or cores, thereby increasing the overall processing speed and performance of a system. These APIs provide a way to manage threads, processes, and data across multiple cores or processors, making it easier for developers to take advantage of Parallel Processing. Majorly used Parallel Processing APIs by various companies are: -

- CUDA - Compute Unified Device Architecture
- OpenCL - Open Computing Language
- OpenMP - Open Multi-Processing
- MPI - Message Passing Interface

Table 3 shows company details of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI, with the details related to API developed year, founder member who developed the API, Current CEO of the company, number of employees in the company and the company URL. Company details who have developed these Parallel Processing APIs are mentioned below: -

(1) CUDA - Compute Unified Device Architecture

Company Developed: Nvidia Corporation

Nvidia Corporation is a computer-based establishment that develops, designs and manufactures Graphics Processing Units (GPUs).

(2) OpenCL - Open Computing Language

Original Developer: Apple Inc.

Company Developed: Khronos Group

Khronos Group is an amalgam of 170 companies that are open, which are into the development and maintenance of interoperability standards in 3D graphics, virtual and augmented reality, parallel computing, AI.

(3) OpenMP - Open Multi-Processing

Company Developed: OpenMP Architecture Review Board

OpenMP Architecture Review Board (or OpenMP ARB) is a cluster of computer hardware and software-based companies like IBM, Intel, AMD, and Oracle Corporation.

(4) MPI - Message Passing Interface

Company Developed: It is considered as the De Facto standard for the exchange of information between processes in parallel programs.

Message Passing Interface (MPI) was developed at Austria, in 1991 with a set of researchers started with the work related to parallel computing and execution model.

Table 3: Company Detail of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI

Parallel Processing API	Company Developed	Company Details				
		Started	Founder	Current CEO	Employees	Company URL
CUDA	Nvidia Corporation	1993	Jensen Huang, Curtis Priem and Chris Malachowsky	Jensen Huang	25,000+	https://www.nvidia.com/en-in/
OpenCL	Apple Inc. and	2000	Consortium of companies: Intel	Neil Trevett is the current President of Khronos Group	44+	https://www.khronos.org/

	Khronos Group		Corporation, Sun Microsystems etc.			
OpenMP	OpenMP Architecture Review Board	1997	By both Intel, and the U.S. Department of Energy	Mr. Michael Wong of IBM Canada is the CEO of the OpenMP Architecture Review Board	10+	https://www.openmp.org
MPI	De Facto standard for communication among processes that model a parallel program	1991	Jack Dongarra, Tony Hey, and David W. Walker	MPI Group Committee Members	-	https://www.mpi-forum.org/

7. COMPANIES USING PARALLEL PROCESSING API :

Parallel Processing can be used in Computational Finance & Business Economics, Artificial Intelligence (AI), Machine Learning (ML), Data Science (DS), Numerical Analysis and Design of Algorithms where large amounts of data processing is a requirement. Foremost companies that use the Parallel Processing APIs and various applications, systems, models, and projects that are developed using Parallel Processing techniques are listed below: -

(1) Nvidia Corporation

Nvidia Establishment is an international computer software and hardware company based in California, America. The company majorly designed Graphics Processing Units (GPUs) and Application Programming Interfaces (APIs) for parallel applications. It also developed System on a Chip Units (SoCs) for mobile computing and automotive market applications.

- NVIDIA is the creator of CUDA Parallel Processing API, and they use it extensively in their products and solutions. NVIDIA does many research projects using CUDA in the application field of deep learning, healthcare, autonomous vehicles, and robotic processes.
- NVIDIA uses OpenCL in designing software development tools like CUDA toolkit that allow it to develop cross-platform applications.
- OpenMP is used by NVIDIA in optimizing its GPUs performance.
- CUDA is developed using MPI that allows applications to run on distributed systems.

(2) International Business Machines Corporation (IBM), nicknamed Big Blue

IBM is a multinational knowledge corporation located in New York, America. It has offices in 175 countries around the globe. IBM provides services in all three major fields like computer hardware, middleware, and software in the technology domain. It has services from mainframe systems to nanotechnology. It is an organization that focuses highly on research in various fields of technology.

- IBM uses CUDA in various projects like medical image analysis, quantum computing, and predictive analytics. It is also used in designing enterprise solutions and high-performance computing clusters.
- OpenMP is used by IBM to optimize the processor performance and software applications, to increase the scalability of systems.
- IBM used MPI in developing the Blue Gene supercomputer which is highly scalable.

(3) Advanced Micro Devices, Inc (AMD)

Advanced Micro Devices, Inc. (AMD) is an electronic device development company based in California, America. It works majorly on semiconductor development like computer processors.

- CUDA is used by AMD to increase the processing capacity of its graphics processors and data centers. It is working with CUDA in the project domain like: - artificial intelligence and virtual reality.
- OpenCL is used in the development of AMD's 3D content creation software named Radeon ProRender. It is used in GPU acceleration in complex processes.
- OpenMP is used by AMD in optimizing the performance of its processors and increasing the scalability of software applications.

(4) Intel Corporation (Intel)
Intel Corporation is an international system-based company in California, America. Intel is the world's biggest semiconductor chip manufacturing enterprise.
- Intel used OpenCL in the development of its graphics cards and in designing applications in the domain of molecular dynamics simulations and quantum computing.
- Intel uses OpenMP to improve the performance and scalability of its processors. OpenMP software development kit is developed by Intel for the Intel architecture.
- Intel MPI is the proprietary MPI library developed by Intel for providing fast communication between nodes in distributed computing.

(5) Cray Inc. (Cray)
Cray Inc. is an American supercomputer firm centered in Washington which builds supercomputer techniques for data storage and analytics. It is the subsidiary of Hewlett Packard Enterprise.
- Cray uses OpenMP in designing business applications for scientific and technical computing.
- MPI is used in the development of HPC data analytics platform.

(6) Siemens
Siemens is a German multinational company based in Munich, Germany. It is the largest industrial manufacturing company and maker of medical diagnostics equipment in Europe. It has principal company divisions of Digital Industries, Smart Infrastructure, Mobility, Healthcare and Financial Services.
- CUDA is used in industrial automation and control systems by Siemens. It is also used in advanced medical imaging equipment.
- Simcenter CFD is the software developed by Siemens for Computational Fluid Dynamics using OpenCL to reduce the simulation time and increase the accuracy of results.

(7) Baidu, Inc
Baidu is a Chinese worldwide technology establishment specialized in artificial intelligence and based in Beijing.
- Baidu is developing projects in AI, speech and image recognition and Natural Language Processing (NLP) using CUDA.

(8) Hewlett Packard Enterprise (HPE)
Hewlett Packard Enterprise (HPE) is an international information technology business based in Texas, America that provides services in domain like servers, storage, networking, software and consulting.
- HPE uses CUDA to accelerate the servers of HPE and on the company’s research projects like genomics research, machine learning, and natural language processing.

(9) Samsung
Samsung Group is a multinational manufacturing firm based in Seoul, South Korea.
- CUDA is used by Samsung in its AI based research and development projects including NLP, computer vision, and autonomous vehicle technology.

(10) Dell Inc. (Dell)
Dell Inc. is an American computer-based company that manufactures, sells, maintains, and supports personal computers (PCs) and its associated requirements. The company manages supply chain and electronic commerce to sell servers, data storage devices, network switches, computer hardware equipment's, printers, etc.
- Dell uses CUDA to increase the computing power of its data center applications like: - seismic data analysis, financial modeling, and genome sequencing.

(11) Apple Inc. (Apple)
Apple Inc. is the world's biggest computer-based enterprise in terms of profit, based in California, America. Apple was started as Apple Computer Company on April 1, 1976, by Steve Wozniak, Steve Jobs, and Ronald Wayne to build and market Wozniak's Apple I personal computer.
- Apple uses OpenCL to enable optimized performance of computing devices and technologies with high performance in rendering, video encoding, and real-time editing.

(12) Adobe Inc. (Adobe)
Adobe Inc. is an international technology driven company based in California, America. The company has developed major software products like: - Adobe Photoshop image editing software,

Adobe Illustrator vector-based illustration software, Adobe Acrobat Reader, and the Portable Document Format (PDF). The company developed software instruments for audio-visual design, creating, editing, and publishing.

- Adobe uses OpenCL for performance optimization in a lot of their applications. Adobe's Premiere Pro, After Effects, and Photoshop are some of the popular products that use OpenCL to accelerate tasks like video editing, color grading, and image manipulation.

(13) Blackmagic Design Pty Ltd. (Blackmagic Design)

Blackmagic Design Pty Ltd. is a digital movie-based firm and hardware producer based in Victoria, Australia. The company developed high performing digital cameras and video making software like DaVinci Resolve and Blackmagic Fusion.

- The firm used OpenCL for its DaVinci Resolve video editing software, for color alteration and audio creation and editing through GPU processing.

(14) MathWorks

MathWorks is an American corporation that developed widely used mathematical computing software like MATLAB and Simulink, that support data analysis and simulation.

- MathWorks uses OpenCL in MATLAB software, to enable high-performance computing on GPUs, to solve large and complex computational problems.

(15) Maxon Computer (Maxon)

Maxon is a software company that produces software solutions for content creators which is based in Germany. Following are the major products of Maxon: - 3D software and Cinema 4D (used for content creation), Red Giant and Redshift renderer tools (used for editing, motion design and filmmaking), ZBrush (used for digital sculpting and painting) and Cinebench (used to evaluate hardware performance).

- OpenCL is used in Maxon's Cinema 4D for rendering complex 3D scenes and to accelerate tasks like reflections, shadows, and lighting.

(16) Unity Software Inc. (Unity Technologies)

Unity Software Inc. is a video game development company based in San Francisco; America that developed a product named Unity (a licensed game engine).

- Unity uses OpenCL to improve performance of complex visual effects.

(17) Microsoft Corporation (Microsoft)

Microsoft Corporation is an international technology-based establishment based in Washington, America. Microsoft's software products are Windows operating systems, Microsoft Office suite, and the Edge web browsers. Microsoft was founded by Bill Gates and Paul Allen in April 1975. Company dominates the personal computer operating system market with MS-DOS, followed by Windows.

- Microsoft uses OpenMP to optimize the performance of its software applications through Parallel Processing of Windows operating systems. Microsoft also used OpenMP in the Visual Studio development environment.

(18) Fujitsu Limited (Fujitsu)

Fujitsu is an ICT equipment and services corporation based in Tokyo, Japan. Company produces personal and enterprise computing products, like x86, SPARC and mainframe compatible servers.

- Fujitsu uses OpenMP to optimize the processors performance and increase the scalability of its software applications.

(19) Lenovo Group Limited (Lenovo)

Lenovo is an American Chinese international computer-based company that majorly design, manufacture, and market personal computers and devices like desktop computers, laptops, tablet computers and smartphones. It also develops terminals, servers, main frame, data storage devices, IT management systems and applications, and smart TVs.

- Lenovo uses OpenMP in its high-performance computing applications used for scientific computing, and in its business applications.

(20) Lawrence Livermore National Laboratory (LLNL)

LLNL is an institution in the field of science and technology based in California, America that prominently works on research and innovation. It was established in 1952, and funded by the US Department of Energy, and managed by National Security. The institution is accountable for ensuring protection to the nation's nuclear weapons. It is also responsible for preventing arms of mass ruin usage and ensuring native land security. It must solve various countrywide major problems like energy and ecological demands, technical research and outreach and commercial effectiveness.

- LLNL used MPI in its CANDLE project, which is a cancer research project with large-scale simulations.

(21) Argonne National Laboratory (ANL)

ANL is a Govt. sponsored research and development firm based in Illinois, United States. It is funded by the United States Department of Energy and overseen by the University of Chicago.

- MPI is used by ANL, in its supercomputer named Mira to make it highly scalable.

8. SWOT ANALYSIS OF PARALLEL PROCESSING API :

SWOT analysis is a management framework generally used to perform the company analysis by top level management as a critical analysis of a company's performance [25]. It is used in finding Strengths-Weaknesses-Opportunities-Threats of a particular business and associated policies. This paper, we have used SWOT analysis in identifying the various features of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI, along with the competency each one in the market of High-Performance Computing. Also, each APIs limitations and its performance in comparison with others is identified.

8.1. SWOT Analysis of CUDA Parallel Processing API:

SWOT Analysis of CUDA Parallel Processing API is shown in Table 4.

Table 4: SWOT Analysis of CUDA Parallel Processing API

STRENGTHS +	WEAKNESSES –
▪ Unified Memory (in CUDA 6.0 or later) and Unified Virtual Memory (in CUDA 4.0 or later) ▪ Shared Memory	▪ Latest version of CUDA follows C++ Syntax Rule ▪ No Interoperability ▪ Minimum Unit Block of 32 Threads
OPPORTUNITIES +	**THREATS –**
▪ Scattered Reads ▪ Improved Performance on Downloads and Reads ▪ Support Bitwise and Integer Operations	▪ No Fallback Support for Older Versions ▪ Hardware Dependency to NVIDIA Hardware

Source: [Author]

(1) Strengths

- Unified Memory (in CUDA 6.0 or later) and Unified Virtual Memory (in CUDA 4.0 or later)

  Unified Memory model represents single memory address-space for the entire processors in a computer, whereas Unified Virtual Memory model represents single virtual memory address-space for the whole memory in the computer, so that pointers can be accessed from GPU code. Unified Memory allows applications to allocate data by either CPUs or GPUs. Unified Memory provides higher performance than Unified Virtual Memory.

- Shared Memory

  Shared memory is assigned per thread group, so that all threads in the group have retrieve permission to the common shared memory. Shared memory is much faster than local and global memory access and threads retrieve details from shared memory by other threads of the same thread group. This leads to various uses like: - user-managed data caches, high-performance cooperative parallel algorithms, and global memory merging.

(2) Weaknesses

- Latest version of CUDA follows C++ Syntax Rule

  Newer versions of CUDA source code follow C++ language constructs, whereas earlier forms used C language rules. Thus modified CUDA programs may not be compatible with its older versions.

- No Interoperability

CUDA has very limited interoperability options, like one directional interoperability with OpenGL. OpenGL can retrieve details from CUDA memory, but CUDA cannot retrieve details from OpenGL memory.

- Minimum Unit Block of 32 Threads
  In CUDA, one thread block should have a minimum of 32 threads and a maximum of 1024 threads. If each of 32 threads yields the common running sequence, branches in the program code do not affect the performance.

(3) Opportunities

- Scattered Reads
  As Shared memory is given per thread group, all threads in the group have permission to retrieve the common shared memory. Thus, CUDA will be able to fetch data from any address in memory as Scattered Reads.
- Improved Performance on Downloads and Reads
  CUDA applications can improve their performance by reducing CPU-GPU data transfer.
- Support Bitwise and Integer Operations
  Single-precision floats like Integer division and modulo operations provide better performance with higher cost; and bitwise operations can be used to avoid the same. There are two types of runtime math operations with or without preceded underscores.
  Functions with __functionName() labeling standard represent precisely to the hardware level. They are high-speed but results in lower accuracy (e.g., __sinf(x) and __expf(x)). Functions with functionName() labeling standard are slower in execution but provide greater accuracy (e.g., sinf(x) and expf(x)). Execution of __sinf(x), __cosf(x), and__expf(x) are faster in running compared to sinf(x), cosf(x), and expf(x).

(4) Threats

- No Fallback Support for Older Versions
  Later releases of CUDA do not provide alternative assistance for older versions.
- Hardware Dependency to NVIDIA Hardware
  CUDA is supported by only NVIDIA Hardware, thus it is highly machine dependent.

8.2. SWOT Analysis of OpenCL Parallel Processing API:

SWOT Analysis of OpenCL Parallel Processing API is shown in Table 5.**Table 5:** SWOT Analysis of OpenCL Parallel Processing API

STRENGTHS +	WEAKNESSES –
▪ OpenCL provides Abstract Memory Model and Portability ▪ OpenCL Kernel can run on any Supported Software Implementation	▪ Cannot directly implement Proprietary Hardware Technologies like Parallel Thread Execution (PTX) on NVIDIA GPUs without sacrificing Portability. ▪ OpenCL is rarely used for Machine Learning ▪ OpenCL has no Dynamic Memory Handling
OPPORTUNITIES +	**THREATS –**
▪ OpenCL support Heterogeneous System Architecture ▪ OpenCL uses C/C++ to carry over the Kernel Computations done on the Device	▪ CUDA is Faster than OpenCL

Source: [Author]

(1) Strengths

- OpenCL provides Abstract Memory Model and Portability
  OpenCL has an Abstract Memory Model that supports portability across various hardware devices. It also enables parallelism to the developers by acting as an interface between programmers and hardware. OpenCL API that supports cross-platform parallel program development on varied environments. OpenCL also supports intense memory requirements and data-parallel implementation.
- OpenCL Kernel, be able to execute on any supported Software Implementation
  As a framework, OpenCL allows developers to develop parallel programs which execute on both CPUs and GPUs of various hardware vendors like AMD, Intel, ATI, Nvidia etc.

(2) Weaknesses

- Cannot use Proprietary Hardware Technologies like Parallel Thread Execution (PTX) on NVIDIA GPUs deprived of Portability.
  Nvidia's CUDA programming supports Parallel Thread Execution (PTX) as a low-level parallel thread virtual machine and instruction set architecture for a thread execution from a parallel thread array. Cooperative Thread Array (CTA) is a group of threads which run a kernel concurrently or in parallel.
- OpenCL is rarely used for Machine Learning
  OpenCL has limited libraries for supporting Machine Learning. Qualcomm OpenCL accelerates Machine Learning operations, enables edge training, reduces CPU overhead of dispatching ML workloads and provides advanced math built-ins. oneDNN is an open-source cross-platform OpenCL extension for accelerating Deep Learning applications.
- OpenCL has no Dynamic Memory Handling
  As OpenCL does not have provision for Dynamic Memory Handling, it can either perform the creation of the largest possible array size for a particular program statically or create the dynamic array on CPU and pass it as a kernel argument.

(3) Opportunities

- OpenCL support Heterogeneous System Architecture
  OpenCL supports parallelism between Heterogeneous Computing Architectures. Communication between GPU and the processor is performed through C++; std::atomic template. The std::atomic template represents a type of atomic so that one thread can write to an atomic object while another thread can read from it.
- OpenCL uses C/C++ to carry over the Kernel Computations done on the Device
  OpenCL views a processing unit as a group of compute components consisting of work items. Each work item is a thread, and a group of threads is known as a computer component. OpenCL uses C/C++ to perform the kernel computations on the device like creating buffers, calling kernels, mapping the memory back to CPU, etc. OpenCL uses optimization techniques to improve the parallel computations done on GPU which results in better performance.

(4) Threats

- CUDA is Faster than OpenCL
  Execution time comparison of CUDA programs with OpenCL on NVIDIA GPUs shows that CUDA is thirty percentage speedier in comparison to OpenCL. OpenCL kernel can be compiled at runtime for achieving the portability that adds up to the OpenCL's running time.

8.3. SWOT Analysis of OpenMP Parallel Processing API:

SWOT Analysis of OpenMP Parallel Processing API is shown in Table 6.

Table 6: SWOT Analysis of OpenMP Parallel Processing API

STRENGTHS +	WEAKNESSES –
▪ Easier to code and compile than other Parallel Programming APIs ▪ Gradual Parallelization - Parallelism can be achieved incrementally ▪ Code is easier to understand and more easily maintained	▪ Can execute OpenMP programs only through Shared Memory Computers ▪ Needs a Compiler that is compatible with OpenMP ▪ Commonly used in Loop Parallelization
OPPORTUNITIES +	**THREATS –**
▪ Serial Regions and Parallel Regions ▪ Support Multiple Type of Synchronization	▪ Limited Scalability ▪ Does not support Distributed Memory Parallel Schemes

Source: [Author]

(1) Strengths

- Easier to code and compile than other Parallel Programming APIs
  OpenMP programs follow a structured programming style that makes it easier to understand. It is easier to locate the entry and exit of synchronized blocks of OpenMP programs.
- Gradual Parallelization - Parallelism can be achieved incrementally.
  The two principles on which OpenMP is designed are: - Sequential Equivalence and Incremental Parallelism. Sequentially Equivalent programs provide the same results even if it executes on one thread or many threads. These programs are easier to understand, write, and maintain. Incremental Parallelism is the process of converting serial code into a parallel code through incremental steps. At each increment, code can be verified for its correctness. OpenMP supports Incremental Parallelism for the shared memory model, known as Gradual Parallelization.
- Code is easier to understand and more easily maintained.
  OpenMP is a portable and scalable programming tool that provides developers an environment for designing parallel models for systems like standard personal system or high-performance supercomputer. OpenMP programs execution starts with one process known as master thread. The master thread executes sequentially until the first parallel section is met. When a parallel section is met, master thread performs: -
  a) Using the FORK command, create a set of threads.
  b) Becomes the master of the group of threads that are created and assigns thread id 0 within the group.

(2) Weaknesses

- Can execute OpenMP programs only through Shared Memory Computers
  OpenMP API is useful in creating multi-threaded, shared memory parallelism. One shared memory process contains many threads, that all threads perceive a shared variable similarly. It is the responsibility of the developer to ensure that the variable is updated by different threads as needed.
- Needs a Compiler that is compatible with OpenMP
  OpenMP parallelism uses compiler directives which are embedded in the source code. Compiler generated automatic parallelization is not supported by OpenMP.
- Commonly used in Loop Parallelization
  OpenMP supports parallelizing loops with few parameters for achieving the Parallel Processing of tasks. Loop Parallelization in OpenMP is known as a job-sharing model which can be placed inside a parallel section.

(3) Opportunities

- Serial Regions and Parallel Regions
  OpenMP allows a programmer to discrete a program into serial sections and parallel sections. This allows the development of a normal program as serial code, without any modification in OpenMP.
- Support Multiple Type of Synchronization
  When several threads are in execution concurrently, there is a requirement for thread synchronization so that one thread synchronizes with another thread at parallel regions. OpenMP has two classes of synchronization named: - explicit and implicit synchronization.

(4) Threats

- Limited Scalability
  Scalability of OpenMP programs depends on the performance of the shared memory node on which the program is executing.
- Does not support Distributed Memory Parallel Schemes
  Distributed memory systems represent computing models with multi processors, and each processor with its own memory. In Distributed Memory Parallel Systems programming jobs efficiently operate with local details, but for remote details job threads must communicate with remote processors to transmit details. OpenMP does not have the concept of communication with multiple processors for the exchange of remote data.

8.4. SWOT Analysis of MPI Parallel Processing API:

SWOT Analysis of MPI Parallel Processing API is shown in Table 7.

Table 7: SWOT Analysis of MPI Parallel Processing API

STRENGTHS +	WEAKNESSES –
▪ Runs on either Shared or Distributed Memory Architectures ▪ Most problems parallel code can be made easily through MPI in comparison to other Parallel Processing API ▪ All processes can have its own Local Variables	▪ Conversion of Serial to Parallel Version of a problem needs major programming changes ▪ Testing of the program is harder
OPPORTUNITIES +	**THREATS –**
▪ Less Expensive ▪ Increased Scalability	▪ Applications performance depends on communication link between the nodes ▪ Programmer is responsible for Synchronization Algorithm in Shared and Distributed Architecture

Source: [Author]

(1) Strengths

▪ Runs on either Shared or Distributed Memory Architectures
Message Passing Interface (MPI) is the method used to transfer messages among multiple computers executing a parallel program in the distributed memory architecture. MPI also supports shared memory programming architecture, so that parallel programming on clusters of shared memory nodes can be done.

▪ Most problems parallel code can be made easily through MPI in comparison to other Parallel Processing API
MPI allows the designing and implementation of programs that can run through parallel and distributed computing with coordination among multiple processes. MPI has more flexible control structures than other Parallel Processing APIs, which makes it a choice in solving an extensive range of problems.

▪ All processes can have its own Local Variables
Every child process created in MPI has its own local variables, which makes it easier to execute parallel processes and share the results among multiple processes through communication.

(2) Weaknesses

▪ Conversion of Serial to Parallel Version of a problem needs major programming changes
Designing an algorithm using parallel computing has two regions, regions of programs which cannot run in parallel (known as Serial Region) and regions of programs which can run in parallel (known as Parallel Region). MPI takes more time in designing Parallel Region in comparison with Serial Region.

▪ Testing of the program is harder
General debugging tools support debugging by considering each process at a time that is appropriate for serial execution of a program. MPI programs must use a debugger that supports the execution model to see the execution result of multiple processes running in parallel.

(3) Opportunities

▪ Less Expensive
MPI supports parallel programs on distributed computing architecture. Distributed systems are less expensive in comparison with multiprocessing systems with shared memory access. Thus, the use of MPI in developing parallel programs is more feasible in comparison with other APIs.

▪ Increased Scalability
MPI supports distributed computing architecture where several systems can interconnect with each other in solving a parallel program, which increases the scalability of the application.

(4) Threats

▪ Applications performance depends on communication link between the nodes
As MPI is used in parallel computing of programs in distributed environments, intra-node communication efficiency determines the application performance.

- Programmer is responsible for Synchronization Algorithm in Shared and Distributed Architecture Synchronization is the major design measure for parallel programming on shared and distributed architecture. Ensuring the synchronization in both shared and distributed architecture lies on the programmer who designs the parallel algorithms.

9. SUGGESTION AND RECOMMENDATIONS :

Based on the Company Analysis of Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI, following suggestions are proposed as recommendations:

(1) Parallel Processing techniques are used in various application areas like: - Monte Carlo simulations, Stochastic Programming Problems, Knowledge Representation, Image Processing, Logic and Production Rules, Natural Language Processing (NLP), Data Filtering, Data Mining, Robotic Process Automation (RPA), Machine Learning (ML) Algorithms and Numerical & Data Analysis.

(2) Four major Parallel Processing Application Programming Interfaces used by various companies are: - CUDA, OpenCL, OpenMP and MPI. These APIs are developed by the below mentioned companies: -
  - CUDA - Compute Unified Device Architecture is developed by Nvidia Corporation.
  - OpenCL - Open Computing Language is developed by Apple Inc. and Khronos Group.
  - OpenMP - Open Multi-Processing is developed by OpenMP Architecture Review Board.
  - MPI - Message Passing Interface is developed as De Facto standard for communication among processes that model a parallel program.

(3) Parallel Processing APIs CUDA, OpenCL, OpenMP and MPI are used by various companies to develop parallel applications and projects. Companies that are using CUDA, OpenCL, OpenMP and MPI techniques are shown in Table 8.

Table 8: Companies using Parallel Processing APIs CUDA, OpenCL, OpenMP and MPI

Sr. No.	Company Name	Usage of Parallel Processing APIs			
		CUDA	OpenCL	OpenMP	MPI
1	Nvidia Corporation	✓	✓	✓	✓
2	International Business Machines	✓	✓	✓	✓
3	Advanced Micro Devices, Inc (AMD)	✓	✓	✓	
4	Intel Corporation (Intel)		✓	✓	✓
5	Cray Inc. (Cray)			✓	✓
6	Siemens	✓	✓		
7	Baidu, Inc	✓			
8	Hewlett Packard Enterprise (HPE)	✓			
9	Samsung	✓			
10	Dell Inc. (Dell)	✓			
11	Apple Inc. (Apple)		✓		
12	Adobe Inc. (Adobe)		✓		
13	Blackmagic Design Pty Ltd. (Blackmagic Design)		✓		
14	MathWorks		✓		
15	Maxon Computer GmbH (Maxon)		✓		
16	Unity Software Inc.		✓		
17	Microsoft Corporation (Microsoft)			✓	
18	Fujitsu Limited (Fujitsu)			✓	
19	Lenovo Group Limited (Lenovo)			✓	
20	Lawrence Livermore National Laboratory (LLNL)				✓
21	Argonne National Laboratory (ANL)				✓

Source: [Author]

(4) SWOT analysis performed on CUDA and OPenCL shows that CUDA has hardware dependency to NVIDIA hardware, whereas CUDA is faster in execution in comparison with OpenCL.
(5) SWOT analysis performed on OpenMP and MPI shows that OpenMP has limited Scalability, whereas MPI can be used in both shared and distributed architectures.

10. CONCLUSION :

Parallel Processing techniques are extensively used in the application domain of Computational Finance & Business Economics, Artificial Intelligence, Machine Learning, Data Science, Numerical Analysis and Design of Algorithms. Company analysis of four major Parallel Processing APIs - CUDA, OpenCL, OpenMP and MPI shows that these APIs are recent techniques with a wide range of applications and possibilities. Various companies that are using these APIs show that these APIs have significant levels of application processing capabilities in the Parallel Processing domain and many new application areas can use the scope of these APIs further. SWOT analysis performed on these APIs will allow any researcher working in the Parallel Processing environment to select the appropriate APIs as per the research problem.

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A Systematic Review on Customers Shopping Response towards Online Impulsive Buying Behaviour

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Subject Area: Business Management.
Type of the Paper: Literature Review.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10467931
Google Scholar Citation: IJAEML

How to Cite this Paper:
Rachana & Sujaya, H. (2023). A Systematic Review on Customers Shopping Response towards Online Impulsive Buying Behaviour. *International Journal of Applied Engineering and Management Letters (IJAEML), 7*(4), 320-348. DOI: https://doi.org/10.5281/zenodo.10467931

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0207

Received on: 08/12/2023
Published on: 31/12/2023

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ABSTRACT

Purpose: *Online Impulsive buying, which accounts for 40% of sales in developed nations, has a big impact on the current consumer markets. The purpose of this study is to thoroughly investigate the complicated dynamics of this behaviour, comprehending the factors that lead to impulsive purchases and the subtle interactions between customer trust and buy intents. The research is aimed at providing essential insights into the changing digital consumer landscape that is impacted by the interaction of convenience, emotional triggers, and impulsive behaviour. Specifically, it aims to unravel the change from trust to intention to buy and ultimately leading to online impulsive buying.*

Design/Methodology/Approach: *This study depends on secondary sources gathered from a variety of sources, including case studies, journal articles, magazines, books, and internet searches.*

Findings/Result: *Findings reveal that, retailers are strategically using consumers' emotions to drive impulsive purchases through their online shopping habits. Contextual considerations, trust-building programs, and website subtleties all significantly influence decision-making. These results highlight the crucial role that these components play in influencing online impulsive purchases, providing businesses with a framework to encourage impulsive buying, client loyalty, and happiness in the ever-changing world of e-commerce.*

Originality/Value: *This review summarizes findings from the research on the various aspects influencing consumers' online purchasing decisions. It provides a thorough grasp of the factors influencing consumers' online buying behaviour, making it a valuable resource for internet businesses and marketers. Equipped with this understanding, enterprises can devise customized promotional plans intended to enhance spontaneous purchasing, resulting in increased revenue and profitability within the virtual marketplace.*

Type of Paper: *Literature Review*

Keywords: Online impulsive buying, Customer perception, Customer satisfaction, Purchase intention, SWOC analysis.

1. INTRODUCTION :

The shopping process for consumers has been greatly expedited in recent years due to retail innovations including the advent of self-service kiosks, alluring product exchange offers, the widespread usage of credit cards, and the availability of monthly instalment plans. Impulsive, leisurely, and frivolous buying has become a fun and simple activity as a result of the retail landscape's shift. The impulsive buying behaviour is the act of making impulsive purchases that are frequently sparked by outside stimuli, one's own instincts, or unexpected desires. These purchases usually take place outside of a person's predetermined spending limit and purchasing goals. Researchers define impulse buying as an unplanned and unwanted purchase made quickly, frequently on the spot, without careful thought. It is often set off by exposure to a stimulus that causes a quick, strong want to buy. High-arousal emotions and hedonistic reasons are typical of impulse buying behaviour, while utilitarian factors predominantly influence planned and habitual purchases (Chen W. K.et al.(2020). [1]).

Marketing professionals have often shown a deep fascination with the nuances of consumer behaviour. They work to understand how customers view, interact with, and choose among the wide range of options available to them, including products, brands, and the extent to which external variables like peer groups, families, and salespeople impact their choices. Nowadays, the internet plays a crucial role as the main source of information and is easily incorporated into daily life. Organizations have tapped into the internet's enormous potential as a strategic tool to obtain an advantage over rivals (Hamill. J. (1997). [2]). Consumers who experience an instantaneous, frequently strong, and persistent want to acquire something right away are said to be acting impulsively. This buying drive is hedonically complex and frequently causes conflict in the mind. Additionally, impulsive purchases frequently occur with little thought given to their possible repercussions (Rook, D. W., & Fisher, R. J. (1995). [3]). Impulsive purchases account for over 40% of total sales in economically developed nations and generate approximately $4 billion in revenue annually. This is a substantial amount of money that comes from approximately 40% of consumers. This figure highlights the significant influence that impulsive purchasing has on the contemporary consumer market and demonstrates the significant financial power that impulsive and unplanned purchases carry (Kacen, J. J., & Lee, J. A. (2002). [4]).

Women have a significant impact on the phenomenon of impulsive buying. Their propensity for dressing well, keeping up with the newest styles, and actively collecting stylish stuff can be linked to this influence. An intriguing interaction between a number of variables, such as one's own fashion inclination and the availability of both money and time indicates that they have a significant effect on the propensity for hedonistic consumption and the feeling of good feelings. This suggests that people's resource allocation and preference alignment especially when it comes to fashion have a big impact on how they behave when they make impulsive purchases and how happy they feel about it (Babin, B. J., & Boles, J. S. (1998). [5]).

Due to its significant influence on consumer preferences and retail dynamics, impulsive buying behaviour is a major concern for vendors and retailers. Customers use impulsive purchasing to satisfy their emotional needs. This suggests that retailers intentionally appeal to the emotions and aspirations of impulsive consumers in order to enhance sales and satisfy customers (Hausman. A. (2000). [6]). The importance of novelty, thrill, and wonder in triggering impulsive purchasing behaviour is highlighted by (Saad, M., & Metawie. (2015). [7]). Retailers use these components to create a retail atmosphere that inspires customers to act spontaneously and impulsively. These tactics are especially important when it comes to internet shopping, as customers follow a unique process. The consumer journey in the world of online buying entails obtaining product information, placing orders, and completing payments before delivery (Arnold, M. J., & Reynolds, K. E. (2003). [8]).

Trust and user-friendly website interfaces are essential for drawing in and keeping online customers. To encourage impulsive spending among online buyers, it is imperative to provide a seamless and secure online shopping experience (Floh, A., & Madlberger, M. (2013). [9]). Physical establishments interior and external environments, sales, and discounts all have a significant role in promoting impulsive purchasing behaviour. These components have the potential to foster enduring consumer relationships and brand loyalty. Retailers may harness the power of impulsive purchasing behaviour, influence consumer preferences, and build enduring brand loyalty by strategically implementing such strategies (Al-Salamin, H., & Al-Hassan, E. (2016). [10]). Trust is an inclination to behave in a way that entails depending on other people and acting in a specific way. This notion of trust includes both behavioural and belief-based components (Poon, P., Albaum, G., & Shiu-Fai Chan, P. (2012). [11]). Remarkably, earlier studies have suggested that trust is the basic building block of all social interactions. Trust is essential and has been shown to be the foundation for interactions between buyers and sellers in the business and marketing domains. This emphasizes how crucial trust is in determining and impacting customer loyalty, behaviour, and the dynamics of business.

2. OBJECTIVES :

(1) To understand the online impulsive buying behaviour of a customer through their shopping response.
(2) To study the factors that lead to impulsive buying behaviour when shopping online.

(3) To understand how social media influences the customer when buying online.
(4) Tolist out the SWOC analysis of online impulsive purchasing behaviour.

3. METHODOLOGY :

The primary source of information used in this qualitative research project comes primarily from secondary sources. Using a wide range of sources, including books, scholarly journals, periodicals, websites, and other publications or articles relevant to the topic, the study is based on a thorough evaluation of the literature. Search engines like Google Scholar and ResearchGate were used to find the information needed for this study.

4. RELATED RESEARCH WORKS :

The main objective of this research is to perform a comprehensive literature review. This review will aid in gaining a better understanding and in-depth analysis of prior research. The study has selected relevant descriptive reviews for inclusion. The accessible literature from journals published between 2011 and 2021was thoroughly reviewed using keywords such as "Impulsive buying," "Customer perception," "Stimuli," "Types of impulsive buying," "Trust," "Promotions," "Positive mood,"

4.1 DESCRIPTIVE FOCUS:

1. Impulse buying behaviour involves consumers experiencing a sudden urge to make unplanned purchases when encountering products online. Various factors significantly influence this impulse buying phenomenon. Since consumers vary in their tendencies for impulsive buying, this study can offer valuable insights. The research holds significant potential for e-marketers, enabling them to design strategies that can stimulate impulsive buying behaviour and boost product sales. E-retailers can create approaches that directly impact consumers' personal behaviour, such as offering products in bundles and leveraging engaging promotional content like videos. This approach may particularly target financially comfortable consumers and utilize the influence of peer groups. Additionally, this study sheds light on the ethical considerations that play a major role in shaping consumers' perceptions when making impulsive purchases online. (Kumar, S., & Kaur, A. (2018). [12]).
2. According to the study's, online impulsive buying behaviour is positively impacted by the quality of the information, services, and systems. The study also finds that, when taking into account variations in gender and educational attainment, both utilitarian and hedonic values mediate the relationship between online impulsive purchasing behaviour and website quality traits. With an emphasis on the necessity of improving the system, service, and information quality of their websites to promote online impulse buying behaviour, this research has important ramifications for web developers, marketers, and online merchants. (Hashmi H. et al. (2019). [13]).
3. Five major aspects are taken into account in order to analyse the effects of impulse buying: hedonic motivation, website quality, trust, situational circumstances, and variety seeking. People are found to be more likely to make impulsive purchases when hedonic motivation is included in social media marketing. Furthermore, the effectiveness of a website has a big impact on persuading visitors to buy products right away. Customers are also drawn to make impulsive purchases when they have faith in a brand or product. Additionally, the study's conclusions show that situational factors and a customer's demand for diversity also encourage impulsive purchases (Bansal, M., & Kumar, S. (2018). [14]).
4. The results of the study demonstrate the importance of the moderating effect of hedonic motivation, especially when considering the connection between online impulse purchasing behaviour and time scarcity promotion. It is found that this association is significantly stronger at higher degrees of hedonic motivation. Hedonic motivation does not have any clear influence in these relationships, and they have a small effect size. Therefore, the study concludes that when it comes to the price promotion qualities influencing online impulse buying behaviour, hedonic drive is ineligible to function as a moderator. In spite of this, it is evident that price promotion features positively and directly affect online impulse purchases, independent of any moderating effects from hedonic motives. It is clear that time scarcity promotion influences online impulse purchase behaviour more than price promotion attributes when taking into account the moderating effect of hedonic motivation (Bahrah, E. N., & Fachira, I. (2021). [15]).

5. The research findings indicate that a variety of factors may impact a consumer's inclination towards making impulsive purchases. These elements include gift promotions, free returns, free shipping, free website design, and the availability of comprehensive product information. Still, these characteristics have less of an impact than "online comments" and "price discounts." Furthermore, moods and emotions can also have a big impact on what motivates people to make impulsive purchases (Lai. J. (2018). [16]).
6. The study's findings suggest that there are variations in the levels of positive emotions related to shopping and unplanned behaviour depending on the purchasing channels chosen by individuals. These results indicate that individuals who opt for social media as their purchasing channel exhibit a greater tendency for unplanned purchases compared to those who prefer traditional offline channels. Additionally, individuals who make purchases through online shopping websites tend to experience more positive emotions associated with shopping in contrast to those who opt for offline channels (Ata, S., & Sezer, A. (2021). [17]).
7. The main elements and causes that encourage impulsive online shoppers' purchases have been found by this study, such as expediency, socio-emotional trade-offs, and magnetic sales promotions. It was discovered that Rebates and Discounts, especially when combined with Clearance Sales and Promotional offers, were the most potent stimulus for inciting customers to make impulse purchases. These rewards have a big impact on customers' plans to make purchases. In the context of online shopping, customers' impulse buying behaviour may be predicted by using three key factors: expediency, socio-emotional trade-offs, and magnetic sales promotions. These elements are successful in persuading consumers to make impulsive purchases, frequently without the consumers' full knowledge (Singhal M.et al.(2015). [18]).
8. The study indicates a number of significant elements that, especially in the retail fashion industry, operate as triggers for impulsive purchases. The study's findings highlight that interest in fashion, having a good attitude, and having a tendency toward impulse purchases are the main factors influencing this behaviour. On the other hand, it was discovered that factors including hedonism, enjoyment of shopping, and self-worth had little bearing on impulsive purchases. The study's findings also provide significant new information on how these characteristics mediate each other. Positive mood is found to be the only factor mediating the association between shopping satisfaction and impulse buying behaviour (IBB). Positive mood, however, only partially mediates the link between fashion participation, self-esteem, hedonism, impulse purchase tendency, and IBB. This implies that, to varied degrees of mediation, a pleasant mood is a key mediator in the relationship between these variables and impulse buying behaviour (Ahmad M.et al. (2019). [19]).
9. The results of the study show that customer emotional responses are positively shaped by the convenience and simplicity of online purchasing web stores, including aspects like simple navigation and a well-organized layout. These elements help to raise clients' arousal and positive mood during their online purchasing experience. On the other hand, buyers are less likely to feel pleased when navigating and using an online purchasing website, which can result in negative emotional reactions. Furthermore, data and statistics from the study verify that the informativeness of online shopping websites that is, the availability of all information and knowledge required for customers also positively affects online shoppers' emotional reactions. In other words, Customers' emotional experience when they shop online is positively impacted when they can readily obtain the information they need on a website (Habib, M. D., & Qayyum, A. (2018). [20]).
10. The study adds to the body of knowledge by examining the dynamics of users' responses to websites with different levels of quality, especially with regard to how impulsive they are. Higher impulsiveness consumers respond more favourably to high-quality websites and, on the other hand, are more adversely affected by low-quality ones, according to the study. Beyond the objective quality of an e-commerce website, one of the most important factors in understanding the differences in responses to website quality is an awareness of the innate impulsivity of the consumer base. This study also essentially highlights the need of taking into account customers' impulsive tendencies even though overall website quality is still important (Wells, J. D. et al. (2011). [21]).

5. EMERGING ISSUES :

Factors effecting online Impulsive Buying Behaviour

Individual customers' purchasing decisions are impacted by a variety of circumstances, therefore understanding buying behaviour is critical for organizations to succeed in their objectives. Understanding the complexities of consumer purchasing behaviour has been the focus of numerous study projects for decades. This knowledge is essential because it makes better forecasting and insights into consumer behaviour and motivations possible, all of which greatly enhance the effectiveness of corporate operations as a whole (Stavkova, J. et al. (2008). [22]). Impulse buying is the phrase used to describe impulsive purchases that are carried out without any preconceived notion of buying a specific product category or meeting a specific demand. This type of conduct is defined by the lack of pre-shopping goals and happens when a consumer feels an overwhelming impulse to buy something without giving it much thought. It's crucial to remember that buying products that are out of stock and that you are reminded of when you see them are not classified as impulsive purchases (Muruganantham, G., & Bhakat, R. S. (2013). [23]).

5.1 Peer group/ Social Media factor influencing the OIBB

Purchase intent is significantly influenced by a number of social capital factors, including social engagement, peer trust, reciprocity, sharing language, and reciprocity language. Through social media, one can make personal relationships and gain credibility for a product or service through good interactions and recommendations from friends or other influencers. Potential customers are influenced and a good brand image is shaped by the use of sharing language, which is visible in user-generated content and online reviews (Xiang, H. et al. (2022). [24]). Electronic word-of-mouth (eWOM) wields a significant influence on high-level impulse buying behaviour, yielding positive effects. The prevalence of such communication channels plays a crucial role in elevating consumer awareness about products and concurrently diminishing uncertainty in their minds. This implies that individuals who occasionally indulge in social media seek insights and experiences from previous consumers, strategically mitigating risks associated with their purchase decisions. In essence, the abundance of eWOM not only facilitates informed consumer choices but also contributes to a reduction in perceived risks, ultimately influencing impulsive purchasing behaviours positively (Husnain, M. et al. (2016). [25].

Table 1: Show Peer group/ social media influence the Online Impulsive Buying Behaviour

S. No.	Area/Focus of Research	Contribution	Reference
1.	Peer pressure	Peer pressure is the term used to describe the active and passive effects that peers have over an individual's behaviour. Active peer pressure, on the one hand, refers to peers making conscious attempts to persuade others to do particular things. Conversely, passive peer pressure occurs when people avoid taking specific behaviours because they want to be accepted by their peers or because they are afraid of being rejected by them. Peer pressure can therefore take on diverse forms, influencing behaviour by means of both positive reinforcement and the avoidance of negative feedback.	Ungar, (2000). [26]
2.	Social Influence	Consumers' ability to exercise social influence over their peers has a direct relationship with their level of competence and reliability. Furthermore, the s-commerce system may greatly improve customers' capacity to trade social support, which is essential for promoting social influence, by offering support for customisation and social engagement.	Xi, et al., (2016). [27]
3.	Subjective norms	Different peer behaviours have different effects on impulse buying and self-control. This emphasizes	Efendi, et al., (2019).

		how important peers are in influencing consumer behaviour. Teenage friends or classmates seem to be more vulnerable to the impact of their peer groups due to the amount of time and engagement they spend with their peers.	[28]
4.	Two folds	Peer pressure has two folds. First, when other consumers engage in active purchasing, it creates intense competition among purchasers for a finite supply of commodities. The sense of scarcity created by this competition increases the incentive to buy the product on the spur of the moment. Scarcity plays a role in the impulsive online purchasing behaviour of customers. Second, when a product is viewed as "popular," people tend to assume that it must be good because most people think so. As a result, the product's appeal and scarcity together pique customers' interest, which eventually results in impulsive purchasing.	Li, et al., (2021). [29]
5.	Adolescents have more influence of their peers.	Young consumers are frequently linked to social influence and the effects of peer pressure on buying habits. They may appear to make impulsive purchasing decisions and depend on the support of their peers. This is a very common occurrence in young people and teenagers.	Gopal, et al., (2022). [30]
6.	Real-time Recommendations	The social networking website context amplifies the impact of peers on hasty buying decisions. Social media platforms offer a vast and user-friendly forum for people to express their thoughts, insights, and suggestions about goods and services.	Huang, (2016). [31]
7.	Live -Streaming	The emergence of e-commerce, especially on social media sites like Facebook and Instagram, has changed the face of online purchasing. Social media integration with eCommerce has spawned creative marketing techniques like live streaming that improve communication between customers and sellers. It is believed that as the number of people using social media grows, so will live-streaming shopping, which will lead to an increase in customers' impulsive purchasing behaviour.	Zahari, et al., (2021). [32]
8.	Five factors Model	The study examined at how five factors—variety seeking, environmental circumstances, trust, and hedonic motivation—affect impulsive purchases. Results showed that people are more likely to make impulsive purchases when social media marketing triggers hedonic motivation. Positive impressions of a website's quality also increase the possibility that users would make purchases right away. Customers are more likely to buy impulsively when they have faith in the platform or seller, which promotes last-minute decisions free from prior planning. The study also discovered that customers' tendency to make impulsive purchases is influenced by situational factors and variety seeking. Basically, impulse buying is the process of making instantaneous or spontaneous	Al-Zyoud, (2018). [33]

		purchases under the impact of external variables that lead consumers to make impulsive selections.	
9.	Brand Ambassadors	Influencers on social media have a big impact on the attitude-behaviour gap, which encourages impulsive purchasing among customers. The study shows how impulsive behaviour is affected by the communities of digital celebrities, indicating the significant influence that social media influencers have over purchasing decisions. The results highlight the value of using social media influencers to engage with consumers in ways that go beyond conventional marketing techniques.	Lina, et al., (2022). [34]
10.	Sense of security	Many customers seem to think that doing their shopping online encourages impulsive purchases. The thrill comes from the possibility of finding unusual things on the internet. Additionally, a powerful inducement to make more online purchases is a sense of confidence in online transactions, especially when facilitated by secured payment systems. Moreover, the impact of social media is apparent as customers indicate a high propensity to make purchases that correspond with their unique purchasing preferences when they come across pertinent material on these platforms.	Mahalakshmi, (2019). [35]
11.	Social Media Advertisement	clients' propensity for online impulse purchases is influenced by the favourable effect of perceived personalization on the perceived relevance of social media advertisements. The outcomes also demonstrate how perceived personalization shapes people's opinions about the novelty, value, and relevancy of social media advertisements.	Dodoo, N. A., & Wu, L. (2019). [36]
12.	Peer credibility and competence	Peer credibility and competence have a considerable impact on two different forms of social influence that have the power to dramatically alter customer behaviour. Basically, peers' credibility and experience become important variables that can affect how customers are affected by people in their social networks. Furthermore, it underscores the mediating function of the interchange of informational and affective social support among consumers, stressing the complex character of social impact in a consumer environment.	Hu, et al., (2019). [37]
13.	The interactive features	The interactive features provided by social media sites, like rating, reviewing, commenting, and feedback, which enable users to make well-informed judgments about what to buy. Notably, this influence is especially noticeable among female customers, who are more likely to decide quickly and impulsively when thinking about making a purchase.	Yue & Razak, (2018). [38]
14.	Fear of Scarcity	Excessive social media use is a major factor in the relationship between scarcity messaging and impulsive purchasing among Indonesian	Elisa, et al (2022). [39]

		consumers. In particular, increased consumer concern under the difficult COVID-19 pandemic circumstances seems to amplify the effect of scarcity messaging as an external trigger on compulsive and impulsive buying inclinations.	
15.	Heterophily and Homophily	The growth of social media customers is now more vulnerable to being influenced by social media influencers to make impulsive purchases. Their ability to build parasocial bonds with their followers will determine how successful these influencers are. Influencers can cultivate two-sided parasocial ties that satisfy their followers' needs for emotional and informational support by using a clever combination of heterophily and homophily. By creating content that meets the requirements of followers—whether they be informational or emotional—this strategy effectively encourages impulsive buying. Social media influencers essentially use these individualized connections to influence their audience's hasty purchases.	Hu, et al (2023). [40]

5.2 Website features influencing the Online Impulsive Buying Behaviour.

In order to encourage customers to make impulsive purchases, online businesses must pay close attention to the aspects of website quality. The results show that simplicity of use is the most important factor influencing online impulse purchase behaviour among these variables. Factors like the website's intuitive operations and information clarity fall under the category of ease of use. This suggests that the possibility of impulsive purchases can be greatly increased by creating websites with easy-to-navigate content and simple user interfaces (Turkyilmaz, C. A., Erdem, S., & Uslu, A. (2015). [41]). A website's quality is crucial in the e-commerce industry since it influences customers' impressions, which in turn affects their decisions to buy. The significance of website quality in enhancing consumer purchase intentions has attracted the interest of academic scholars and industry practitioners (Ongsakul, V. et al. (2021). [42]).

Table 2: Show website features influence the Online Impulsive Buying Behaviour.

S. No.	Area/Focus of Research	Contribution	Reference
1.	Well-designed website.	Customers with high levels of impulsivity have a stronger propensity to react favourably to an expertly designed website. In contrast, their responses are typically more negative when they come upon a subpar website. Thus, even though an e-commerce website's overall quality is important, understanding the impulsiveness that exists within the customer base is essential to understanding the dynamics that underlie varied responses to different website quality levels.	Parboteeah, et al., (2009). [43]
2.	Effect of website quality in customer satisfaction	An individual's overall opinion regarding the purchasing experience is significantly shaped by their interaction with a service site and subsequent sense of satisfaction. This constructive interaction—which is made possible by a beautifully designed, high-quality website—goes beyond simple functionality and helps to create a welcoming environment for online buying. When a user is satisfied, it acts as a catalyst, creating a good	Widagdo & Roz (2021). [44]

		attitude that has a big impact on their decision to buy later.	
3.	Visual appeal	Visually appealing websites are more likely to grab users' attention and create positive feelings in them. A well-designed website's practical advantages can expedite client encounters by cutting down on the time and effort needed to locate particular services. Additionally, these practical advantages may stimulate consumers to make impulsive purchases.	Chen, et al., (2019). [45]
4.	Online cues	The three factors of perceived product availability, visual appeal, and website usability work together as important online cues that greatly impact and promote impulse buying. One important consideration is how easy a website is regarded to use, which includes how straightforward and natural the online purchasing experience is. Users are more likely to make impulsive purchases on websites that are easy to navigate because it reduces obstacles and promotes making decisions quickly.	Liu, et al., (2013). [46]
5.	E-Wallet.	Users are more likely to conduct impulsive, unplanned transactions when they positively identify and feel satisfied with using e-wallets. Because it frequently results in the fast fulfilment of desires, this phenomenon can be beneficial for consumers and improve their overall shopping experience. Consumers can strike a balance between enjoyment and financial restraint by making more informed judgments by acknowledging the possibility of impulsive purchases motivated by favorable e-wallet experiences.	Lee, et al., (2023). [47]
6.	Sense of comfort and confidence.	The possibility of making impulsive purchases online is directly correlated with a website's quality. It follows that customers are more likely to make impulsive purchases when they are pleasantly impacted by the excellent websites offered by online businesses. An excellent e-commerce website instils confidence and comfort in users, encouraging spontaneous purchasing. A greater proportion of impulsive internet buyers can be attributed to improvements in confidence and less uncertainty. When they are positively influenced by an attractive website that online businesses provide, they are more likely to make impulsive purchases.	Hasim, et al., (2018). [48]
7.	Surfing activity	Online reviews provide consumers with perceived utilitarian and hedonistic value, which enhances their browsing habits. This surfing activity ultimately influences consumers' impulse buying behaviour by having a beneficial effect on their propensity to make impulsive purchases. Furthermore, this study suggests that those who are highly impulsive also favor the hedonic value in online reviews, while others who are less impulsive emphasize the utilitarian worth more. For customers with higher levels of impulsivity,	Zhang, et al., (2018). [49]

		browsing has a more noticeable impact on the impulse to buy.	
8.	Online reviews	customer reviews from the past are crucial in predicting whether an internet business will succeed or fail. This phenomenon is ascribed to the regular encounter of online customers with these reviews during their website visits, and the consequent influence of these reviews has a direct bearing on their propensity to engage in online impulse buying behaviour.	Hong,et al., (2021). [50]
9.	Pop-up advertisements	Pop-up advertisements have a significant impact on the target audience's intention to buy. These advertisements appear out of nowhere on websites, drawing users' attention and creating a sense of urgency that leads to rash purchases. In addition, the continuous display of pop-up advertisements improves recall of crucial product attributes including features, costs, and other pertinent information, which reinforces their influence on purchase intent.	Balhareth, (2023). [51]
10.	Online promotion activity	A significant amount of online promotion activity creates a unique shopping experience for mobile users. In this environment, a number of situational factors, including promotion components, the social context, features of the mobile website, and time and budgetary constraints, work together to shape consumer behaviour.	Liu & Zhang (2019). [52]
11.	Seasonal offers	Customers are often filled with a sense of urgency and excitement during flash sales because of their exclusive deals and limited-time offerings. Customers are stimulated by the unique environment created by the anticipation of a limited-time offer, which makes their shopping experience more dynamic and engaging. When compared to typical or routine transactions, flash sales are more enjoyable because of this additional stimulation.	Dsilva & Elangovan, (2021). [53]
12.	Use of credit cards	The direct association between credit card usage and impulsive purchases exhibits a notable positive impact on compulsive buying behaviour. Additionally, this influence indirectly affects compulsive purchases, mediated by both credit card usage and impulsive buying tendencies. Credit cards facilitate easy and unrestricted access to transactions, providing users with the flexibility to make purchases in various situations. Consequently, the uncontrolled utilization of credit cards poses a significant risk of fostering compulsive buying habits, emphasizing the need for effective control measures.	Cuandra & Kelvin, (2021). [54]
13.	Internet celebrities (ICs)	Internet celebrities (ICs) have gained importance in the changing landscape of consumer behaviour as a key element encouraging impulsive purchases. This phenomenon highlights a paradigm change in which the endorsements and suggestions of influencers	Chen, et al., (2021). [55]

		(ICs) hold substantial weight in consumer decision-making. The point where spontaneous purchase and IC endorsement collide presents a new scenario where trust becomes crucial.	
14.	Mobile shopping Apps	Improving mobile applications' usefulness, usability, and interaction has been found to be a crucial component affecting how satisfied and happy consumers feel with them. Increased user satisfaction is anticipated to result from these improvements, which will ultimately strengthen the tendency toward impulsive purchasing. It is not only directly related to user pleasure but also acts as a mediator in the relationship between the entire user experience and the functioning of a mobile augmented reality app when people find it easy to use.	Do, et al., (2020). [56]
15.	Website security	Customers are more likely to feel secure and at ease while browsing and making purchases on a website that they believe to be reliable and secure. A sense of trust is fostered by assurances on the security of financial and personal data, which allay worries about possible threats. Because they feel more secure, users may be more likely to make impulsive purchases because there may be less hesitancy and friction during the purchasing process.	Narimanfar & Ashtiani, (2021). [57]

5.3 Trust influencing the Online Impulsive Buying Behaviour.

Establishing consumer confidence is heavily dependent on the legitimacy of the message distributed by digital influencers as well as the platform or media that delivers it. This trust becomes a crucial component affecting impulsive buying behaviour in the world of Social Networking Sites (SNSs), where digital influencers have a significant amount of power. The perceived validity and dependability of the material given by influencers is referred to as message credibility. Customers are more likely to form a favourable opinion of the goods or services being pushed when they believe the messaging that influencers are trying to convey (Shamim, K., & Islam, T. (2022). [58]. Brand awareness has a significant impact on consumer trust and perceived risk in the context of social commerce. Popular companies are more likely to inspire consumer trust, which lends them legitimacy and dependability in the context of social commerce. Because they are more familiar with these companies, consumers are less afraid to interact with a recognizable and trustworthy company, which reduces perceived risks. In a social commerce setting, a well-known brand's simple existence acts as a strong endorsement, allaying worries and boosting trust in prospective customers (Han, M. C. (2023). [59].

Table 3: Show the Trust factor influence Online Impulsive Buying Behaviour.

S. No.	Area/Focus of Research	Contribution	Reference
1.	Online trust	When it comes to online purchases, trust is best understood as customers' willingness to overlook certain flaws as long as they have high hopes for the online retailer's future activities. In light of the favourable expectation for the online store's dependability, honesty, and ability to live up to expectations in future exchanges, it denotes a readiness to ignore apparent weaknesses or uncertainties in the current transaction. This trust-based dynamic plays a critical role in determining how customers view the	Kimery & McCord, (2002). [60]

		online business, how they make decisions, and how secure they feel. Trusted customers are more inclined to make purchases because they have faith that their future contacts with the online store will consistently meet their expectations and provide great experiences that will outweigh any current restrictions.	
2.	Web shopping and trust	The actions customers take to purchase goods or services online are collectively referred to as web shopping. Consumer decisions to conduct online transactions are largely influenced by trust, which is a key component of the online buying experience. The words flow naturally from one another, demonstrating the trust and dependability users have in the online stores where they shop and browse. Building trust is essential for online retailers because customers want to feel confident in the safety of their transactions, the value of the goods or services, and the legitimacy of the website as a whole.	Shim, et al., (2013). [61]
3.	Intention to purchase online.	Relying exclusively on behavioural metrics may not always be as beneficial as planned actions, such as building trust in online purchase. If businesses focus on building trust in the online purchasing process, they can better capture the customer's mind and encourage more deliberate, preference-driven purchases. Constraints may force customers to make hasty purchases rather than real ones.	Funke & Day, (1976). [62]
4.	Brand orientation	Numerous online businesses in the e-commerce space match their corporate name to their brand. In this case, when consumers are more likely to make impulsive online purchases, the trust that comes with corporate and brand names acts as a stand-in for comprehensive product information. This emphasizes how important brand orientation is for building trust and encouraging rash purchases.	Ward & Lee, (2000). [63]
5.	Quality orientation	A major factor in building trust and, in turn, encouraging impulsive purchasing behaviour is the focus placed on quality oriented. Consumers can develop trust in an online store when they sense that the company is dedicated to providing high-quality goods and services. Because they are assured of receiving high-quality products, buyers in the shopping enjoyment sector are prompted to make impulsive online purchases as a result of this trust, which in turn makes them feel more confident and satisfied.	Gehrt, et al., (2007). [64]
6.	Previous experience with Online purchases	Trust is built on good experiences in the past with an online platform: trustworthy product details, easy payment processing, fast delivery, top-notch customer support, and strong privacy and security protocols. Impulsive purchasing occurs when clients are comfortable, trusting, and confident in their online purchases.	Burke, (2002). [65]
7.	Connection between buyers and sellers	In the world of internet purchasing, trust is an essential component that holds the transactional connection between buyers and sellers together. The three main pillars of this trust are predictability, fairness, and	Doney & Cannon, (1997). [66]

		dependability. Furthermore, trust is seen as a financial calculation in which values are deduced from actual relationship maintenance expenses and the relationships that are established and maintained.	
8.	Online social network	In the field of social computing, the idea of trust in online social networks has gained prominence. It can be applied to a wide range of situations, such as friend referrals, e-commerce, and trust-based access control systems. The formation and evaluation of trust are critical in these various situations, which reflects the increasing understanding of the significance of trust in influencing user interactions and enabling dependable connections in the digital sphere.	Zhao & Pan, (2014). [67]
9.	Ethics and Trust	When customers have faith in a company or brand, they are more comfortable making impulsive and hasty purchases. The establishment and maintenance of this trust are facilitated by ethical business practices. For example, genuine and transparent product information, reasonable prices, and dependable customer support all help to create a favourable impression of the brand.	Van, et al., (2009). [68]
10.	Price sensitivity	A sense of value and dependability is fostered in customers when they see a price reduction or obtain a free voucher, leading to an implicit faith that they are getting a good bargain. Since consumers feel more secure in making a purchase when they think they are receiving a good deal, the impression of affordability plays a critical role in influencing impulsive buying decisions. In addition to encouraging impulsive purchases, the pricing strategy's trust element builds a favourable relationship between the customer and the brand, which may encourage repeat business and long-term loyalty.	Syahrini & Arif, (2019). [69]
11.	Online reviews	The impulsive nature of purchases is frequently determined by various important factors, and consumer behaviour has a considerable impact on the online buying scene. One important factor is how entertaining people think online reviews are. Reviews that are interesting and positive can thrill and satisfy readers, which may lead them to make impulsive purchases. The reputation of the reviewer is also a crucial consideration. Because a great reputation lends legitimacy to the information presented, consumers are more likely to act impulsively and believe evaluations from reliable and trustworthy sources.	Chen & Ku, (2021). [70]
12.	Hedonic factor	The drive for instant gratification and pleasure is known as hedonic motivation, which makes impulsive purchases a desirable way to satisfy emotional needs. But trust gives customers a sense of comfort and confidence by lowering the perceived dangers connected to rash purchases. These variables work together to foster an environment that is favourable to impulsive purchasing because customers are more inclined to follow their impulses when they are driven by pleasure and have faith in the businesses engaged in the transaction.	Lavuri, et al., (2022). [71]

13.	Situational factor	Retailers who provide easy credit lines or discounts associated with obtaining a charge card might have a beneficial impact on consumers' financial perceptions. Customers feel free to spend in this setting because of these situational considerations. Furthermore, as emotion and browsing have a significant influence on impulsive purchases, businesses should constantly prioritize building trust and fostering a positive shopping experience.	Foroughi, et al., (2012). [72]
14.	Advertisement	Social media advertising uses the interactive elements, eye-catching visuals, and in-the-moment interaction of the platform to stimulate impulsive purchasing. Impulsive buying is not only promoted but also effortlessly integrated into the user experience on social media due to the combination of persuasive advertising strategies, frictionless purchasing alternatives, and social influence.	Chawla, (2020). [73]
15.	Fairtrade	Knowledge of Fairtrade (FT) is an essential component for both product involvement and antecedent trust. Customers' degree of engagement with the product and their level of faith in Fairtrade has a positive impact on their readiness to pay more for Fairtrade goods. Consumer product involvement is highly influenced by the degree of trust that people have in the Fairtrade movement.	Aksoy & Ozsonmez, (2019). [74]

5.4 Positive emotions' impact on impulsive purchases

Shopping can be made more enjoyable when people are in a good mood, which increases their susceptibility to impulsive purchases. Making impulsive purchases is one method that customers who are in a pleasant emotional environment could try to maintain or even improve their cheerful disposition (Ahmad, M. B. et al,(2019). [75]). Individuals with a high need for cognition (NC) who were in a pleasant mood reported a higher chance of repercussions and more favourable attitudes than those in a negative mood. Furthermore, respondents in happy moods evaluated a marginally higher likelihood of positive consequences and a lower likelihood of negative repercussions in comparison to subjects in negative moods (Wegener, D. T et al,(1994). [76]).

Table 4: Shows how positive mood/emotions impact impulsive buying

S. No.	Area/Focus of Research	Contribution	Reference
1.	Positive mood	Online impulsive buying behaviour is influenced by positive emotions, which are set off by captivating and alluring promotions. Promotions can elicit feelings of excitement, pleasure, or satisfaction in consumers, which can lead to impulsive purchasing decisions motivated by the need to preserve or improve their happy emotional state.	Tu, et al., (2017). [77]
2.	Creativity	The association between physical workspace characteristics and employees' creativity is significantly mediated by the activation of happy mood. Interestingly, those who are in an activated pleasant mood are far more likely to be able to benefit from the positive effects of a physical workspace on creativity. On the other hand, a decreased happy mood in this relationship does not show the same degree of relevance as a mediator.	Lin & Chang, (2020). [78]
3.	Emotional	Emotionally intelligent individuals know when their own	Hejase, et

	intelligent	emotions are low and try to make up for it. This is where the relationship between self-motivation and purchasing, especially impulsive buying, takes an interesting turn. Remarkably, a lot of consumers might not even recognize that when they go shopping, it serves as a purposeful catalyst for inspiration during dark moments.	al. (2018). [79]
4.	Utilitarian products	Good moods make people more impulsive online, especially when they're buying utilitarian products, and they also tend to keep their levels of impulsivity higher. People with high social values are more susceptible to this effect.	Arruda, et al., (2023). [80]
5.	Emotional balance	A steadier and in control decision-making process is enhanced by emotional balance. People who are emotionally balanced are less prone to be influenced by impulsive or temporary feelings. In the context of impulsive buying, where the choice to make a purchase is frequently motivated by irrational emotions, this consistency is vital.	Al-Masri, (2020). [81]
6.	Mood clarity, mood healing and mood monitoring.	Mood clarity is strongly influenced by the interaction of regulatory focus motives, namely mood healing and mood monitoring. Hedonic purchasing values are impacted when people search for happy experiences to improve their mood, engage in mood-repairing behaviours, and simultaneously assess their emotional states. This dynamic relationship exerts significant influence over the impulsive purchasing tendencies of individuals. The correlation between mood clarity and regulatory focus motives clarifies the complex relationships between psychological variables and consumer behaviour. It also illuminates the complex processes by which moods influence impulsive buying behaviour in the context of hedonic shopping values.	Parsad, et al., (2021). [82]
7.	Salespersons' retail service quality	When people are feeling good about themselves, they have a higher propensity to be Impulsive buying than when they are feeling bad. Mood acts as a complete mediator for purchase amount, directly influencing Impulsive buying. The Salespersons' Retail Service Quality (SRSQ) also have an effect on IB. Mood serves as a partial or complimentary mediator for both buy and store-visit intentions, highlighting the complex relationship between successful sales service, emotional states, and ensuing customer behaviours.	Pornpitak pan, et al., (2017). [83]
8.	Pre and post purchase mood	Pre-purchase emotions and the innate propensity for impulsive purchases both have a favourable impact on consumers' impulse buying habits. People are more likely to make impulsive purchases when they are in a favourable pre-purchase mood, which is defined by enhanced emotions or excitement. In a similar vein, a tendency to make impulsive purchases acts as a separate motivator for this kind of conduct. It's interesting to note that impulse buying had no appreciable effect on post-purchase mood, while being positively associated with pre-purchase mood and tendencies.	Ozer & Gultekin, (2015). [84]
9.	Mood and time pressure	People are more likely to make impulsive purchases when they are feeling positive and experiencing feelings	Bahrainiza d &

		such as joy or enthusiasm. Impulsive purchases are also influenced by time constraints, such as having little time to think issues through before making a decision. The beneficial effects of time constraints and mood on impulsive purchases highlight how emotional states and outside influences influence consumer behaviour. According to these results, which demonstrate the dynamic interaction of situational and psychological factors, impulsive purchasing habits are largely fostered by favourable moods and time limitations.	Rajabi, (2018). [85]
10.	Retail environment.	Impulsive purchase is directly influenced by the retail environment, and this effect is strengthened when favourable emotional reactions are created. Impulsive buying is encouraged when a store's ambiance is deliberately chosen to arouse good feelings, such as coziness, beauty, or sensory appeal. The direct influence shows that a store's atmosphere and physical characteristics can both independently encourage impulsive buying. Furthermore, the indirect channel through positive emotional responses highlights how the store environment's ability to generate strong emotional responses greatly increases the risk of impulsive buying, underscoring the complex function that ambiance plays in influencing consumer behaviour.	Sultan, et al., (2018). [86]

5.5 Hedonic motivation and its impact on impulsive purchases:

The relationship between social influence and hedonic incentive strongly influences behavioural intention, and payment habit plays a key mediating role in this process. Hedonistic motivation, which is motivated by the desire for pleasure and enjoyment, interacts with social influence to reflect how outside influences affect personal choices. This combined force influences behavioural intention directly as well as through the ingrained payment patterns of individuals (Khatimah,H. et al,(2018).[87]). The desire for pleasure and satisfaction, or hedonic motivation, is a major factor in determining whether or not people would utilize augmented reality apps on their phones. Hedonic motivation has a significant and beneficial impact, indicating that users are more inclined to interact with applications when they are looking for pleasurable and satisfying experiences (Mallari, E. F. I., et al, (2023). [88]).

Table 5: Shows how Hedonic motivation impact impulsive buying.

S. No.	Area/Focus of Research	Contribution	Reference
1.	Hedonic incentives	Hedonic incentives, which include aspects like idea, satisfaction, and adventure, have a beneficial impact on impulsive purchasing behaviour. Every dimension has a unique influence on how consumers make decisions. Adventure-driven motivations allude to a need for fresh and thrilling encounters, which leads to rash buying of novelty-oriented goods. Gratification motives, which are linked to impulsive purchasing behaviours, are the desire of pleasure and instant gratification. The attraction of imaginative or creative products is reflected in idea-related reasons, which lead to impulsive purchases motivated by the need for something fresh and original.	GÃ¼ltekin, (2012). [89]
2.	Gamification	A combination of gamification dynamics, electronic word-of-mouth, and enjoyment	Aghdaie, (2021).

		significantly affects the propensity for impulsive purchasing in the context of consumer behaviour. More specifically, gamification relies heavily on aspects like status, rewards, self-expression, and charitable actions to improve user experience and promote enjoyment. This increased pleasure then serves as a stimulant for compulsive purchasing behaviours.	[90]
3.	Lifestyle and hedonic pleasure	The attraction of hedonistic shopping, which is motivated by the need for enjoyment and emotional fulfilment, has a big influence on impulsive purchases. When people shop online, they combine lifestyle decisions with the need for instant gratification because they want to feel both useful and satisfied emotionally. Comprehending the complicated details of the middle-class consumer sector in the digital marketplace is vital for marketers to customize their methods.	Ustanti, (2018). [91]
4.	Positive emotions	Positive emotions operate as a mediator between hedonic shopping motivation and impulse buying. Stated alternatively, hedonic purchasing incentive is translated into impulsive buying behaviour largely through the influence of happy emotions. Customers with higher hedonic purchasing motivation are more likely to feel good and have more impulse buying inclinations. Furthermore, there is a direct correlation between fashion participation and an increase in impulsive buying, suggesting that fashion engagement itself acts as a separate catalyst for impulsive purchasing behaviour. In the context of hedonistic purchasing and fashion engagement, an understanding of these complex relationships helps to illuminate the subtle motivations underlying consumer impulse purchase.	Andani & Wahyono, (2018). [92]
5.	Store environment	The effect of store environment on consumer satisfaction varies according to the context of the purchase; hedonistic and utilitarian environments exhibit different effects. In particular, the environment within stores becomes the most important factor in explaining consumer happiness in hedonistic purchasing, whereas product placement becomes the most relevant factor in utilitarian shopping situations. As a result, one important finding is that various store atmospheric cues have different effects on customer satisfaction in various shopping contexts. This emphasizes how crucial it is to customize environmental elements to suit customers' unique requirements and preferences in various kinds of shopping experiences.	Calvo-Porral & Lévy-Mangin, (2021). [93]
6.	Situational factors	Situational factors have a significant and favorable impact on college students' impulsive buying and hedonic shopping motivation in Manado City's mall. These outside factors serve as triggers,	Mamuaya & Tumiwa, (2017). [94]

		increasing the desire for enjoyable shopping experiences while also encouraging impulsive purchasing behaviours. Situational circumstances both directly contribute to impulsive purchasing behaviour and heighten the attraction of hedonic shopping, demonstrating the relationship between the two. This dynamic relationship highlights the role that external settings play in influencing college students' purchasing habits. It also highlights the complex interaction that exists between situational factors, hedonic shopping incentive, and impulsive buying in Manado City's retail environment.	
7.	Price discounts	Price reductions and promotional support have a definite, favorable, and considerable effect on hedonic shopping motivation. Customers are directly stimulated to seek out hedonic purchasing experiences when they come across alluring promotions and price reductions. A strong incentive that amplifies the allure of hedonistic purchases is the possibility of saving money or getting more value. This direct correlation highlights how economic incentives influence consumer behaviour and how powerful price-related elements are in enhancing the hedonic purchasing experience. Therefore, companies can successfully tap into and boost consumers' hedonic spending incentives by properly implementing discounts and promotions.	Anggarwati, et al., (2023). [95]
8.	Serendipity, trust, experience	Serendipity, the delightful surprise of finding unanticipated goods, piques curiosity and leads to rash choices. A sense of security is created by having faith in the brand or product, which lowers reluctance and encourages spontaneous purchasing. Furthermore, customers are propelled into a state of increased engagement and spontaneity during the flow experience, which is marked by immersive and pleasant interactions, which encourages impulsive buying behaviour. Together, these components establish a favorable setting where the chance finding, reliability, and immersive experience heighten the attraction of rash purchases, illustrating the complex interaction between psychological variables and consumer behaviour in the context of impulsive buying.	Bao & Yang, (2022). [96]
9.	Website attributes	When considering other aspects of websites, the effect of the user experience is the most significant factor on the hedonic motivation of consumers. Hedonistic motivations in online shopping are greatly influenced by a smooth and entertaining online experience. Furthermore, the association between impulsive buying behaviour and website attributes—such as web experience, quality, and content—is significantly mediated by hedonic incentive. Users' hedonic motives are stimulated	Hiranrithikorn & Banjongprasert, (2022). [97]

		when they are engrossed in a satisfying and pleasurable online experience, which in turn influences their propensity for impulsive purchases. This complex web of connections highlights how important online surroundings are in influencing consumers' impulsive purchasing behaviour as well as hedonic motivation.	
10.	Sales promotion attributes	Sales promotions exert a profound influence on hedonic shopping, triggering impulsive buying behaviours. The allure of discounted prices, limited-time offers, or special deals creates a sense of urgency and excitement, enhancing the overall hedonic experience for shoppers. This heightened emotional state, fueled by the perception of gaining value, intensifies the desire for impulsive purchases. The urgency and perceived benefits of the sales promotion contribute to impulsive buying tendencies, as consumers are motivated to seize the opportunity and fulfill immediate gratification. Thus, sales promotions play a dual role, enhancing the hedonic appeal of the shopping experience and catalyzing impulsive buying through a potent combination of psychological and economic incentives.	Liao, et al., (2009). [98]

6. CURRENT STATUS :

Online impulse buying has significantly increased due to factors such as social media influence, targeted advertising, easiness of one-click shopping, and other factors. Impulsive buying has increased due to the convenience of internet transactions and the growing rush that comes with speedy rewards. Retailers use scarcity tactics, time-limited sales, and tailored recommendations to intensify impulsive decision-making. Financial consequences are a concern when buyers may exceed their budget. Online marketers must prioritize the convenience of their customers. Ensuring safe online transactions is essential, with a particular emphasis on protecting consumer data by implementing strict privacy protection guidelines.

7. IDEAL SOLUTION FOR CURRENT STATUS :

Convenience and data security should be given top priority by marketers to improve online impulsive purchasing behaviour. The DPIIT's (Department of Promotion of Industry and Internal Trade) must propose a better policy which aims to establish a regulator, formulate an e-commerce law, and impose penalties, covering both Indian and foreign-funded platforms. It emphasizes healthy competition with brick-and-mortar establishments and requires internet retailers to keep client information up to date. Strict guidelines for personal information protect privacy is much needed. Customers use social media to look for product reviews and information. They must be cautious of deals and discounts and choose reliable websites. In recently scenario, impulsive purchases can be influenced by building a strong online presence and trust.

8. RESEARCH GAP :

This study delves into the factors influencing trust and its connection to online impulsive buying behaviour. Previous research highlights social influence, website quality, hedonic motivation, and trust as key drivers of impulsive buying. Unlike existing literature, this study positions trust as a mediating factor. In the current context, making careful online purchases is crucial and transforming impulsive buying into a rewarding experience.

9. RESEARCH AGENDA :

Internet marketers, researchers, online companies, and customers all have a keen interest in impulsive buying behaviour. It's critical to comprehend the key elements in the contemporary digital world that lead consumers to make hasty purchases. The impulsive purchasing decisions of consumers are shaped by various factors, including social impact, website quality, trust, pricing, and advertisements. These factors are indicative of the changing nature of online market.

1. What are the factors influencing impulsive purchasing behaviour?
2. Do trust have any influence on online impulsive buying?
3. How does the social media influences online buying behaviour?
4. Whether subjective norms influence the customer perception while buying online and does it lead to online impulsiveness?

10. ANALYSIS OF RESEARCH AGENDA :

a. Factors influencing impulsive buying behaviour:

The complex nature of impulsive buying is a problem for market researchers. The intricate interactions between the variables driving impulsive purchases have a synergistic effect that increases sales turnover in the end. For merchants and marketers, this phenomenon is helpful as it highlights how crucial it is to comprehend and utilize the intricacy of impulsive purchasing behaviour in order to succeed in business (Sumetha, M., & Vasanthi, S. (2016). [99]).

b. Trust element affecting online impulsive buying:

Impulsive purchases are predicted by an individual's level of trust in internet retailers. Impulsive buying is more common among clients who believe that internet platforms are reliable. As a crucial factor in their decision-making process, trust promotes dependability and security in online transactions. Marketers may take advantage of this understanding by giving trust-building initiatives top priority in their online stores, fostering an atmosphere that favors impulsive buying among the student population (Adriansyah, M. A., & Rahman, M. T. (2022). [100]).

c. Social media influences online buying behaviour:

Online shopping has been popular due to the extensive integration of social media platforms on mobile devices, which has changed e-commerce. Social media retailing gives customers an immersive experience by enabling in-depth evaluations and comparisons of desired goods and services with competing ones. Users improve their decision-making process by utilizing the abundance of customer input. This dynamic is further amplified by online communities, which facilitate the exchange and reception of a wide range of shopping experiences. Customers can now make well-informed decisions and feel more engaged in the community thanks to this networked environment, which also makes online purchasing more socially and participatory (Ebrahimi, P., et al., (2023). [101]).

d. Subjective norms influence the customer perception while buying online.

One important factor contributing to impulsive purchasing behaviours is subjective norms, which refer for societal influences and expectations. It affects people's intentions to make impulsive purchases when they believe that their friends or society norms support such actions. Impulsive purchasing actions may stem from a desire to live up to imagined societal standards. Proximal behavioural control, which expresses a person's confidence in their capacity for spontaneous buying, also influences purchasing intentions. For marketers looking to impact impulsive purchasing behaviour in their target market, comprehending and addressing these variables is crucial.

11. FINAL RESEARCH PROPOSAL :

Based on a thorough analysis and review of the relevant literature, this article advises investigation exploring Customer Reactions to Online Impulsive Buying.

(a) **Proposed title**: Customers' Shopping Response towards Online Impulsive Buying Behaviour
(b) **Geographical area of study**: Dakshina Kannada District, Udupi District and Bengaluru urban.
(c) **Target respondents of the study**: Consumers who buy online.

12. SWOC ANALYSIS OF ONLINE IMPULSIVE BUYING BEHAVIOUR OF A CUSTOMER :

SWOC analysis provides a complete overview of the factors inducing online impulsive buying behaviour, helping companies plan and address both strengths and weaknesses in the dynamic e-commerce landscape.

Table 6: The SWOC Analysis of online impulsive buying behaviour of a customer.

Strengths:	**Weaknesses:**
a. Online platforms provide a suitable shopping experience, allowing users to make purchases anytime, anywhere. b. Customers have easy access to a wide range of products with just a few clicks. c. Data analysis allow personalized product references, increasing the possibility of impulsive purchases based on individual preferences. d. Online retailers can employ attractive promotional strategies, such as flash sales and limited-time discounts, to stimulate impulsive buying behaviour.	a. Customers miss the physical inspection of products, leading to potential dissatisfaction upon receiving the purchased item. b. The vast collection of options online can overwhelm customers, making it challenging to make well-planned decisions. c. Lack of face-to-face interaction reduces the emotional connection between the buyer and the product, which may affect customer satisfaction. d. Customers may hesitate to make impulsive purchases due to concerns about online safety and the security of their financial information.
Opportunities:	**Challenges:**
a. Companies can make use of influencers and social media networks to reach followers' impulsive purchasing tendencies. b. Real-time feedback and reviews can influence impulsive buying behaviour positively, building trust and credibility. c. Customer data can be used to identify patterns and trends, enabling businesses to tailor their strategies to trigger impulsive purchases. d. As mobile devices become more common, systems should be optimized for mobile commerce to take advantage of spontaneous purchase opportunities.	a. Customers may be less satisfied with impulsive purchases because of the problems related with returning or refunding them due to the online nature of transactions. b. Post-purchase regret is a common outcome of impulsive buying, particularly when consumers discover they made rash decisions without giving them enough thought. c. Strong competition in the online marketplace may make it hard to stand out and capture impulsive buyers amid numerous alternatives. d. Ad-blocker usage and banner blindness are on the rise, which could lessen online advertising's ability to encourage impulsive purchasing.

(SOURCE: Compiled by the Researcher)

13. SUGGESTIONS :

To further encourage impulsive purchasing, marketers should place a high priority on improving the data security and simplicity of online transactions. Stressing the need of putting strong privacy protection policies into place is crucial to gaining and retaining client trust. Furthermore, balancing levels of competition is ensured by encouraging regulatory agencies such as DPIIT to create a regulator, create comprehensive e-commerce legislation, and implement penalties. This strategy protects consumer interests while also promoting healthy competition. To influence and maintain impulsive purchases in the present environment, it will be essential to maintain a strong online presence and build trust through open and honest procedures.

14. LIMITATIONS :

Online impulsive buying behaviour have varied opportunities but, it also comes with challenges. In comparison with physical stores, the dependence on virtual interactions can reduce the amount of sensory stimulation, which could have an impact on the triggers of impulsivity. The development of trust is also impacted by the digital sphere, which raises questions regarding the protection of personal data. Retailers still have difficulties in comprehending the many variables that impact impulsive purchasing, including cultural differences. Online trends are cyclical, which means that companies have to be flexible and quick to adjust. In conclusion, the necessity of responsible marketing tactics in the online retail industry is underscored by ethical issues when utilizing impulsive conduct for financial gain.

15. CONCLUSION :

Impulsive online purchasing accounts for about 40% of all sales in economically developed countries, greatly influencing today's consumer marketplaces. Retailers intentionally appeal to consumers' dreams because they understand the emotional demands that motivate hasty purchases. The quality, knowledge, and complex details of a website are important factors that impact customers. E-marketers must employ strategies that emphasize situational factors, trust-building, and hedonic motivations in order to effectively encourage spontaneous purchases. Furthermore, online buying experiences are greatly impacted by elements like ease of use, emotional reactions, and well-designed websites. Recognizing differences in emotional states, channels of purchase, and impulse buy triggers gives marketers a thorough insight and allows them to customize strategies that appeal to a range of consumer demographics.

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Tech-Business Analytics in Tertiary Industry Sector

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Subject Area: Computer Science.
Type of the Paper: Exploratory Research.
Type of Review: Peer Reviewed as per |C|O|P|E| guidance.
Indexed In: OpenAIRE.
DOI: https://doi.org/10.5281/zenodo.10473829
Google Scholar Citation: IJAEML

How to Cite this Paper:
Kumar, S., Krishna Prasad, K. & Aithal, P. S. (2023). Tech-Business Analytics in Tertiary Industry Sector. *International Journal of Applied Engineering and Management Letters (IJAEML)*, *7*(4), 349-454. DOI: https://doi.org/10.5281/zenodo.10473829

International Journal of Applied Engineering and Management Letters (IJAEML)
A Refereed International Journal of Srinivas University, India.

Crossref DOI: https://doi.org/10.47992/IJAEML.2581.7000.0208

Received on: 20/11/2023
Published on: 31/12/2023

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ABSTRACT

Purpose: *Tech-business analytics play a crucial role in the tertiary industry sector by enabling data-driven decision-making and providing analytical insights to enhance customer experiences, improve operational performance, and drive corporate growth. This sector, which includes industries such as healthcare, finance, education, and professional services, benefits from tech-business analytics through the analysis of vast data sets like patient records, financial transactions, student performance, and customer interactions. By identifying patterns, trends, and insights within these data sets, businesses can make more informed decisions.*

Design/Methodology/Approach: *The tertiary industry sector employs an organized, iterative approach to tech-business analytics, which involves defining business issues, collecting and cleansing data, analysing this data, interpreting the results, and communicating these findings to stakeholders. Through this process, businesses are empowered to make informed decisions that support their growth and development.*

Findings/Result: *The report talks about how Tech Business Analytics in the Tertiary Industry Sector will have controlled the expansion itself from its evolution to this point.*

Originality/Value: *A description of how business analytics varies from tech business analytics in the tertiary industry sector. For technical purposes, there is also a generic architecture that examines 30 recently published Tech Business Analytics in Tertiary Industry sector research projects.*

Paper Type: *Exploratory Analysis.*

Keywords: Business Analytics (BA), ICCT underlying technologies, Tech-Business Analytics, TBA, Tertiary Industry, Data Science, Big Data Analytics, Research gap in Business Analytics, ABCD Listing, Tech-business Analytics, Service industry,

1. INTRODUCTION :

The tertiary industry sector, sometimes known as the service sector, is primarily responsible for the economic growth of many countries. It is made up of industries that provide services to both consumers and businesses, such as healthcare, banking, education, and professional services. Businesses in these industries are depending more and more on tech-business analytics to boost operational efficiency, enhance customer experiences, and promote economic growth. Tech-business analytics in the tertiary industrial sector uses statistical and machine learning approaches to analyse data that these businesses produce, including patient records, financial transactions, student performance, and customer interactions. Businesses can gain insights into patterns and trends using this data to help them make decisions. The tertiary industry sector, which is commonly referred to as the "service sector," is essential to modern economies around the globe. Many different businesses and endeavors fall under this category since they provide services rather than tangible goods. This sector is characterized by its focus on giving customers experiences, information, interactions, and intangible values. The importance of the tertiary industry sector cannot be overstated because it not only fosters economic growth but also increases people's standards of living in both their communities and as individuals. The Tertiary Industry Sector's Primary Characteristics

(1) Intangibility: The tertiary sector, in contrast to the primary and secondary sectors, deals with intangible products and services like education, healthcare, entertainment, financial services, and consultancy. These services frequently rely on skill, wisdom, and experience.

(2) Interaction and Personalization: To accommodate varying tastes, the tertiary sector mainly relies on interpersonal interaction and customization. Customers' individual demands are frequently taken into account when providing services, creating individualized experiences that might increase customer loyalty.

(3) Inseparability: The production and consumption of services frequently occur simultaneously. An illustration would be the direct delivery of medical services to patients by a healthcare professional, which makes the production and consumption of the service inseparable in both time and place.

(4) Variability: Services' consistency and quality can vary since people play a human role in providing them. Customer happiness depends on maintaining constant service quality, which can be difficult.

(5) Perishability: A service cannot be saved for later use because it is a perishable good. Loss of revenue potential might be seen in unused appointment times or vacant seats on flights.

The tertiary industry is important in economy and society due to following reasons:

(1) Economic Growth: Economic expansion and job creation are significantly influenced by the tertiary sector. It contributes greatly to the GDP and employment prospects in many industrialized economies.

(2) Innovation and Technology: By consistently adjusting to shifting consumer expectations and new technological advancements, the industry fosters innovation. The use of technology to deliver services improves accessibility, convenience, and efficiency.

(3) Quality of Life: People's daily life are directly impacted by the services the tertiary sector offers. The entire well-being of individuals and communities is improved by having access to high-quality healthcare, education, entertainment, and financial services.

(4) Urbanization: The primary and secondary industries give way to the tertiary sector as economies grow. As more individuals move into cities in quest of better work opportunities and access to services, this movement frequently coincides with growing urbanization.

(5) Globalization: Compared to physical items, services are simpler to export across borders. As a result, services have become more globally accessible, allowing companies to access new markets and diversify their sources of income.

(6) Job Opportunities: The tertiary sector provides a wide variety of employment opportunities, from expert services like legal and financial consultancy to creative professions in the entertainment and arts industries, supporting a diverse and workforce. As a result, the tertiary industry sector, which provides necessary services to raise living standards and promote economic growth, forms the foundation of contemporary economies. Due to its flexibility in responding to shifting consumer preferences and technology developments, it will continue to play a significant role in the world economy.

The circular economy concept, according to Aithal, S. et al. (2023) [1], is crucial for the primary, secondary, tertiary, and quaternary sectors of industry. This concept has a big impact on lots of different industry sectors since it promotes sustainable practises, resource efficiency, waste reduction, and innovation. In addition to generating economic value and reducing their negative effects on the environment, industries may help the transition to a more resilient and sustainable economy by embracing circular ideas.

According to Batouta, K. I., et al. (2023) [2], in light of the scarcity of natural resources and the rising cost of energy, the scientific community is becoming increasingly interested in developing novel strategies that will improve energy efficiency.

Kumar, S., et al. (2023) [3] recommend integrating big data technology and the underlying ICCT technologies in order to create a new type of business analytics that can be utilised to address semi-structured and unstructured issues in primary, secondary, tertiary, and quaternary industry sectors. The new inquiry is referred to as tech-business analytics (TBA). Understanding the concept of TBA and how it affects an organization's innovation outcomes is the main aim of this study.

Jia, W. et al. (2023) [4] assert that this article conducts a comprehensive and detailed analysis of China's forest industry chain and its effects on the national economy using the 2018 China Input-Output Table (153 departments), additional pertinent data made available by the National Bureau of Statistics, and the input-output method developed by Wassily Leontief. The findings indicate that there are 105 industrial departments in the Chinese forestry industry's backward industrial chain. With 56.05 percent of all purchases falling into this category, China's forestry industry makes the most tertiary industrial goods purchases. The tertiary industry's production has a significant negative influence on forests. China's forestry accounts for 93.47% of all forestry sales and sells the most items in the forward industry chain, which consists of 131 distinct industrial sectors.

Tech-business analytics are a tool that integrates data analytics and ICCT supporting approaches, in accordance with Kumar, S., et al. (2023) [5]. Prior to going on to secondary or quaternary industries, the industry's problems are first streamlined or fixed. The goal of Tech-Business Analytics is to employ technology and data analysis to enhance the characteristics and quality of goods and services across a range of industries. Analysing data from many sources is necessary to comprehend consumer behaviour, market trends, and other elements that may affect the success of a product.

The work of Tzeiranaki, S. T., et al. (2023) [6] contributes to our understanding of the tertiary energy usage and efficiency in the EU, as well as the driving forces behind it, the effectiveness of implemented strategies and measures, and suggestions for future research and new policy creation. Policies must be changed in order to meet the objectives established by the EU for 2030 and to provide the basis for reaching carbon neutrality by 2050.

This will be done, in accordance with Li, X. et al. (2023) [7], in order to set up a four-sector general equilibrium model and a rural industrial integration indicator to look into the effects of capital subsidies granted to capital-using sectors in rural industrial chains on rural industrial integration and social welfare. Here are what we've determined: Capital subsidies for rural areas can help close the economic gap between urban and rural areas and promote rural industrial integration (but only if specific short-term goals are achieved).

The information and service economies, which have become the main forces behind the expansion of the national economy, are primarily driven by the tertiary industry, according to Li, Q., et al. (2023) [8]. To support development in the central plain region and achieve structural convergence of industries for quick, wholesome, and long-term economic growth, it is crucial to conduct a spatial structural study of the evolution of the industrial structure. The dynamic and non-linear relationships both within and between industries must, however, be taken into account in traditional statistical analysis. This provides a novel geographical analytic approach based on the gravity model in this study to assess the tertiary sector in China's Central Plains Economic Region (CPER).

Primary, secondary, and tertiary industries in Saudi Arabia are together regarded as a pillar of the economy, with significant potential and promising job opportunities, according to Alkandi, I. G. et al. (2023) [9]. As a result, it is essential that both native and foreign enterprises operating in the Kingdom succeed. This study aims to investigate the effects of incentives and rewards on employee performance in the Saudi industrial sectors as well as the relationship between job satisfaction and both. The sample, which consisted of 216 full-time employees, was chosen from the research population, which was made up of employees in the industrial sectors of Saudi Arabia's Eastern Region.

A number of waves of secondary industry relocations have occurred in China during the past 20 years, according to Lin, B., et al. (2023) [10], where specific secondary industries have moved from one region or province to another. The secondary industries (mostly the industrial sectors) have a substantial impact on the regional carbon intensity because they contain a greater number of energy-intensive enterprises than the primary and tertiary industries do.

According to Aithal, P. S. (2023) [11] says that businesses are finding it difficult to survive and expand in the twenty-first century because of the numerous difficulties and uncertainties they must face. In order to sustain a business over the long term, it must be able to both keep its current clientele and draw in new ones. To do this, it must employ a variety of tactics for delighting, educating, and satisfying its current clientele while also generating a colossal amount of demand through the production of new business value.

According to Kumar, S., et al. (2023) [12], by integrating big data technology and the ICCT's supporting technologies, a new class of business analytics has been developed that can be used to

address semi-structured and unstructured problems that arise in primary, secondary, tertiary, and quaternary industry sectors. The newest study's working term is tech-business analytics (TBA).
Aithal, P. S., et al. (2023) [13] claim that technology is an application of science that is employed as a tool to address social issues. Innovations in the delivery of higher education are possible because to a component of ICCT. After COVID-19, the online education delivery paradigm gained prominence and was based on ubiquitous education technology (UET).
The goal of tech-business analytics, according to Kumar, S., et al. (2023) [14], is to employ technology and data analysis to enhance the features and quality of goods and services across a range of industries. In order to accomplish this, data from a variety of sources is used to spot patterns in consumer behaviour, market trends, and other elements that might affect how a product or service is viewed by a target market.
Technology, according to Aithal, P. S. et al. (2023) [15], is a science-based application that is used as a tool to address societal challenges. Because of an ICCT component, innovations in the delivery of higher education are now conceivable. Following COVID-19, the paradigm for online education delivery, which was based on UET, rose to prominence.
Kumar, S. et al. (2023) [16] recommend that the primary industry sector's TBA be the organisation of the effectiveness and sustainability of agricultural extraction activities. TBA can assist companies in this sector make data-driven decisions that will improve operations and lessen their environmental effect because of the primary sector's reliance on natural resources and environmental concerns. TBA, for instance, can assist agricultural companies by maximising crop yield by gaining access to information from weather sensors, soil sensors, and other sources.
According to Gupta, S. et al. (2023) [17], cloud computing encouraged the creation of agile software. Software is the new oil. Software that is open-source to a greater or lesser extent (70–90%) is inescapable. Open source promotes innovation through teamwork, shortens the time to market, and supports the development of recent ground-breaking technology. In some ways, open source is consuming or guiding the software industry.
According to Gupta, S. et al. (2023) [18], the population's rapid development has brought up the issue of securely keeping enormous amounts of data. With a cutting-edge approach to data encryption and hashing, problems with privacy, security, data processing, and other aspects can be overcome. Blockchain and the Internet of Things technologies will enhance the current ecosystem. The AES algorithm will be used by the proposed model to encrypt biometric and demographic data. Data will also be scrambled using the SHA-256 algorithm and stored in the symmetrically distributed Interplanetary File System (IPFS).
Varambally, K. V. M. (2023) [19] states that the primary objective of this study was to evaluate the ABCD analytical framework's Advantages, Benefits, Constraints, and Disadvantages of CSR in order to identify the crucial components and factors affecting value creation through CSR.
According to Mittal, V., et al. (2023) [20], solving sustainability issues requires that the transportation sector make the transition to carbon neutrality. In order to calculate the transport sector's carbon footprint as it moves closer to carbon neutrality, this study describes a model in detail. The model attempts to aid decision-makers by assisting them in predicting the potential effects of different decisions involving infrastructure and transportation technology.
According to Daradkeh, M. (2023) [21], there has apparently been much discussion about the value of business analytics (BA) in fostering knowledge creation and corporate innovation. The contribution of knowledge orientation and business analytics capabilities to the promotion of new business models, however, is poorly supported by actual data. This study develops a model to investigate the connection between knowledge orientation and BA capabilities and how it influences the development of business models. Both the knowledge-based view and the dynamic capabilities theory are used to achieve this.
Business analytics is a major force behind smart manufacturing, according to Wanner, J., et al. (2023) [22]. These authors attribute this to growing data availability, the development of data processing and transmission technologies, and the rise of data availability. But because of the diversity of local advancements and the field's transdisciplinary complexity.
According to Schmitt, M. (2023) [23], our rapidly evolving digital economy, which is moulded by international rivalry, calls for more data-driven based on AIML. The advantages of deep learning (DL) are numerous, but they are also constrained, which has prevented widespread industry adoption up

until this point. In spite of its popularity, this study discusses why DL struggles to gain traction in the field of business analytics.

Identifying the commercial value of big data analytics (BDA) is one of the ongoing issues in the field of information systems (IS) research, according to Muchenje, G., et al. (2023) [24]. To evaluate the phenomenon and gain a better knowledge of how BDA generates economic value, it is required to analyse theories in detail. The task-technology fit (TTF) concept is examined in this study to acquire a new and improved understanding of the business value of BDA.

By fusing systems provide planners and decision-makers with crucial and competitive information, according to Bharadiya, J. P. (2023) [25]. By improving the quality and timeliness of data, business intelligence (BI) strives to give managers a better understanding of where their organisation stands in relation to competitors.

According to Alnawayseh, S. E., et al. (2023) [26], cellular computing is an exciting and promising field. It is projected that the field's future developments would take a variety of shapes. The development of more sophisticated and efficient cellular-based computing systems that can manage challenging calculations and data processing tasks is one potential element. This could lead to the creation of new tools and technologies in a number of fields, including health, biotechnology, and environmental monitoring.

According to Penpokai, S., et al. (2023) [27], this is to investigate organisational constructs that are related to HR Analytics in large organisations that conduct business in Thailand. In order to analyse their interaction with the HR Analytics, this study introduces two organisational constructs: technology adoption and HR competencies.

According to Bag, S., et al. (2023) [28], the production and delivery of pharmaceuticals at the proper time, place, and quantity are a part of the healthcare supply chain. In a world of uncertainties, particularly hazardous pandemics, companies are focusing on the Omni channel healthcare approach, and one of the urgent aspects to accomplish is the digitalization of the healthcare supply chain. In order to empower absorptive capacity in Omni channel health care processes, a collaborative platform powered by big data analytics and artificial intelligence (BDA-AI) technology has been developed. The goal of this paper is to examine the background of this platform and its effects on organisation performance.

This research article's main objective, according to Fatima, A. et al. (2023) [29], is to identify common network risks and offer defences against them. Everybody has access to the internet in the present era. Security is a major concern for everyone. Expert hackers violate security every day and take advantage of flaws to access sensitive and private data.

According to Morales-Serazzi, M., et al. (2023) [30], this study provides evidence that the difference in information quality (DIQ) between knowledge producers and users (marketing) accounts for a major portion of the high failure rates in the execution of analytical projects for marketing decisions.

The practise of using data analysis to gather insights and make defensible business decisions is referred to in this paper as tech business analytics. This is frequently done with the use of technology and cutting-edge tools. This method entails gathering, processing, and evaluating data pertaining to many company areas, including operations, consumer behaviour, market trends, and more. The service sector, commonly referred to as the tertiary industry sector or the service industry, is one of the three main economic sectors. Instead of generating tangible commodities, it comprises activities that give services. The tertiary sector includes industries such as retail, education, healthcare, finance, hospitality, entertainment, and a variety of professional services. Understanding preferences, purchasing patterns, and trends through analysis of customer data can help organisations better adjust their services to fit the demands of their customers. improving operations through data analysis, resource allocation, and workflow management, which results in cost savings and increased operational effectiveness. Data analysis is used to keep track of market trends and rivalry, enabling businesses to modify their offerings in response to shifting customer needs. using data to develop individualised customer experiences, such as focused marketing initiatives or specialised service provisions.

2. EFFECT OF ADVANCES IN TECHNOLOGY IN TERTIARY INDUSTRY SECTOR:

Technological developments have fundamentally altered the way services are provided and made it possible for businesses to run more efficiently and profitably in the tertiary industry sector. The tertiary industry sector is affected in the following ways by technological advancements as listed in Table 1:

Table 1: Effect of advances in technology in service (tertiary) sector industries

S. No.	Aspects	Description
1.	Higher Efficiency	Businesses in the service industry may now automate numerous repetitive jobs and processes, which boosts production and efficiency. For instance, firms are now able to provide customer care more rapidly and efficiently thanks to chatbots and other automated technologies.
2.	Better Access	Technology developments have also made it easier for those who live in rural or underserved locations to receive services. For instance, telemedicine services and online educational platforms have made it possible for people to receive high-quality services from any location with an internet connection.
3.	Greater Individualization	Additionally, technology has made it possible for companies to offer more individualised services that are catered to the unique wants and tastes of their clients. For instance, client preferences can be determined and individualised recommendations can be made.
4.	Higher Competition	The ability of new entrants with cutting-edge business models and technologies to displace established service providers has boosted competition in the service sector as a result of technological advancements. As an illustration, online financial service providers have challenged established banks and financial organisations.
5.	Enhancing Data Analytics	Businesses can now gather and analyse enormous amounts of data, which has opened up new opportunities for insight and creativity. Data analytics, for instance, can be used to spot trends and patterns in consumer behaviour, which can result in new corporate strategies and better customer experiences.

As a result, technology improvements have had a significant impact on the tertiary industry sector, allowing businesses to provide services more effectively and efficiently while also altering the way services are offered. The advancement of technology will likely keep the service sector growing and innovating.
Over the past century, developed countries' economies have changed from being dependent on manufacturing to being dominated by the "service sector".
(1) Improved labour productivity. Increased worker productivity is primarily what causes tariffization. With improved technology and labour productivity, producers like farmers and manufacturers can produce more with fewer workers. Workers have more money to spend on services as a result of increased productivity. So that you can work in the tertiary industry, which requires more labour, save your labour.
(2) Globalisation. Globalisation and free trade have made it possible for the US, the UK, and other industrialised nations to import more produced goods.
(3) Income elasticity of demand. The majority of our money is spent on luxuries like travel and fine meals. Compared to raw materials, manufactured goods have a lower income elasticity.
(4) Technology. In the past century, both computers and telephones were developed. A completely new world of tertiary services has been made possible by the expansion of the internet. An economy dependent on services worries some individuals.

2.1 Effect of ICCT including Business Analytics in Service Industry:

The impact of ICCT and business analytics on the services sector has been enormous. The integration of ICCT with business analytics has the following implications in the service sector:

Table 2: Effect of ICCT underlying technologies in service industry

S. No.	Aspects	Description
1.	Increased customer satisfaction	ICT has made it possible for companies in the service sector to give customers a more individualised and practical experience. Businesses can employ mobile apps, for instance, to give customers immediate access to services, and data analytics can be applied to tailor recommendations and promotions based on the tastes of the audience.
2.	Enhanced Effectiveness	Businesses may now automate rote jobs and procedures thanks to ICT and business analytics, which boosts productivity and efficiency. For instance, companies can manage customer service requests using chatbots and other automated systems, and they can utilise data analytics to streamline processes and cut costs.
3.	Higher Level Decision Making	Businesses may now make more informed decisions based on data-driven insights thanks to the convergence of ICT and business analytics. Data analytics, for instance, can be used to spot trends and patterns in consumer behaviour, empowering companies to plan their marketing and product development strategies.
4.	Higher Agility	Additionally, organisations can now be more flexible to shifting market conditions thanks to ICT and business analytics. Businesses, for instance, can utilise data analytics to track trends and act swiftly in the event of changes in customer demand or rival activity.
5.	Improved Positioning in the Market	Businesses have been able to obtain a competitive edge in the market as a result of the integration of ICT and business analytics. Companies that can use data analytics, for instance, to understand consumer behaviour and market trends, are better positioned to provide novel products and services that cater to changing consumer wants.

Thus, the integration of ICT and business analytics has had a transformative impact on the service sector, enabling businesses to provide customers with a more individualised and convenient experience, increase productivity and efficiency, make better decisions, be more agile and responsive to shifting market conditions, and gain a competitive advantage. As technology advances, the combination of ICT and business analytics is anticipated to continue to stimulate innovation and growth in the services sector.

3. OBJECTIVES BASED ON PAPER :

(1) To analyse the thorough assessment and the significance of technology in the Tertiary Industry Sector.
(2) To evaluate the idea of tech-business analytics in the tertiary industry sector.
(3) To compare the Tech-Business Analytics model and its use in the Tertiary Industry sector.
(4) To interpret the TBA between the service business and the production industry.
(5) To study, using the ABCD analysis framework, the Pros, Cons, and Drawbacks of Tech-Business Analytics in the Tertiary Industry sector.
(6) To study the impact of tech-business analytics on the effectiveness of the sector of tertiary industry.

4. REVIEW BASED RELATED RESEARCH WORK :

Table 3: Business analytics in service industry

S. No.	Area	Issue	Outcome	Reference
1	To increase the competitive productivity of tourism	It consists of a framework for competitive productivity (CP), big data analytics (BDA) research, information systems	Through BDA, they seem to be doing a better job of achieving the goal of developing	Mariani, M. et al. (2021). [31]

	locations (CP), big data and analytics from a theoretically integrated approach are used.	for destination management, and smart travel destinations. It is a thorough conceptual framework for competitive productivity in tourism destinations (TDCP).	sustainable destination business intelligence to help tourism destinations accomplish their financial targets.	
2	Big data analytics and data security procedures affect how effectively the service supply chain operates.	It will look into the effects of big data analytics, data security, and supply chain innovation on the efficiency of the services supply chain. According to the study's findings, a company's capacity to manage data security and its performance and capacity for service supply chain innovation are both favourably and strongly correlated with big data analytics.	Since information was shared across participants in service supply chain networks, firms with weak data governance and protection faced problems with data security.	Fernando, Y. et al. (2018). [32]
3	In consumer-generated reviews, big data and business analytics are being used to investigate the key elements influencing visitor happiness.	In this study, UGC and business analytics are used to assess the important factors that influence hotel customers' pleasure. It also shows how business analytics methods can be used in the academic and hospitality sectors.	Through the use of business analytics, the current study lays a strong platform for future research into the relationship between specific evaluation variables and visitors' overall happiness. Analysing service gaps in these crucial criteria can assist hoteliers in addressing performance-related concerns.	Lee, M. et al. (2020). [33]
4	Supply chain efficiency and data analytics as digital procurement rises	With an emphasis on the function of data analytics in procurement digitalization, its goal is to examine digitalization as a performance driver for the supply chain. The study looks at how data analytics, digital procurement skills, operational efficacy in the supply chain, and their effects on business success interact.	The results show a substantial correlation between supply chain success and data analytics proficiency in digital upstream supply chain procurement operations.	Hallikas, J. et al. (2021). [34]
5	Study of the effects of linear and FsQCA on knowledge-based HRM, business analytics, and creative	As Industry 4.0 and the information economy evolve, many businesses are investing substantial resources in business analytics expertise and knowledge-based human resource management (HRM) practises. This study proposes a	The fsQCA results, however, showed that organisational agility is both a necessary and sufficient condition for obtaining high levels of inventive performance. However, obtaining	Enad Al-Qaralleh, R. et al. (2021). [35]

	performance in the hospitality sector.	conceptual model that uses knowledge-based theory as a theoretical framework to examine the combined effects of knowledge-based HRM practises, business analytics capabilities, and organisational agility on creative performance.	distinctive findings merely needs a strong analytical base.	
6	Pakistan's retail industry and "Business 4.0"'s effects on organisational performance	The robots, cloud computing, big data analytics, and Internet of Things (IoT) are the five essential Industry 4.0 technologies that it aims to assess and ascertain the effects of on the operational performance of Pakistan's retail sector. Senior-level employees who were aware of business 4.0 technologies were the target demographic, which was decided upon as the retail business in Pakistan. This group also includes subordinates who reported to first-level managers and higher-level employees.	The results provided preliminary evidence that disruptive technologies from Industry 4.0, such as 3D printing, big data analytics, cloud computing, IoT, and robotics, could help Pakistan's retail sector address a number of problems and challenges, such as low revenues, rising costs, and disorganised systems.	Ali, S. et al. (2021). [36]
7	Maintaining Competitive Advantage Through Knowledge Management and System Dynamics: Business Intelligence for Long-Term Competitive Advantage.	Future researchers in business intelligence will profit from it as it adds to the body of literature, especially in terms of achieving a sustainable competitive advantage. When considering the tools necessary to implement business intelligence, professionals will profit from the strategy. The study's applications may further be broadened by applying the research's findings to different economic sectors and geographical contexts.	The government, a number of businesses, and other parties involved in the Bangladeshi RMG industry can all benefit from the study's conclusions.	Ahmad, A. (2015). [37]
8	Using social media analytics and incorporating them into B2B marketing to take advantage of corporate networks in the social media era.	To facilitate the use of social media analytics (SMA) in B2B marketing and to harness the benefits of business networks in the social media era, it offers a capacity-based organisational development plan for SMA capabilities.	When it comes to using social media for B2B marketing, US-based companies appear to be well ahead of those in other nations.	Wang, Y. et al. (2020). [38]
9	Enhancing service organisations'	The marketing information system (MkIS) receives all of the emphasis in today's data-	The research increases theoretical knowledge of the resource-based	Rahman, M.S. et al. (2020). [39]

	competitive competitiveness in a data-rich environment	rich business environment, but the MkISMC's management capabilities are equally, if not more, important. While many service companies are looking forward to the return of MkIS, others are suffering.	perspective, market orientation, and dynamic capacity that create the interaction of MkISMC, UMAN, and SINM in achieving service businesses' competitive performance in the dynamic data-driven business environment.	
10	Instead of attempting to be "sexy," let's focus on educating managers for the (big) data-driven business era.	This essay will look at the challenges that the present business curriculum faces in order to address the learning issues brought on by the emergence of a data-driven corporate environment. It examines how digitization has affected businesses, focusing on big data analytics (BDA) and data science (DS), with a focus on managerial responsibilities and decision-making procedures.	Business schools and higher education should adapt, the study suggests, in order to more effectively meet the educational issues related to big data analytics and data science training. In order to achieve this, it uses case studies to stimulate conversation about how the rise of a data-driven business era is altering managers' duties and responsibilities.	Carillo, K.D.A. (2017). [40]

Table 4: ICCT in service industry

S. No.	Area	Issue	Outcome	Reference
1	Future Challenges and the European Air Transport Regulation's Successes	Following the development of the aviation single market, the policy has most recently been extended to cover the liberalisation and regulation of ancillary services as well as environmental protection, international aviation policy, safety, and security.	The EU will aim to strengthen its position as a global counterforce, symbolised by aviation, by setting the standard for environmental policies and market liberalisation.	Gudmundsson, S.V. (2019). [41]
2	Options for Cost-Effective and Long-Term Logistics	For long-term logistical success, efficiency gains are required but insufficient. Moving beyond cost-cutting or even cost-neutral programmes will be necessary for the industry to achieve its long-term energy savings and carbon reduction goals. In addition to emphasising the necessary next steps, we present these possibilities in a logical sequence.	The established method employed a 0–4 rating system to rank the contributions made to each of these four components by different enablers and practises discovered during a WSC's primary operations.	Smokers, R., et al. (2014). [42]

3	The cost of Volkswagen's Dieselgate scandal: exposed	This study tries to objectively establish an instance of business crises and events spreading over sectors and supply networks.	At the industry and supply chain levels of the analysis, it was discovered that the German automaker's fraud expanded to neighbouring enterprises.	Fracarolli Nunes, M. et al. (2016). [43]
4	The scandal over Volkswagen's excessive emissions	In order to pass emissions tests and meet rigorous fuel and performance targets despite emitting up to 40 times the permitted quantity of hazardous pollutants, Volkswagen admitted to US regulators in September 2015 that it had installed "defeat devices" in many of its diesel vehicles. The EPA postponed approving VW's 2016 diesel vehicles, and the firm ceased selling its 2015 models as a result of the recently disclosed facts. The defeat devices caused VW to report its first quarterly loss in more than 15 years, and this resulted in a decrease in the value of its stock.	Our predictions indicate that the Volkswagen scandal had a statistically significant and economically significant negative influence on BMW, Mercedes-Benz, and Smart's sales, stock returns, and public sentiment in the United States. With regard to these German non-Volkswagen manufacturers, the scandal directly led to a loss of sales of around 76,000 vehicles over the course of the next year, translating into a revenue loss of close to $3.7 billion.	Lynch, L.J., et al. (2016). [44]
5	Environmental policies that benefit innovation on a global scale	It demonstrates that petrol taxes would be too low without coordinated regional strategies, and that each region will use the petrol rating tax to lessen the harm caused by foreign traffic.	The moderating effect was found to be unfavourable but statistically significant. As well as numerous contributions from this research, assumptions about decision-making are made.	Kumar, M. (2019). [45]
6	Research on Radicalization as Transformative Learning: A Theoretical and Applied Study	In order to promote a multidisciplinary understanding of violent radicalization, this theory places a strong emphasis on how people learn, alter their meaning perspectives, and modify their behaviour.	Radicalization is the process through which someone becomes primed and inspired to engage in violent behaviour on both an emotional and cognitive level.	Wilner, A. et al. (2020). [46]
7	Apps for banking and online shopping use cloud computing and AI.	Customers won't grasp the task completely until it is finished, thus business intelligence (BI) combined with banking expertise will be a superior alternative in cloud computing. Even with their shortcomings, pricey,	Modern cloud computing, artificial intelligence, environmental elements that reduce BI delivery times, and rising BI expenses contrast with	Xue, M., et al. (2021). [47]

		complex, rigid, and integrated BI infrastructures aid in the blending of data from EC and banking apps. The cloud computing architecture is also examined in this study as a potential solution to problems with data processing.	the traditional BI of EC apps.	
8	An Indian case study illustrates how the sharing economy might help remove obstacles to the use of electric vehicles.	This looks at what the Government of India (GOI) has done and what needs to be done to boost R&D in the electric vehicle industry. The barriers to electric vehicle commercialization in India are outlined. Data collection, analysis, and assembly involve the use of secondary sources. Secondary data gives a detailed view of both the global and Indian situations.	The academic study of technology's adoption as a standard format has not been covered in prior works.	Kumar, R., Jha, et al. (2021). [48]
9	Examining India's economic, governmental, and product-standards experiences in connection to the global car industry	The document's structure is shown in the ensuing lines. The study opens with a succinct summary of the WP.29 Forum and European Commission's cooperation on harmonising vehicle regulatory requirements.	Additionally, these trading partners increase the value of India's exports.	Chakraborty, D., et al. (2020). [49]
10	Corrupt practises in the supply chain breach sustainability standards by dressing as sheep.	Private, voluntary, and enforceable sustainability norms have increased recently. Corruption in the supply chain has grown in popularity and now occurs frequently as a way to get past sustainability requirements.	However, strategies for getting past sustainability regulations, like supply chain manipulation, have proliferated.	Silvestre, B.S., et al. (2020) [50]

Table 5: Artificial Intelligence and Robotics in Service Industry

S. No.	**Area**	**Issue**	**Outcome**	**Reference**
1	Customer evaluations of artificial intelligence-based service delivery and operational resilience.	The operations of service companies are progressively using artificial intelligence (AI). Production systems and operations management scholars claim that it is still uncertain whether	Customers' satisfaction with service operations is affected in an asymmetrical way by their interactions with mechanical AI: while positive interactions have a positive and significant impact on overall	Mariani, M. M., et al. (2023). [51]

		clients of operations receiving AI support are satisfied. This study applies the three-factor theory of customer happiness to online review data to close this gap by measuring the impact of AI-enabled service operations on total customer satisfaction as measured by online review ratings.	customer satisfaction with AI-enabled service operations, negative interactions have a negligible impact on customer satisfaction.	
2	Key ideas in 4.0 technologies and artificial intelligence for services	In fact, the Fourth Industrial Revolution, which is currently underway, differs from earlier technologies in three key ways: (1) As technology advances, human capabilities are outpaced to the point where individuals or even corporations are unable to control it; (2) customers accept living in newly created technological surroundings; and (3) the distinction between people and technology becomes increasingly hazy.	Each of these three separate features of Technologies 4.0 in services is connected to the fundamental AI ideas.	Belk, R. W., et al. (2023).[52]
3	Understanding the motivations for artificial intelligence adoption (or resistance) in the hotel industry: Exploring consumer-robot interaction.	Although there is a substantial body of research on AI services in the hotel business, additional research is necessary to understand consumer experiences with AI services and the factors that affect their adoption (or rejection) by consumers.	The factors that affect consumer behaviour towards AI and robotic services can direct the development and implementation of AI and robotic services in the hospitality industry.	Rasheed, H. M. W. et al. (2023).[53]
4	Advanced robotics uses deep learning, machine learning, and artificial intelligence.	Due to advancements in artificial intelligence, machine learning, and deep learning, robots are becoming smarter, more efficient, and more adaptive to difficult tasks and environments.	Additional research including the applications of AI, ML, and DL in sophisticated robotics systems is also advised in order to fill the gaps between the existing studies and published publications.	Soori, M., et al. (2023).[54]

5	AI in hotel and tourism industries. present research state and potential future directions	The travel and hospitality industries have lately seen a significant transition that has been fuelled by advancements in information and communication technologies. The scientific study on these topics is still hazy and dispersed, despite the expanding literature on AI and tourism.	In the study, a bibliometric analysis is built using the ISI database, and the intellectual structure of the study is mapped using social network analysis.	Nannelli, M., et al. (2023). [55]
6	Research on artificial intelligence (AI) for the travel and hospitality industries has lasted thirty years.	With a focus on the content, focal points, essential terminology, and trends of the subject, this study intends to assess the growth of artificial intelligence (AI) research relevant to the hotel and tourism industries.	These four clusters that make up the study of AI are: the technology of AI, the adoption of technology, the perception of consumers, and future developments.	Kong, H., et al. (2023). [56]
7	The "watching-eye" effect and privacy issues are two examples of artificial intelligence's negative side in use.	Artificial intelligence (AI) has the potential to raise privacy issues that should be carefully explored, but have not yet received sufficient attention. The watching-eye effect is used in this study to examine how privacy concerns act as a buffer between the impact of AI on customers' uneasiness and those worries.	Although both sexes are affected, women are more severely affected. This work makes a significant contribution to the corpus of knowledge on business ethics and service ethics in AI and provides advice on how to effectively address concerns about privacy and personal information.	Hu, Y., et al. (2023). [57]
8	Artificial intelligence's Place in Banking	While still utilising outdated technology, banks frequently contact with a variety of customers. Modern technological breakthroughs have almost automated all industrial operations from beginning to end, necessitating transformation in outmoded financial management organisations.	Automation enables institutions to boost earnings while enhancing overall performance and human reliance.	Umamaheswari, S., et al. (2023). [58]

9	Artificial intelligence chatbots providing live support: A research priority for the future	The results highlight the advantages and disadvantages of utilising responsive chatbot technology and offer light on important theoretical foundations focusing on human-computer interactions.	This contribution states that efforts are still being made to develop anthropomorphic, interactive chatbots that can mimic human customer service representatives.	Camilleri, M. A., et al. (2023). [59]
10	Investigating how artificial intelligence affects consumer repurchase intent: A mediation and moderation approach	Business practises and customer purchasing habits have been significantly altered by digital technologies. This study mixes artificial intelligence, social media interaction, conversion rate optimisation, and a positive consumer experience to analyse consumer repurchase intentions in the hospitality sector.	In order to please consumers and ultimately increase their willingness to use, share, and create content on social media platforms for hospitality organisations, marketers must consider how to make postings more engaging with videos, photos, and animations.	Nazir, S., et al. (2023). [60]

Table 6: Blockchain in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	These most important criteria for evaluating blockchain application services for public sectors	Innovative new services will develop as a result of merging blockchain with established industries' processes to better them, yet services that cannot be fully utilised by blockchain will also grow. This study looked into the elements to take into account while using blockchain technology's features into business practises.	Blockchain activity is expected to increase as industries undergo full-scale digital transformation.	Lee, J. et al. (2023). [61]
2	Blockchain: An engine for the next fintech revolution	The study and development of blockchain technology is currently popular. Following the blockchain proof of concept, the banking sector adopted the technology and changed the foundational ideas of finance. In the Fintech industry, problems including	In order to open up new doors for this industry, the financial services sector uses blockchain technology. Fintech applications of blockchain are another rising area.	Taherdoost, H. (2023). [62]

		missed deadlines, protracted fund-raising cycles, and escalating losses are common, and they frequently occur as a result of weak management.		
3	Blockchain-Internet of Things Applications: Opportunities and Challenges in Industry 4.0 and Society 5.0.	Numerous insurance companies have thought about how blockchain could boost their effectiveness. There is still a lot of anticipation about this immutable technology even if it hasn't been utilised to its full potential. Insurance companies must determine whether to use blockchain technology, just as many other businesses.	For Industry 4.0 and Society 5.0, this report delivers an in-depth investigation of IoT applications based on blockchain. For those who intend to continue their study of blockchain-based IoT applications, the following sections cover important topics such unresolved issues, challenges, and potential future research areas.	Tyagi, A. K., et al. (2023). [63]
4	Review of Blockchain Technology Adoption in the Travel and Tourism Sector From a Sustainability Perspective.	As new, creative business models develop throughout time, the adoption of Blockchain technology in the tourism sector is already a reality. Its primary goal is to improve the quality of service delivered to the final client and the effectiveness of the tourism service value chain.	The information gleaned from the investigation shows that operations in the tourism industry that involve marketing, logistics, and clever business models are utilising this technology to a higher extent.	Prados-Castillo, J. F. et al. (2023). [64]
5	Blockchain with Low Power in Industry 4.0	Significant technological advances and advancements have occurred in industry over the past ten years. Industry 4.0 and IIoT (Industrial IoT) are two trends that the industrial sector is going towards more and more. The Blockchain technology can be used to get beyond the IoT's constraints in terms of security and data reliability.	An effective multiservice approach is advised for water management. Customers and water service providers will benefit from services like consumption tracking, traceability, etc.	Frikha, T., et al. (2023). [65]
6	A dissected TPB model of how financial professionals	It is important because of how quickly blockchain applications have gained popularity among	The findings show that the research methods used in this study, which	Kumari, A., et al. (2023). [66].

	would use blockchain technology.	investment professionals. The goal of the study is to determine how widely blockchain technology is trusted and embraced in the Indian financial services sector.	involve users in formal contexts, are effective.	
7	ImseStudio is a platform for service manufacturing with blockchain integration that is secure.	The manufacturing industry is transitioning to a service-oriented model in the age of digitization. But a large number of small and medium-sized firms (SMEs) continue to rely on antiquated manufacturing techniques, finding it challenging to employ manufacturing resources due to their short budgets and limited capacity for digitalization.	It is an off-chain rule-based matching system is created to connect consumer orders with manufacturing services. and the entire blockchain platform is designed and developed using the major methodology known as service-oriented architecture (SOA).	Liu, X., et al. (2023). [67]
8	Model for cross-chain collaboration for geriatric health information that is supported by blockchain from the standpoint of the entire process.	As the population ages and fewer people have children, there is a growing need for older health care, which raises the need for elderly health information.	This is to build a cross-chain collaboration model for geriatric health information using blockchain technology with the help of the virtual chain's underlying logic.	Hu, M., et al. (2023). [68]
9	How to pick the best blockchain platform: A case study on the healthcare industry using a cutting-edge rough MCDM framework.	Manufacturers of medical products, insurance companies, third-party logistics (3PL) companies, and regulators are typically found in healthcare networks, which are complex systems. Modern technology should enable effective healthcare systems to offer patient care services that are both easily accessible and of the highest calibre in the long run.	This test presents a case example that explains how to pick the most useful BP for a healthcare institution. The findings of this inquiry are supported by numerous analyses.	Erol, I., et al. (2023).[69]
10	Pharma supply chain industry's blockchain-based solution.	Continent-spanning manufacturers, suppliers, and consumers are all included in the intricate supply chain systems used in modern pharmaceuticals. The	Smart contracts also control the way that businesses connect with customers by keeping track of IoT containers, including those containing prescription	Abdallah, S., et al. (2023). [70]

		transportation and sale of medicinal items supplied online currently suffer from a serious lack of transparency.	drugs, and properly informing them of any changes.	

Table 7: Cloud Computing in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	Utilising cutting-edge analytical technologies, these may evaluate the viability of cloud service providers for Industry 4.0.	It remains difficult to accurately assess how well Industry 4.0 technology providers, such as those that offer cloud computing and the Internet of Things (IoT), are performing. The effectiveness of cloud service providers (CSPs) for Industry 4.0 has been evaluated using developed and implemented methods.	By employing a real-world dataset to verify the viability of our methodology, it offers practitioners a practical method with solid academic basis for evaluating the sustainability of CSPs for Industry 4.0.	Azadi, M., et al. (2023). [71]
2	Cloud computing and energy efficiency empirical research.	As a result of cloud computing, the dynamics of energy consumption between service providers and clients have changed, necessitating a study of the effects on users in order to compare them to those on vendors. The effects of cloud computing on the environment may then be thoroughly understood thanks to this.	The results show that SaaS gives operational benefits by encouraging energy-efficient production, in contrast to IaaS, which primarily helps to reduce the energy consumption of internal IT infrastructure and equipment.	Park, J., et al. (2023). [72]
3	Utilisation of cloud computing and a significant data management challenge in the healthcare sector.	Data administration is often a massive duty in the healthcare industry. Millions of patients are involved, and it is important to carefully preserve the data for use in the public's and the general interest in the future. The healthcare sector is attempting to integrate cloud computing into their system in order to better implement their response to the problem.	The healthcare industry has benefited greatly from cloud computing. The healthcare sector is currently experiencing tremendous challenges as a result of the pandemic, and it is growing more and more reliant on cutting-edge technologies.	Sharma, D. K., et al. (2023). [73]

4	Analysing the connections between context, innovation, and cloud computing.	Since cloud computing has lately come to be identified as a key component of the technical ecosystem for digital transformation, this study aims to analyse how it contributes to digital innovation and how those two things are related.	The verifiable findings with illustrative statistics demonstrate how important cloud computing is to the process of digital transformation. Furthermore, it presents managerial implications for both hypothetical and real-world management scenarios.	Sharma, D. K., et al. (2023). [74]
5	In Nigeria, the advantages of cloud computing for environmentally friendly building are being investigated.	One of the digital transformation ideas employed in the banking, healthcare, and construction industries is the utilisation of cloud computing. This essay analyses how cloud computing might help with sustainable construction in Nigeria.	The results of the RII analysis show that data storage iniquitousness (i.e., location independence), high situational awareness, team communication, compatibility with cutting-edge manufacturing facilities, and enhanced project planning are all very advantageous.	Oke, A. E., et al. (2023). [75]
6	The advantages and difficulties of cloud computing in developing nations	Developing nations can benefit from a number of opportunities, including better access to technologies and services, by using cloud computing. Businesses might be able to employ equipment and software created with companies in mind if they have better access to technology and services.	Cloud computing adoption may be significantly hampered by worries about data security and privacy. This is because companies could not have faith in the security of their data if it is kept on servers situated in other nations.	Razi, M., et al. (2023). [76]
7	Trends in service industry digital transformation	The evolution of the DT in the service sector is examined in this paper. The 2,897,024 publications that published in journals that Scopus indexes between 1991 and March 4, 2022 were the subject of this investigation, for which researchers gathered data. Eventually, 1831 of the 2,683 papers were picked for examination after being reclassified.	The key developers of the three stages of DT in the service industry. The research's findings have theoretical and practical ramifications that offer strategic guidance for establishing and putting DT in the service industry into practise.	Chin, H., et al. (2023). [77]

8	The usage of digital twins in the oil and gas industry is being studied using edge and cloud computing.	Minor accidents in the oil and gas industry can have a big detrimental impact on the community, the environment, and the company. For this type of business, adequate operational procedures for monitoring and maintenance are crucial.	In order to establish a digital twin, it is essential that cloud and edge computing be used because they provide access to more storage and processing capabilities while removing the need for a strong local IT infrastructure.	Knebel, F. P., et al. (2023). [78]
9	Management and educational applications of cloud computing	Today's information and communication technologies work hand in hand to deliver the best business solutions. One of these current passionately debated and well investigated issues is cloud computing, which still has a tonne of room for expansion and research.	This study aims to look into the effects of cloud computing on academic institutions and business management.	Gupta, A., et al. (2023). [79]
10	Analysis of cloud-based ERP, or enterprise resource planning.	ERP management information systems are typically used for business expansion and operations. With integrated, systematic, and organisational management features, the effectiveness of various management resources, including enterprise customers, project operations, material procurement, supply, and production, is maximised in the company.	The ERP corporate management information system started consciously merging with the idea based on cloud computing's properties. In this paper, we mainly talk about the features and benefits of cloud-based ERP enterprise management information systems, and we also carefully evaluate the impacts of their adoption.	Duan, L. (2023l). [80]

Table 8: Forensic Technology & Cyber Security in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	Pakistan's Cyber Threat Analysis and Cyber Forensic Investigation Infrastructure	Cyber forensics are gaining popularity due to the explosive growth of technology crime. Cyber forensics' goal is to give situational awareness in order to recognise and preserve digital evidence, extract information, and analyse that information in order to support	The study's goals include giving policymakers an empirical basis on which to build a thorough CFI framework for the nation as well as insights and suggestions for enhancing the infrastructure to better	Haque, E. U., et al. (2023). [81]

		pressing decision-making. However, there is currently a lack of significant structure in Cyber Forensic Investigations (CFIs) that prevents them from reliably revealing the main patterns of cyberattacks.	combat cybercrime in Pakistan.	
2	An extensive review and survey of the literature on cyber security and cyber forensics for smart cities.	Towns and cities are implementing smart technologies like the Internet of Things (IoT), cloud computing, and artificial intelligence (AI) in order to become "smart cities." Smart cities have incorporated a number of network technologies, including the Internet and the Internet of Things (IoT), to share real-time information and improve the comfort of their citizens' daily lives. However, there aren't many comprehensive research on cybersecurity and cyber forensics in smart cities.	The Internet of Things (IoT) is a technology component of smart cities that has been the subject of numerous studies employing machine learning and deep learning since 2020. IoT devices transmit enormous amounts of data, and it is anticipated that ML and DL will continue to play important roles in research on smart cities.	Kim, K., et al. (2023). [82]
3	Examining the application of blockchain technology to digital forensics and cyber incident response.	In today's networked society, both governmental and non-governmental organisations as well as large, medium, and small businesses are vulnerable to cyberattacks. For a quick and effective response to an attack like a phishing or ransomware attack, each of these enterprises requires a trustworthy, or better yet, established and accurate reference database and platform for the correct analysis and storage of digital evidence.	Utilising this technology will help organisations respond to situations more effectively and increase their chances of apprehending and prosecuting cybercriminals. The report concludes with a discussion of the potential limitations and challenges of implementing blockchain technology and offers recommendations for further research to further the field of cyber incidence response.	Fakiha, B. (2023). [83]
4	India's adoption and knowledge of recent developments in cyber security	Due to the greater accessibility of goods, services, and applications brought on by the expansion of the internet,	To keep up with the accelerating pace of technology, cyber laws must be continuously improved. Financial aid,	Malik, N., et al. (2023). [84]

	laws and procedures.	much more rigorous security measures are now necessary to guard against cyber-attacks. Child pornography, cyberbullying, phishing, baiting, vishing, smishing, fraud with credit and debit cards, and job fraud are all common cybercrimes.	the initiative to prevent cybercrime against women and children (CCPWC), the Indian Cyber Crime Coordination Centre (I4C), the National Cyber Crime Reporting Portal, the Citizen Financial Cyber Fraud Reporting and Management System, the Information Technology Act of 2000 (IT Act), the Indian Penal Code of 1860 (IPC), the Indian Computer Emergency Response programme, the National Cybersecurity Framework (NCFS), and other laws and programmes are just a few examples.	
5	Issues, Problems, and Potential Solutions for Cloud Forensic	The popularity of cloud computing, which is a web-based utility model, cybercrimes that harm web-based systems are equally important to cloud computing. An immediate identification and location of the attack's source are required in order to perform a forensic investigation into a cyber-attack. Although substantial research on challenges and their solutions has been done in this area, research on techniques and strategies is still in its early stages.	Every stage of cloud forensics faces challenges, therefore before we can devise a thorough solution to address these issues, we must first know cloud technology and its forensics environment. Although there are papers that discuss cloud forensics, a document that compiles the most recent problems and answers is still lacking. This chapter has covered the cloud environment as well as potential dangers and attacks.	Akter, S. S., et al. (2023). [85]
6	Forensic examination of computer tools and systems is used to combat cybercrime.	Cybersecurity is now a global concern, and sophisticated and pervasive cyberattacks are on the rise. The integrity of digital evidence used in legal proceedings in the civil and criminal judicial systems is strengthened by computer forensics.	The employment of computer forensic techniques in the investigation and prosecution of cybercrime is suggested. Computer forensics can be classified into the following categories in this study: network forensics, mobile	Drobotov, S., et al. (2023). [86]

		The objective of this study is to develop proposals and suggestions for the application of technologies for forensic research of computer tools and systems in the fight against cybercrime.	forensics, malware forensics, electronic forensics, database forensics, and criminology of memory. According to the authors, there is no regulatory framework for international cooperation, digital evidence collection, or cybersecurity.	
7	Impacts of emergency cyber threats during emergency scenarios are among the difficulties to field hospitals' cybersecurity	The provision of emergency treatment and services is improved through the use of technology and IT resources in healthcare and by emergency response staff in field hospitals. However, these advantages raise more and more questions about the infrastructure's security, including that of medical equipment, health information, etc. This study examines how cyber threat actors use an ongoing emergency to exploit and attack the healthcare emergency response IT infrastructure. Healthcare is an appealing target due to its vast source of valuable data and its poor defences.	It also examines the opportunistic strategy employed by cyber threat actors and shows the inventive themes used by new vulnerabilities to successfully deploy social engineering campaigns and physical assault scenarios. It also identifies the effects of the cyberattacks on the stakeholders and the infrastructure for emergency response.	Ahmed, N. B., et al. (2023). [87]
8	Analysing research on cybercrime and security	As internet-based technology, goods, services, and networks proliferate, cybersecurity has become one of the most critical issues. Cyber forensics is a sort of treatment, whereas preventing cybercrime is a type of treatment. Both of these are essential components of digital security.	The study includes bibliometric results relating to the authors, organisations, nations, keywords, sources, and documents with the highest levels of international collaboration in the fields of forensics and cybersecurity.	Sharma, D., et al. (2023). [88]
9	Cybercrime-based digital forensics analysis, as well	The Internet has emerged as a key medium for the diffusion of knowledge around the world thanks	It is vital to bolster legislation, enhance pertinent mechanisms, and bolster supervisory	Chen, C., et al. (2023). [89]

	as research on the application of the rule of law to space administration.	to the social informatization that is developing so quickly.	capability in response to changing conditions and new policies. In order to guarantee that this objective may be accomplished, ideal technical tools and safeguards must also be established.	
10	A framework for compliance auditing and forensic analysis for protecting critical infrastructure.	Modern communities are becoming more and more reliant on the goods and services offered by Critical Infrastructure (CI), which includes manufacturing facilities, power plants, and networks for distributing energy. Due to their nature, scale, and complexity, such CIs frequently receive help.	By implementing the framework using a cloud-native technique, both the functional and non-functional requirements can be satisfied. Additionally, an experimental investigation of the framework's scalability is conducted.	Henriques, J., et al. (2023). [90]

Table 9: Digital Marketing and Business in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	An empirical investigation of how the usage of digital marketing and e-commerce impacted MSMEs' sustainability and financial performance during the COVID-19 outbreak.	This study set out to look at how the EC and DM platforms and strategies impacted MSMEs' capacity to function profitably and sustainably in the face of the devastating COVID-19 pandemic.	Digital marketing strategies were also found to have a big impact on how well MSMEs performed financially. However, it was discovered that there is little correlation between DM methods and the long-term viability of MSMEs.	Gao, J., et al. (2023). [91]
2	With the aid of bibliometric analysis of global research trends, the future directions of digital marketing in small and medium-sized businesses are visualised.	A bibliometric examination of the digital marketing research done by small and medium-sized businesses (SMEs) is the goal of this study. In the study, works over the last 20 years were subjected to performance analysis, co-citation analysis, bibliographic coupling, and scientific mapping.	It provides researchers with information on the state of research in the area of literature on digital marketing in SMEs and directs them in the right path. Future research directions are also given for this area of study.	Amiri, A. M., et al. (2023). [92]
3	Digital marketing is being used by	The tourism sector is a crucial part of society since it helps most	The evaluation of digital marketing usage in the tourism industry and a	Anuj, Upadhyay, R.

	Uttarakhand, India's tourism business.	nations' economies and social structures grow and thrive. Modern firms must increasingly incorporate digitization into their operations. It has altered the way that organisations operate and given one of the quickest platforms for interacting with customers. The tourist sector has seen a considerable transition thanks to digitization. Traditional tourism has changed thanks to digitization, becoming a modern, creative, and technologically sound sector.	suggestion for how to encourage more firms in Uttarakhand, India, to embrace digital marketing. This tutorial provides an illustration of the theoretical model along with an empirical test to see if the aforementioned things are connected.	K., et al. (2023). [93]
4	A survey of digital marketing in the medical field.	By using digital marketing rather than traditional marketing, hospitals can better understand sophisticated users. The objective of hospital marketing is to assess and understand the needs and preferences of potential patients in order to successfully address those demands. The costs of using the internet, email, and social media are lower than those of direct marketing, and they can close the gap and open doors for the promotion of services to remote clients. They can also make customers more aware of the services that are widely accessible.	A systematic review's method of choosing studies was used for this scoping review. Open Knowledge Maps and Google Scholar were used to compile pertinent studies. To apply digital marketing effectively, there is a need for innovation. Furthermore, online registration and media promotion can be done via hospital applications.	Chandra, A. F., et al. (2023). [94]
5	Alterations in attitudes and intents to purchase financial services and goods as a result of digital marketing and promotion techniques.	A sample of 400 people who watched financial commercials on YouTube, Facebook, etc. participated in an online survey that was carried out in India. Responses were obtained from 347 fully completed surveys. The interrelationships	The Technology Acceptance Paradigm (TAM) model, which measures consumer attitudes and intentions to purchase financial goods and services, serves as the foundation for the study paradigm.	Dogra, P., et al. (2023). [95]

		between constructs were examined.		
6	Digital marketing optimisation for the hospitality sector	Digital marketing is becoming a vital part of the hospitality industry since it enables hotels to engage with and reach out to potential guests. As the majority of people spend their time online, it essential. Currently, not all hotels take advantage of the chance to invest in yearly budgets to boost the efficiency of digital marketing techniques like social media, which merely makes promotions without engaging with followers, SEO investment, and online hotel reviews.	Hotels can use digital marketing effectively to draw in and keep consumers nowadays. The magazine's primary goal is to put forth digital marketing ideas for the various hotel target markets and the widest range of tourism stakeholders.	Bhandari, R., et al. (2023). [96]
7	Comprehensive evaluation of the body of research on SMEs and digital marketing.	The purpose of this study is to evaluate the body of existing literature on the application of digital marketing and its effects on SMEs. This study details how SMEs are affected by the adoption of digital marketing methods.	Although some SME companies use digital marketing, their outcomes are not comparable enough for us to recommend a particular strategy for doing so.	Jadhav, G. G., et al. (2023). [97]
8	Reviewing the current status of research on digital marketing in SMEs using data-driven techniques.	Digital marketing methods have emerged and are now used by both SMEs and large businesses as a result of the development of the Internet and the application of traditional marketing techniques. These businesses combine data sciences with digital marketing tactics to boost sales, build brand recognition, or break into new industries.	This is identified a total of seven state-of-the-art data science applications in digital marketing that are utilised by SMEs in their online marketing initiatives based on the findings. These programmes are examined and graphically displayed.	Saura, J. R., et al. (2023). [98]
9	The move from traditional to digital marketing, does it affect Ethiopia's organization's profitability?	The influence of transitioning from a traditional marketing mix to a digital marketing mix on organisational profitability is examined in the context of Ethiopia in this study. Descriptive	Since the digital transformation acted as a mediating factor, the independent factors collectively explained the majority of the variance in profitability.	Kebede, K., et al. (2023). [99]

		and explanatory study designs were created using qualitative and quantitative research approaches.		
10	Utilising digital advertising to its fullest potential for internet marketing.	Because to the expansion of the internet, business practises are changing, particularly those utilised in retail outlets where the viability of the business models depends on the ability to do transactions electronically.	In this case, social media is being used in digital marketing to boost sales, especially in e-commerce apps. In the era of globalisation, this is especially true.	Wuisan, D. S., et al. (2023). [100]

Table 10 : 3D Printing in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	An overview of 3D printing, medical image processing, and design for orthopaedic surgeons.	The result of technological and industry advancements, one medical specialty that closely follows technological advancement and adopts it into everyday practise swiftly is orthopaedic surgery.	In this study, it will go over the fundamental ideas behind these parts using Shapr3D and 3D Slicer as examples of CAD platforms and medical image processing platforms, respectively, from the perspective of orthopaedic surgeons.	Bahadır, B., et al. (2023). [101]
2	Resources and competencies for value in healthcare 3D printing services Co-creation.	The usage of 3D printing in healthcare is still in its infancy, although several service providers are promoting it among hospitals worldwide.	By providing knowledge, expertise, insights, and training to the surgical teams, the specialised developers are better able to boost hospitals' capacity to absorb 3D printing technology.	Chaudhuri, A., et al. (2023). [102]
3	The Modular Product Architecture for Sustainable Flexible Manufacturing in Industry 4.0 uses examples like the 3D printer and electric toothbrush.	To manage the effects of customised requirements on fluctuating market demand, industry 4.0, a flexible manufacturing system, and sustainability can be implemented.	As a factory grows, the modular design must be modified or reorganised in accordance with it.	Habib, T., et al. (2023). [103]
4	An analysis of the conceptual framework for a blockchain-based	Although 3D printing (3DP) has experienced fast expansion, it has also raised ethical and social questions. A couple such	The platform might support the worldwide digital assets IP protection process as well as the	Chan, H. K., et al. (2023). [104]

	authentication platform for the protection of intellectual property in the 3D printing industry.	examples are the capacity to print immoral items and IP infringement.	standardisation of the 3DP industry's development.	
5	Assessing the Cost and Utility of a New 3D Printing Service: Securing the Future.	In order to improve clinical results and deliver higher-quality care as personalised and precision medicine grow more common, the health care industry depends on rising technologies and innovations.	Recent developments in 3D printing technology have accelerated its adoption and extension into the healthcare industry while lowering costs and raising awareness.	Bastawrous, S. (2023). [105]
6	An academic hospital's utilisation and costs of 3D printing in the first year.	On the cost and advantages of implementing 3D printing at a hospital, little information is currently accessible. The goal of this study is to assess the benefits and costs of using radiography-based in-hospital 3D printing to create anatomic models in a single academic adult hospital.	Standards for anatomical model utility and cost Information about healthcare budgeting can be found in 3D printed medical models. It will take further research to fully grasp the financial benefits of the shortened procedure time.	Ravi, P., et al. (2023). [106]
7	Mass customisation models for cloud-based 3D printing services.	The outcome of speedy production, easy accessibility, and on-demand printing. Many service providers are emerging and offering 3D printers to enable bulk customization within their various service areas. According to technology advancement, these scattered 3D printers can be joined and shared via a cloud-based platform to produce bespoke goods in a flexible and reasonable environment.	To compare the performance of the two suggested models, numerical analyses are carried out. The findings show that in a large city, an optimization-based strategy is superior than a real-time strategy since, on average, the optimisation model may improve earnings by about 100%.	Kang, K., et al. (2023). [107]
8	Using models and actual data, the appropriateness of 3D-printed couplings for industrial application was investigated.	In this research, the use of additive manufacturing to reverse engineer spare components for flexible couplings is investigated.	An analysis of the environmental and economic factors was also finished. The 3D printed prototypes are suitable for swapping out the original, according to the results, under the original	Baladés, N., et al. (2023). [108]

			operating circumstances.	
9	A novel platform for comprehending and engineering microbiomes is provided by 3D printing of microbial communities.	Thanks to 3D printing, it is now possible to produce complex materials quickly on demand. Co-printing of matrices and microbes to produce personalised living materials has become common in recent years.	With the use of 3D printing, it is now possible to precisely arrange microorganisms in 3D space, offering a novel solution to these issues.	Krishna Kumar, R., et al. (2023). [109]
10	Experimental research on thin sandwich structures manufactured in 3D for use in energy-absorbing aircraft applications.	One of the biggest issues in aviation is the creation of lighter and lighter structures. The performance of the aircraft is improved by structural lightening, thus this has been a primary priority.	The current study fits into this framework since it investigates if sandwich panels may be made lighter by using a revolutionary production technique.	Acanfora, V., et al. (2023). [110]

Table 11: The Internet of Things (IoT) in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	IoT technology for circular business models present both opportunities and risks.	In order to promote improvements in environmental performance, circular business models (CBM) have become increasingly important. However, the current literature scarcely touches on the connection between CBM and the Internet of Things (IoT).	The need for case studies that measure CBM's ability to virtualize, exchange, and regenerate is substantial. IoT could reduce energy consumption by 20–30% for the applications indicated in the literature.	Ding, S., et al. (2023). [111]
2	Security problems with the Internet of Things (IoT) and research into remedies.	Consideration must be given to how the various needs of these practical applications will alter the dynamics of protection as smart devices are increasingly used in various contexts. The numerous security concerns, standards, and implementations' relationships to network safety are discussed in the study's summary.	It is necessary to consider reliable and usable IoT protection in order to retain information privacy, ethical behaviour, professionalism, honesty, encryption, intrusion detection, and the ability to recognise as well as versatility, interoperability, and usability.	Rekha, S., et al. (2023). [112]
3	Evaluating the situation and going forward	IoT has recently made great strides, which have accelerated the evolution of healthcare. Earlier	The co-citation network study also identifies other important areas, including cloud-IoT	Rejeb, A., et al. (2023). [113]

	with IoT in healthcare.	studies on IoT applications in healthcare are compiled in this article. An exhaustive evaluation and bibliometric analysis were done to provide an objective summary of the growth of IoT research in healthcare.	integration, fog computing, cognitive smart healthcare, and authentication procedures.	
4	Examining the internet of things' (IoT) application in the retail sector.	This study investigated how important success variables influenced the adoption of the internet of things (AOIoT) by Malaysian customers in the retail industry. 357 respondents were surveyed online and quantitative data were gathered using a cross-sectional methodology.	The results also showed that ATIoT had a positive and significant impact on Malaysian customers' AOIoT. Therefore, Malaysia's corporate community and important authorities should raise consumer understanding of IoT and change their views towards it.	Nawi, N. C., et al. (2023). [114]
5	In Ghana's construction business, new technologies for industry 4.0 and the Internet of Things (IoT): feasibility, deployment challenges, and benefits.	Despite embracing these technologies later than other sectors, the construction sector is currently facing significant difficulties. Construction is one sector that takes a while to adopt cutting-edge technical instruments.	This study focuses on the construction industry community, which broadens its applicability by introducing important stakeholders and individuals who will be affected by these technologies.	Maqbool, R., et al. (2023). [115]
6	Big data analytics (BDA) and the Internet of Things (IoT) are used in digital manufacturing.	Three exemplary enabling technologies for data collection, processing, and use in manufacturing applications are introduced: digital manufacturing (DM), big data analytics (BDA), and the Internet of Things (IoT). Enterprise information systems are thought of as information systems that gather, process, and apply data to support enterprise decision-making at all organisational levels and functional divisions.	It is suggested that a new EA be used to improve the system's adaptability, robustness, and flexibility. To identify critical research areas and provide instructive application-based examples, the potential of the proposed EA for modern manufacturing is studied.	Bi, Z., et al. (2023). [116]
7	A comprehensive study dispelling myths about the	Internet of Things (IoT) adoption in the construction sector is still relatively uncommon	The purpose of this study was to give resources for construction managers	Khurshid, K., et al. (2023). [117]

	Internet of Things (IoT) in the construction business.	despite the fact that it has quickly extended across many industries in the current digital era. Construction 4.0 is driven by technologies like structural health monitoring (SHM), business information modelling (BIM), procurement, and construction safety.	to identify problems, for professionals to examine the hybridization potential of IoT in the framework of Construction 4.0, and for laypeople to understand the advanced scientific research that supports IoT in the construction industry.	
8	Investigate the desire of undergraduate students to use internet of things (IoT) services in the smart classroom using a case study.	There has recently been an increase in interest in the education sector due to the use of Internet of Things (IoT) services for educational purposes. There aren't many studies that specifically examine how IoT services are used in smart classrooms, despite this enthusiasm. In order to better understand students' motives, the current study looks at their intentions to use IoT services in the smart classroom.	Our knowledge of how students plan to use IoT services in the smart classroom is enhanced by the study. Academics, teachers, and IoT developers could find this study useful. However, it has significant drawbacks, such as a lack of qualitative techniques and a sparse use of theories.	Alhasan, A., et al. (2023). [118]
9	With the aid of internet of things (IoT) enabled technology, COVID-19 patient healthcare help.	Research articles on COVID-19 pandemics and IoT in healthcare are examined to examine the potential of this technology. This literature-based research has the ability to provide solutions to connected issues for the specialists who will be addressing the COVID-19 pandemic.	IoT implementation done right could help with a variety of medical issues, including complexity, price, and speed. For individuals with COVID-19 asthma, diabetes, and arthritis, it may only need to be modified to track caloric intake and treatment.	Mukati, N., et al. (2023). [119]
10	Effects of logistics and Internet of Things (IoT) activities on digital operations.	The Internet of Things (IoT) paradigm allows numerous integrated, resource-constrained devices, things, and people to continuously exchange data with one another over the internet protocol.	A quantitative approach employing a descriptive and analytical strategy was used to further this research. Data from 199 respondents that were gathered from security-related businesses in Dubai, United Arab Emirates, were used to make the assessment.	Antouz, Y. A., et al. (2023). [120]

Table 12: Data Storage in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	How the quick service restaurant industry's in-store electronic word-of-mouth is affecting local competition spillovers.	It is simpler to switch behaviours due to the quick service restaurant (QSR) market's fierce competitiveness and close proximity. QSRs have experimented with menus as a result, developing customised experiences.	The study's findings support the theories that parasocial (non-face-to-face) interactions like likes, retweets, and replies fully mediate the impact of in-store engagement on visits from nearby competitors over the course of the following 30 days and that the direction of this effect can change with competitor density in the neighbourhood.	Banerjee, S., et al. (2023). [121]
2	Overview of Industry 4.0.	In order to make quicker, more informed decisions that will ultimately boost the efficacy and profitability of their overall organisation, businesses are constantly looking for ways to access real-time data and insights.	This also investigates the use of blockchain for sustainable development and Industry 4.0, as well as providing a quick overview of the different connected technologies.	Hayat, A., et al. (2023). [122]
3	Utilising Industry 4.0 technologies to support small service businesses.	It can be difficult for managers of service MSMEs to incorporate Industry 4.0 (I4.0) into their organisations, despite the promise that it will help MSMEs become more sustainable.	Theoretical contributions, constraints, and potential directions for further study have all been examined along with a number of management implications.	Pandya, D., et al. (2023). [123]
4	Comparing Risks and Effectiveness of Enterprise Data Security Measures Across Sectors and Organisational Types.	In the study, data security practises of various business sectors and business kinds, including small businesses, large corporations, and government organisations, are evaluated in order to determine how these practises affect the effectiveness of their security measures.	Organisations may benefit from the findings by strengthening their data security procedures and lowering their risk of security incidents.	Bandari, V. (2023). [124]
5	Cloud computing is used by maritime logistics for	The number of supply chains and supply chain players is constantly increasing, which is not surprising given that	In this study, the authors outline the marine cloud's detailed organisational structure	Röseler, C., et al. (2023). [125]

	effective data processing and storage.	maritime logistics is the largest logistics industry by volume and financial value allowing global trade.	and contrast it with traditional systems.	
6	To maintain privacy in industry 5.0, FusionFedBlock fuses blockchain with federated learning.	The current, rapid changes being brought about in different industries by the digital environment are referred to as "Industry 5.0" The industrial setting requires the use of contemporary technologies, such as the Internet of Things (IoT).	With accuracy of 93.5% in a 50% active node for Industry 5.0, the validation findings of the recommended scheme show good performance in comparison to existing frameworks.	Singh, S. K., et al. (2023). [126]
7	Adoption of distributed ledger and decentralised technology to facilitate the shift to smart industries.	In order to undergo digital transformation, industries are currently implementing clever initiatives and cutting-edge business strategies. One of these projects is the use of distributed ledger technology (DLT), which has the potential to promote the smart industrial revolution.	The consequences of the study will be useful for industry regulators, practitioners, and academics who are curious to learn about the cutting-edge ways that clever industries may use DLT to generate value and gain a competitive advantage.	Anthony Jr, B. (2023). [127]
8	Building an intelligent tool swarm in Industry 4.0 that distributes knowledge necessitates the use of multi-access edge computing enabled architecture.	Thanks to Industry 4.0, which has piqued the interest of both academia and business, the development of intelligent machine tools is currently front and centre for industrial enterprises to take a step towards intelligent production.	Using a prototype system, the suggested strategy's practicality and effectiveness are demonstrated. It is used in its application examples and evaluation tests.	Zhang, C., et al. (2023). [128]
9	An examination of how digitization will affect the hospitality and tourism industries' values.	This study's goal is to critically assess the most recent technological developments and digitalization initiatives in the hospitality and tourism (HT) industry, as well as to talk about how these changes will affect different stakeholders (including clients, employees, businesses, and operators) in terms of value creation..	The report contends that digitalization is still in its early stages. However, there are several ways for all parties involved to gain from current and future applications of digitization.	Ozdemir, O., et al. (2023). [129]

10	Using multi-stage authentication from cloud databases, efficient safe cloud data storage and retrieval	Cloud computing is becoming a significant player in the information technology sector thanks to its increased efficacy, broad accessibility, low cost, and several advantages. Similar to this, it gives Internet users extra storage space and makes it possible for speedier data transmission between sites.	The image is broken down and kept in the cloud clearly as an encrypted message and a fingerprint in order to prevent unauthorised access. The key value that is encrypted and decrypted is properly chosen using a search method to increase system security.	Babu, T. K., et al. (2023). [130]

Table 13: Quantum Computers in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	Healthcare innovation in Covid-19 was propelled by quantum computing.	In the Covid-19 era, where rapid coordination between stakeholders including patients, insurance agents, healthcare professionals, and pharmaceutical suppliers is necessary, a standard computer strategy is insufficient. Quick and accurate healthcare solutions are also essential.	The results point to potential uses for quantum computing in the pharmaceutical, hospital, and health insurance industries as well as for patients to quickly and precisely solve issues.	Gupta, S., et al. (2023).[131]
2	Utilising quantum computing to address future industry security issues related to 5G.	The development of upcoming 6G networks has taken centre stage since the deployment of 5G in a few countries around the world. The entire society is now connected thanks to 5G. More data exchange is now possible thanks to ubiquitous internet. Even though 5G offers reduced latency, larger data rates, and high-speed, there are still some security-related flaws.	The 6G network cannot be secured with traditional cryptography alone. Through the use of quantum mechanics, all conventional cryptography may be broken. As a result, modern security methods should be used in their stead.	Mangla, C., et al. (2023). [132]
3	The Development of the Quantum Computing Industry: The Main Obstacles to the Adoption of QC	Industries throughout society are transforming as a result of new digital, disruptive technology. The burgeoning Quantum Computing (QC) sector is also no exception. Governments, major	According to the study's findings, the QC sector is still in its early stages. Of the 34 adoption barriers identified, eight were determined to be the most important due	Nguyen, K., et al. (2023). [133]

	Technology as a Service.	corporations like IBM and AWS, as well as smaller to medium-sized businesses, have all made enormous financial contributions to the development of QC technology.	to their importance and frequency of reference.	
4	Medical applications of quantum computing.	The multidisciplinary field of quantum computing has recently expanded swiftly and garnered substantial interest from both academia and business due to its ability to handle information in fundamentally unique ways and achieve processing powers that were previously unachievable.	It has developed taxonomies in a number of areas, such as background and enabling technologies, applications, needs, architectures, security, open problems, and potential future research topics.	Ur Rasool, R., et al. (2023). [134]
5	An overview of the key problems in quantum communications and computation.	There has been a vigorous scramble for quantum technologies in both academia and industry since the development of quantum technology has progressed so swiftly. Quantum annealers function at scales three orders of magnitude larger than hundreds of qubits, or universal quantum computers. Numerous hundreds of qubits have been supported by universal quantum computers.	So, a substantial number of academic papers and other publications have addressed the subject of race. From a computer science perspective, this essay offers interested readers a starting point for learning about the essential traits of quantum computing and communications.	Yang, Z., et al. (2023). [135]
6	An examination of the tools used by the sector and in open source to produce quantum software.	Quantum computing, an advanced level computing paradigm built on the fundamental principles on which nature functions, notably quantum physics, has the ability to perform complex computations and huge potential to set trends in the new era of computing technology.	Since it differs slightly from conventional computing, quantum computing must be implemented using specialised software. Additionally, a list of exclusive resources provided by leading businesses is available.	Mehta, D., et al. (2023). [136]
7	Using new technologies in the service industries.	Modern technologies such as Artificial Intelligence, Blockchain, state-of-the-art hardware, Quantum Computing,	Within the next five years, the world's economy will transition from smartphones to cutting-edge wearables	Jha, R. S., et al. (2023). [137]

		self-driving cars, machine learning, Virtual and Augmented Reality, Extended Reality, the Enterprise Metaverse, and the Internet of Things, collectively referred to as "Industry 4.0," have had a profound effect on society.	as the fifth generation mobile network (5G) rollout is completed, with augmented reality (AR) glasses setting the pace.	
8	Risk mitigation and sector-specific strategies to accelerate quantum readiness.	It can be challenging for sectors to know where to start given the potential effects of quantum computing on a number of industries, including finance, healthcare, encryption, and transportation. It is crucial to start looking at what needs to be done as soon as possible in order to provide industry with the knowledge, tools, and processes needed to stay up with the quickly evolving breakthroughs in quantum computing.	One method to get ready for quantum computing is by opening a quantum computing office, signing contracts with important quantum computing companies, and learning from organisations that are already involved in the field.	Alsalman, A. I. S. (2023). [138]
9	The 2021 BMW Quantum Computing Challenge is the method used by Supplierthon.	The BMW Group has a supplier scouting method called "Supplierthon" that works especially well for locating partners on R&D projects. This article describes the supplierthon process developed by BMW and describes how it was applied as the company sought out new partners for the introduction of quantum computing.	In order to comprehend how the process works, how it was applied to the issue of quantum computing, and what the results—both expected and unexpected—were, three members of BMW's quantum computing and business development teams were questioned.	Sotelo, R., et al. (2023). [139]
10	Creation and Implementation of Quantum Web Services.	Increasingly potent quantum computers and associated technology have been created as a result of interest in quantum computing among scientists and industry. Programming languages, simulators, and working quantum computers have all been developed by major computer corporations. In	It gives a general overview of how quantum algorithms can be turned into web services, deployed using the quantum computing platform Amazon Braket, and called using traditional web service endpoints. Finally, we'll provide a method for developing and distributing quantum	Romero-Álvarez, J., et al. (2023). [140]

		a manner comparable to Infrastructure as a Service, this infrastructure is accessible through the cloud.	services by extending OpenAPI and GitHub Actions.	

Table 14: Online Education in Service Industry

S. No.	Area	Issue	Outcome	Reference
1	A review of innovative big data-driven online education initiatives used during the COVID-19 pandemic.	Some colleges and institutes have started offering online courses. Through in-depth online instruction and student health checks, teachers help students finish the required learning material and return to class as soon as is practical.	In light of the recent coronavirus epidemic and in light of the issues and challenges faced by creative online education, the thesis can be used to understand these issues and difficulties and to look into the future.	Cui, Y., et al (2023). [141]
2	Using term subject analysis, we may identify the key technologies of knowledge services in the publishing sector.	For administrators and academics in the publishing sector, the analysis of the technical position of the industry is crucial for planning and making choices. We searched and examined the present hot technologies and future trends of knowledge service in the publishing business from the basic and application perspectives.	Our findings indicate that: (1) data analysis and artificial intelligence are crucial to the fundamentals of publishing technology; (2) blockchain and digital advertising are crucial to publishing applications technology.	Bo, F. A. N., et al. (2023). [142]
3	Re-evaluating Education in the Age of AI: Appreciating the Importance of Long-Lasting Skills.	NACE's creation process Despite the fact that AI has the potential to broaden the diversity of learners and enhance learning outcomes, it is more crucial than ever that enduring skills and competencies like communication, critical thinking, creativity, leadership, adaptability, and emotional intelligence are purposefully incorporated into curriculum design.	The education system & AI-driven, and it emphasises the significance of curriculum design and conventional teaching methods in producing a unified educational experience that gives students the opportunity to build lasting abilities.	Hutson, J., et al. (2023). [143]
4	Brick-based classrooms gave way to click-based classrooms during the pandemic. The factors that	The most crucial element in determining success in any service environment is the consumers' opinion of the quality of the service or product, which generates satisfaction and loyalty. Since online instruction has	The study seeks to stimulate further investigation on how to enhance learner experience and enhance click classroom services to provide high-quality	Paposa, K. K., et al. (2023). [144]

	influence the level of service and student satisfaction in click classrooms will be discussed in this essay.	become the new standard in the wake of the pandemic, the current assessment focuses on the service quality of this innovation.	education to all stakeholders.	
5	Benefits and Challenges of Involving Industry in Training for Health Professions	The learning and job preparedness of students in the health professions are facilitated by productive relationships between institutions and business. But creating a lasting industry participation in academic curricula is still difficult.	Context Mechanisms 3 Engagement as an opportunity, partnerships, and job preparedness were found to be outcome configurations that enable engagement outcomes.	Kenny, B., et al. (2023). [145]
6	Trends in the service sectors' digital transition	Through actual application cases and articles from DT-related media, this study investigates the growth of digital transformation (DT) in the service business. In order to conduct this analysis, researchers gathered 2,897,024 papers that appeared in Scopus journals between January 1, 1991, and March 4, 2022. 1831 of these 2,683 items were then picked for inspection after being categorised.	This study looked at the main causes of DT at each of the three stages of its emergence in the service industry. Strategic insights for DT strategy and execution in the service sector are provided by the study's findings, which have both theoretical and practical repercussions.	Chin, H., et al. (2023). [146]
7	COVID-19's effects on the service sector: bibliometric analysis's findings	The basis for the bibliometric choices made in this study is performance analysis and science mapping. The performance analysis is organised by examining the research components' contributions.	In particular, the aviation and tourist industries have been significantly impacted by COVID-19, as have the majority of service-based industries.	Chen, S., et al. (2023). [147]
8	Career education is becoming digitalized during a crisis.	The grade of vocational training must be raised by rapid technological development and adoption across all economic sectors. On the other hand, digital technologies enable a variety of training methods to be used depending on the demands made by different circumstances.	However, as recent experience has demonstrated, the advent of online learning was the only viable solution to keep it going during the COVID-19 and now when school premises are unavailable due to the conflict.	Kovalchuk, V. I., et al. (2023). [148]
9	Food and beverage service industry's use of	Many countries responded to the COVID-19 epidemic. Retailers in rich nations	This expansion was made possible by the flexibility of the	Walcott, P. A. (2023). [149]

	e-commerce as a catalyst What industry makes up the food and beverage sector in Barbados? Caribbean and COVID-19: Interdisciplinary Viewpoints.	have utilised e-commerce to get past laws governing public health, such as those requiring physical separation. In contrast, the adoption of e-commerce has been sluggish in developing nations due to a lack of funding and insufficient payment networks.	technology used, the order placement, payment, and fulfilment procedures implemented, the cooperation of FSBs, and government assistance.	
10	Internet business opportunities in the domestic transportation sector	All economic sectors, including transport, are given new chances by information technology and the digital economy. As a result of the information technology's rapid development and adoption, transport economics is currently undergoing significant changes.	The global economy has changed as a result of the tremendous advancement and application of this technology. In the modern economy, where the global market is typified by competitiveness, diversity of goods and services, and quick product cycle times, transportation enterprises must prosper.	Selivanov, V. V., et al. (2023). [150]

Table 15 : Virtual and Augmented Reality in Service Industry

S. No.	**Area**	**Issue**	**Outcome**	**Reference**
1	Experiencing consumerism and one's self through a magic mirror augmented reality system.	This study's goal is to investigate the implications for users of augmented reality (AR) beauty mirrors from the perspectives of experiential consumerism and the extended self.	The data revealed two key themes: (1) the value of fantasy and imagination, and (2) the (in)authenticity of one's self and of their surroundings as "reality."	El-Shamandi Ahmed, K., et al. (2023). [151]
2	A ground-breaking investigation into the Digital Twin for upcoming augmented reality-based human-centered industry transformation.	More research is being done on this junction since digital twins (DT) and augmented reality (AR) have recently started to show their promise. Given the present trend towards human-centric design, the upcoming generation of Human Cyber-Physical System (HCPS), of which DT is a key component, embraces the potential for integrating operators.	The difficulties and potential effects of AR-assisted DT for a future human-centric industry transformation—including improving product design, robotics-related work, cyber-physical interface, and human ergonomics—are examined.	Yin, Y., et al. (2023). [152]
3	The influence-peddling capacity of	A conceptual model of affecting consumer attitudes through virtual	It was discovered that in virtual reality and augmented reality	Jayawardena, N. S., et al. (2023). [153]

	augmented reality (AR) and virtual reality (VR)-based video ads.	and augmented reality marketing is provided using the social psychology theory of elaboration likelihood model (ELM).	marketing, elements such as the source's authority, social presence, and the content of the message all had a persuasive effect.	
4	Making Virtual and Augmented Reality Opportunities Available Will Revolutionise Healthcare.	It was discovered that in virtual reality and augmented reality marketing, elements such as the source's authority, social presence, and the content of the message all had a persuasive effect.	Data privacy and security issues could occur when the dentist and support personnel manage data.	Mehta, K., et al. (2023). [154]
5	Designing services for augmented reality to improve consumer experiences in retail.	Retailers are increasingly using augmented reality (AR) technologies to enhance consumer interactions and provide better customer experiences. Although AR's potential has been shown in laboratory studies, its commercial impact on real-world applications has been quite small.	Application of the design thinking methodology aids in the successful development of AR services. The essay also offers guidelines for applying the design thinking method in the unique context of augmented reality with the aim of improving customer experiences.	Vaidyanathan, N., et al. (2023). [155]
6	Augmented reality consumer engagement and staff services to boost equality and loyalty	In a physical store context, this project will make use of augmented reality (AR) and people services to more accurately gauge customer equity and loyalty. In regard to AR-based and staff service, the current study examined the connections between customer satisfaction, equity, and loyalty.	Important insights into employee services and augmented reality in a physical store environment are provided by the findings. Customer use of AR services is more prevalent in the contemporary business environment.	Butt, A., et al. (2023). [156]
7	The ability to visit both online and offline businesses and user trust in augmented reality apps must be examined in order to fully grasp how mobile augmented reality is digitally	The study's goals were to find out whether (1) aspects of expectancy-value judgements (EVJ) of uses and gratifications, such as novelty, fashion/status, sociability, and relaxation, influenced trust in augmented reality (AR) apps, and (2) whether trust in AR apps affected usage intention towards AR apps and online/offline store patronage intention.	Users' trust in AR apps, according to the study, was crucial in predicting users' intentions to use AR applications and their propensity to purchase at both online and offline stores. EVJs' perceptions of AR apps were influenced by the novelty, style, and status of their usage and gratifications.	Kang, J. Y. M., et al. (2023). [157]

	revolutionising the retail sector.			
8	A thorough analysis of the literature on augmented reality-based maintenance applications in manufacturing that are geared towards operator requirements.	Smart manufacturing, supported by cutting-edge Industry 4.0 technology, enables mass customisation of goods. Augmented reality (AR) has frequently been utilised to automate manual processes with ambient intelligence by overlaying virtual data over real-world situations. In most contemporary factories, maintenance is still a labour-intensive or somewhat automated process.	The maintenance operations reviewed in previous research have been grouped into four consecutive parts using a general procedure, and the classification outcomes have been examined using the location, kind of maintenance, AR technological components, and integrated external sensors.	Runji, J. M., et al. (2023). [158]
9	Factors affecting an effective adoption of augmented reality in manufacturing firms for the delivery of industrial services.	In order to make it simpler to offer industrial services and technical support to their installed base, the study combines a review of the literature with an empirical investigation of how five important industrial enterprises employ augmented reality.	The authors categorise 18 factors that manufacturing businesses should consider when deploying AR technology to enhance industrial services into four categories: task, personnel, context, and technology.	Aquino, S., et al. (2023). [159]
10	The metaverse era: utilising augmented reality to create cutting-edge customer experiences.	The major goal of this study is to illustrate how augmented reality's (AR) augmentation, interactivity, personalisation, spatial presence, novelty, entertainment, and in formativeness qualities can improve online customer experience (OCE).	It is emphasises the significance of media richness theory in providing a novel framework for understanding the relationship between OCE and AR features.	Habil, S. G. M., et al. (2023). [160]

5. METHODOLOGY :

In order to collect, analyze, and use data to make wise decisions that promote growth and efficiency, a methodology for tech business analytics in the service industry sector must be developed. A thorough methodology is provided here:

(1) Define Business Objectives: Start by defining clear and precise company goals that analytics can aid in achieving, such as enhancing customer satisfaction, streamlining processes, or boosting income.

(2) Data Collection and Integration: Gather data from various sources within your organization, including customer databases, transaction records, website analytics, social media, and third-party data sources. Integrate data from different systems to create a centralized data repository.

(3) Data Cleaning and Quality Assurance: To guarantee precision and consistency, clean and preprocess the data. Find any incorrect or missing data and fix it.

(4) Data Storage and Management: Organize and manage the combined data using a data warehousing technology. To protect sensitive information, implement appropriate data security procedures.
(5) Data Analysis Tools and Techniques: There are several pertinent data analytics techniques and processes, including data mining, machine learning, and statistical analysis. Get the necessary training yourself or hire specialists with it for your workforce.
(6) Key Performance Indicators (KPIs) Selection: Define relevant KPIs that align with your business objectives. Examples include customer retention rate, average transaction value, and service response time.
(7) Data Visualization: Create meaningful visualizations, such as charts and dashboards, to present data insights in an understandable manner. Use tools like Tableau, Power BI, or custom-built dashboards.
(8) Predictive Analytics: Implement predictive models to forecast future trends and customer behavior. Use machine learning algorithms to make data-driven predictions.
(9) A/B Testing and Experimentation: Conduct controlled experiments to test hypotheses and optimize processes. Measure the impact of changes on key metrics.
(10) Business Intelligence Reporting: Generate regular reports and alerts for stakeholders to monitor KPIs and track progress. - Ensure that reports are actionable and provide insights for decision-making.
(11) Continuous Improvement: Create a feedback loop based on analytics insights for ongoing improvement. Adapt strategies and techniques as necessary to achieve company goals.
(12) Data Governance and Compliance: Make that data protection laws, like the CCPA or GDPR, are followed. - uphold standards for data privacy and quality.
(13) Team Collaboration: Promote cross-functional collaboration between data analysts, IT, and business units. - Encourage knowledge sharing and data-driven decision-making culture.
(14) Technology Stack: Invest in the right technology stack, including cloud infrastructure, data analytics tools, and security solutions.
(15) Scalability and Flexibility: Design the analytics framework to be scalable as your business grows. Adapt to changing business needs and incorporate new data sources and technologies.
(16) Performance Monitoring: Continuously monitor the performance of your analytics processes and systems. - Optimize for speed and efficiency.
(17) Training and Skill Development: For your analytics team, provide regular training and skill development. Keep up with the most recent trends and innovations in your field.
(18) Stakeholder Communication: Regularly communicate findings and insights to stakeholders. - Encourage feedback and collaboration in decision-making processes.
(19) Review and Audit: Periodically review the effectiveness of your tech business analytics methodology. - Conduct audits to ensure data accuracy and compliance.
(20) ROI Assessment: Measure the return on investment (ROI) of your analytics initiatives to justify resources and investments.
By employing this methodology, the IT company in the service sector may use data analytics to make wise decisions, enhance client experiences, and promote sustainable growth.

6. CONCEPT OF TECH-BUSINESS ANALYTICS IN TERTIARY INDUSTRY SECTOR :

The tertiary sector, often known as the service industry, uses tech-business analytics to streamline operations, enhance customer experiences, and spur corporate expansion. The tertiary sector includes a wide range of service-based industries, such as finance, healthcare, education, hospitality, entertainment, and more. An summary of the idea is provided below:
(1) Data Collection and Integration: Gather data from various sources within the service industry, such as customer interactions, transactions, online behavior, and operational processes. Integrate data from disparate sources to create a unified dataset.
(2) Customer Insights: Analyze customer data to gain insights into preferences, behavior, and satisfaction levels. Use segmentation and profiling to tailor services and marketing efforts.
(3) Operational Efficiency: Utilize analytics to optimize internal processes, reduce costs, and enhance resource allocation. Predictive maintenance can be applied to industries with physical infrastructure, like utilities or transportation.

(4) Personalization and Customer Experience: Implement personalization strategies to offer tailored services and recommendations. Improve customer experiences through data-driven insights, leading to higher satisfaction and loyalty.
(5) Fraud Detection and Security: Use analytics to detect fraudulent activities and enhance security measures. In financial services, for instance, anomaly detection algorithms can identify unusual transactions.
(6) Resource Allocation and Demand Forecasting: Forecast demand patterns to optimize staffing, inventory, and resource allocation. Adjust services based on predicted demand fluctuations.
(7) Healthcare Analytics: In the healthcare sector, analyze patient data for better diagnosis, treatment, and resource management. Predict disease outbreaks and healthcare trends.
(8) Financial Services: Analyze financial data to assess risk, develop investment strategies, and detect financial fraud. Improve customer service through personalized financial advice.
(9) Education Sector: Use analytics to assess student performance, optimize course offerings, and predict enrollment trends. Enhance e-learning experiences through data-driven content recommendations.
(10) Entertainment and Media: Analyze viewership and engagement data to create targeted content and advertising. - Improve content recommendations for streaming platforms.
(11) Hospitality and Tourism: Use analytics to personalize guest experiences, optimize pricing, and manage bookings efficiently. Predict travel trends to adapt marketing strategies.
(12) Legal and Consulting Services: Utilize data analytics for case prediction, contract analysis, and legal research. Enhance consulting services by providing data-driven insights to clients.
(13) Regulatory Compliance: Ensure compliance with industry regulations, such as HIPAA in healthcare or GDPR in data privacy. Use analytics to monitor and report on compliance efforts.
(14) Technology Stack: Invest in technology infrastructure, including data warehouses, analytics tools, and cybersecurity measures.
(15) Continuous Improvement: Establish a culture of continuous improvement based on data-driven insights. - Adapt strategies and services in response to changing market dynamics.
(16) Collaboration: Foster collaboration between data analysts, domain experts, and IT teams to harness the full potential of analytics.
(17) Data Privacy and Ethics: Ensure the responsible use of data, respecting privacy and ethical guidelines.
Businesses in the tertiary sector may make better decisions, improve customer experiences, streamline operations, and remain competitive in a fast changing environment with the help of tech-business analytics. Organizations in this industry must adopt data-driven strategies and use technology to succeed in the digital world.

7. MODEL OF TECH-BUSINESS ANALYTICS AND ITS APPLICATION IN TERTIARY INDUSTRY SECTOR :

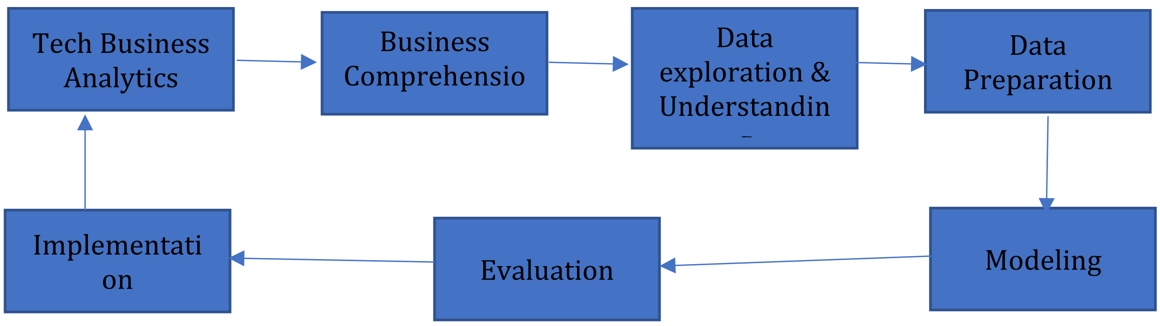

Fig. 1: TBA Model in Tertiary Industry Sector

Several tech-business analytics models are applicable in the tertiary industrial sector. One such technique is the CRISP-DM model, often known as the "Cross-Industry Standard Process for Data Mining," (figure 1) which contains the steps detailed below:
Business comprehension: During this phase, the business opportunity or problem is located, and the analysis's objectives are specified. Recognising the important stakeholders and comprehending the business context are required.

Data exploration and understanding: At this stage, the data sources are determined and the data is gathered. Understanding the data's structure and quality, spotting any gaps in the data or outliers, and getting the data ready for analysis are all necessary steps in this process.
Data Preparation: To get the data ready for analysis, it must first be transformed and pre-processed. Data cleaning, noise and redundancy reduction, and variable selection are required for this.
Modelling: Various modelling approaches are applied to the data at this step in order to find trends, connections, and new information. Techniques like neural networks, cluster analysis, or regression analysis may be used for this.
Evaluation: Using the model's success in achieving the set objectives, the effectiveness of the model is assessed at this step. In doing so, it's important to evaluate the model's precision, dependability, and robustness as well as any potential for development.
Implementation: The model is implemented and integrated into the operational procedures during this step. Creating an implementation strategy and keeping track of the model's performance over time are required.

7.1 Integration of BA with ICCT Underlying Technologies in Service Industry:

The integration of Business Analysis (BA) with Integrated Customer Communication Technologies (ICCT) in the service industry can lead to improved customer experiences, streamlined operations, and better decision-making. Here's how these two areas can be integrated using underlying technologies:

Table 16: Integration of BA with ICCT Underlying Technologies in Service Industry

S. No.	Aspects	Description
1.	**Data Analytics and Business Intelligence (BI)**	Use data analytics tools to gather insights from customer interactions facilitated by ICCT systems. BA professionals can analyze this data to identify trends, customer preferences, and areas for improvement in service delivery. BI dashboards can be created to provide real-time updates on customer communication patterns, service requests, and performance metrics. This helps businesses make data-driven decisions.
2.	**Process Automation**	Integrate ICCT with workflow automation tools. When BA professionals identify bottlenecks or inefficiencies in service processes, automation can help streamline these processes. For example, chatbots and automated response systems can address common consumer questions, freeing up human employees to handle more complicated situations.
3.	**Customer Journey Mapping**	Collaborate between BA and ICCT teams to create detailed customer journey maps. This helps in understanding how customers interact with the service at various touchpoints. Identify pain points and opportunities for enhancing the customer experience. The ICCT systems can then be tailored to address these findings.
4.	**CRM Integration**	Integrate ICCT systems with Customer Relationship Management (CRM) software. This enables a 360-degree view of each customer, their interactions, and preferences. BA professionals can use this data to personalize services, improve customer retention, and upsell/cross-sell effectively.
5.	**Machine Learning and AI**	Implement machine learning and AI algorithms to predict customer behavior. BA can work with data scientists to build models that forecast customer needs, churn risk, or service demand. ICCT systems can then use these predictions to proactively engage with customers.
6.	**Feedback Loops**	Establish feedback loops where insights gathered from BA efforts are used to enhance ICCT systems. For example, if BA identifies common customer complaints, ICCT systems can be adjusted to address these issues more effectively.

7.	**Security and Compliance**	Collaborate on ensuring that ICCT systems adhere to industry regulations and security standards. BA professionals can identify compliance gaps and work with IT teams to address them.
8.	**User Experience (UX) Design**	BA can provide input into the design of ICCT interfaces and user experiences. This ensures that the systems are user-friendly and align with the needs of both customers and employees.
9.	**Change Management**	Collaborate on change management strategies when implementing new ICCT technologies. BA can help identify potential resistance points and develop strategies to ensure a smooth transition.
10.	**Continuous Improvement**	By routinely reviewing and analyzing data from ICCT systems, you may promote a culture of continuous improvement. Identifying opportunities for improvement and innovation can be greatly aided by BA.

In conclusion, the integration of BA with ICCT technologies in the service industry can lead to more efficient operations, improved customer satisfaction, and better strategic decision-making. This collaboration ensures that technology investments align with business goals and customer needs.

7.2 Integration of BA with AI & Robotics Technologies in Service Industry

Integrating Business Analysis (BA) with Artificial Intelligence (AI) and Robotics Technologies in the service industry can lead to increased efficiency, cost savings, and enhanced customer experiences. Here's how these areas can be integrated:

Table 17: Integration of BA with AI & Robotics Technologies in Service Industry

S. No.	Aspects	Description
1.	**Data-Driven Insights**	BA professionals can work with data scientists to leverage AI algorithms for analyzing large volumes of customer data. This can help identify patterns, trends, and customer preferences that inform business strategies.
2.	**Predictive Analytics**	Utilize AI and machine learning to predict customer behavior, service demand, and potential issues. BA can use these predictions to develop proactive strategies and improve decision-making.
3.	**Chatbots and Virtual Assistants**	Collaborate on the development and deployment of AI-powered chatbots and virtual assistants for customer support. BA can help design conversational flows that align with customer needs and service goals.
4.	**Robotic Process Automation (RPA)**	Identify repetitive and rule-based tasks within service processes, and integrate RPA to automate them. BA can help select suitable processes for automation and ensure they align with business objectives.
5.	**Natural Language Processing (NLP)**	Incorporate NLP technologies into customer service chatbots and AI systems to enable more natural and efficient interactions with customers. BA can define the language and tone used in these interactions.
6.	**Personalization**	Collaborate to create AI-driven personalization strategies. BA can identify the data points and customer insights necessary for tailoring services and content to individual preferences.
7.	**Quality Assurance and Compliance**	Work together to ensure that AI and robotic systems adhere to quality standards and regulatory requirements. BA can identify areas where human oversight is essential to maintain service quality and compliance.
8.	**Continuous Improvement**	Establish feedback loops to monitor the performance of AI and robotic systems. BA can analyze feedback and data to make continuous improvements, enhancing the customer experience and operational efficiency.

9.	**Change Management**	Develop change management strategies to ensure a smooth transition when implementing AI and robotics technologies. BA can identify potential resistance points and design strategies to address them.
10.	**Cost-Benefit Analysis**	Conduct cost-benefit analyses of AI and robotic implementations. BA can assess the ROI of these technologies by measuring their impact on efficiency, cost reduction, and customer satisfaction.
11.	**User Experience (UX) Design**	Collaborate on the design of AI-powered interfaces and interactions to ensure they are user-friendly and align with the service industry's goals and customer expectations.
12.	**Training and Skill Development**	BA can identify the skills and training needed for employees to work effectively alongside AI and robotic systems. This ensures that the workforce can adapt to new technologies.
13.	**Ethical Considerations**	Address ethical concerns related to AI and robotics, such as data privacy, bias, and job displacement. BA can help formulate ethical guidelines and policies that align with industry best practices.

By integrating BA with AI and Robotics Technologies in the service industry, organizations can leverage data-driven insights, automation, and enhanced customer interactions to deliver more efficient and personalized services, ultimately leading to improved customer satisfaction and competitive advantages.

7.3 Integration of BA with Blockchain Technologies in Service Industry

Integrating Business Analysis (BA) with Blockchain technologies in the service industry can bring about several benefits such as increased transparency, security, and efficiency in service delivery. Here's how these two areas can be integrated:

Table 18: Integration of BA with Blockchain Technologies in Service Industry

S. No.	Aspects	Description
1.	**Supply Chain Management**	Use Blockchain to create transparent and immutable records of goods and services throughout the supply chain. BA professionals can analyze this data to identify bottlenecks, optimize processes, and enhance the overall supply chain efficiency.
2.	**Smart Contracts**	Implement smart contracts for service agreements and payments. BA can help design these contracts to ensure they accurately capture the terms and conditions of services and automate payment processes when predefined conditions are met.
3.	**Identity Verification**	Develop blockchain-based identity verification systems for customers and employees. BA can ensure that these systems meet regulatory requirements and enhance security and privacy.
4.	**Data Security and Privacy**	Use blockchain for secure data storage and access control. BA can analyze data management processes to ensure compliance with data protection regulations and identify areas for improvement.
5.	**Fraud Detection and Prevention**	Leverage blockchain's transparency to detect and prevent fraud in service transactions. BA professionals can design algorithms and rules to flag suspicious activities and analyze patterns of fraudulent behavior.
6.	**Decentralized Autonomous Organizations (DAOs)**	Explore the potential of DAOs in service industry governance and decision-making. BA can help design governance structures and processes that leverage blockchain's transparency and security.
7.	**Auditing and Compliance**	Use blockchain for real-time auditing and compliance monitoring. BA can work to ensure that blockchain systems capture all relevant data for auditing purposes and help design compliance protocols.
8.	**Tokenization of Assets**	Tokenize service assets or offerings on the blockchain. BA can analyze the implications of tokenization on business models, pricing strategies, and customer engagement.

9.	**Customer Loyalty Programs**	Implement blockchain-based customer loyalty programs to enhance customer retention. BA can design loyalty program structures and analyze the impact on customer behavior.
10.	**Cross-Border Transactions**	Facilitate cross-border transactions and payments using blockchain technology. BA can help identify the regulatory and compliance challenges and design strategies to address them.
11.	**Smart Asset Management**	Use blockchain for tracking and managing service assets efficiently. BA can analyze asset utilization data to optimize maintenance schedules and reduce downtime.
12.	**User Experience (UX) and Interface Design**	Collaborate on designing user-friendly blockchain interfaces for both customers and employees. BA can ensure that blockchain interactions are intuitive and aligned with service industry goals.
13.	**Cost-Benefit Analysis**	Conduct cost-benefit analyses of blockchain implementations, considering factors such as reduced fraud, improved efficiency, and enhanced security. BA can assess the ROI of blockchain adoption.
14.	**Change Management**	Develop change management strategies to facilitate the transition to blockchain-based systems. BA can identify potential resistance points and design strategies to address them.

Integrating BA with Blockchain technologies in the service industry can revolutionize service delivery by enhancing security, transparency, and efficiency. By leveraging blockchain's capabilities, businesses can create trust in their services and gain a competitive edge in the marketplace.

7.4 Integration of BA with Cloud Computing Technologies in Service Industry:

Integrating Business Analysis (BA) with Cloud Computing Technologies in the service industry can lead to increased scalability, flexibility, and cost-efficiency in service delivery. Here's how these two areas can be integrated:

Table 19: Integration of BA with Cloud Computing Technologies in Service Industry

S. No.	Aspects	Description
1.	**Data Analytics and Business Intelligence (BI)**	Utilize cloud-based data analytics and BI tools to gather insights from customer interactions and service data. BA professionals can analyze this data to identify trends, customer preferences, and areas for improvement in service delivery.
2.	**Scalable Infrastructure**	Leverage cloud infrastructure for scalable service delivery. BA can work with IT teams to determine the optimal cloud resources required to meet service demands, reducing the need for large upfront investments in physical hardware.
3.	**Recovery from disasters and business continuity**	Take use of cloud-based backup and disaster recovery tools. In order to lower the risk of downtime and data loss, BA can make sure that service processes have reliable disaster recovery plans in place.
4.	**Remote Work and Collaboration**	Facilitate remote work and collaboration through cloud-based productivity tools and platforms. BA can assess the impact of remote work on service operations and suggest improvements.
5.	**Cost Management**	Monitor and optimize cloud costs. BA professionals can analyze cloud spending patterns, identify cost-saving opportunities, and recommend adjustments to cloud resources and services.
6.	**Service Deployment and Testing**	Use cloud environments for service testing and deployment. BA can work with development teams to ensure that new services and updates are thoroughly tested in cloud environments before deployment.

7.	**Security and Compliance**	Collaborate to ensure that cloud-based services adhere to security standards and regulatory requirements. BA can identify compliance gaps and work with IT teams to address them.
8.	**Data Integration**	Integrate cloud-based data storage and data integration services to streamline access to critical data. BA can help design data integration strategies that ensure data consistency and availability across the organization.
9.	**User Experience (UX) and Accessibility**	Collaborate on designing user-friendly cloud-based interfaces and experiences for both customers and employees. BA can ensure that cloud interactions are intuitive and aligned with service industry goals.
10.	**Change Management**	Develop change management strategies to ensure a smooth transition when adopting cloud technologies. BA can identify potential resistance points and design strategies to address them.
11.	**Service Scalability**	Assess the scalability of cloud-based services and infrastructure to meet changing customer demands. BA can work with IT teams to develop strategies for scaling resources up or down as needed.
12.	**Vendor Evaluation and Selection**	Assist in the evaluation and selection of cloud service providers. BA can help identify the cloud providers that best align with the service industry's specific needs and goals.
13.	**Compliance Monitoring**	Use cloud-based tools for monitoring and auditing compliance with industry regulations and internal policies. BA can ensure that cloud services provide the necessary features and controls for compliance.
14.	**Performance Monitoring and Optimization**	Monitor the performance of cloud-based services and recommend optimizations as needed. BA can analyze performance metrics and suggest improvements to enhance service quality.

Integrating BA with Cloud Computing Technologies in the service industry enables organizations to leverage the scalability, cost-efficiency, and flexibility of the cloud while ensuring that services are aligned with business goals and customer expectations. This integration can lead to improved service delivery and customer satisfaction.

7.5 Integration of BA with Cyber Security Technologies in Service Industry:

Integrating Business Analysis (BA) with Cybersecurity Technologies in the service industry is essential for safeguarding sensitive data, maintaining trust with customers, and ensuring the continuity of services. Table 20 illustrates how these two areas can be integrated:

Table 20: Integration of BA with Cyber Security Technologies in Service Industry

S. No.	Aspects	Description
1.	**Risk Assessment**	Collaborate to assess cybersecurity risks associated with service operations. BA can help identify potential vulnerabilities in processes and systems, allowing cybersecurity experts to prioritize their efforts.
2.	**Data Classification and Protection**	Work together to classify data by its sensitivity level. BA can define data handling procedures, and cybersecurity experts can implement the necessary protective measures, such as encryption and access controls.
3.	**Planned Response to Incidents**	In partnership with BA, create and test incident response plans. By assisting with the definition of protocols for recognizing and reporting security events, BA can ensure a coordinated response to minimize service interruptions.
4.	**Security by Design**	Integrate security into the design of new services and systems. BA can ensure that security considerations are included in the requirements and that security controls are part of the development process.

5.	**User Authentication and Access Control**	Collaborate on user authentication and access control mechanisms for services. BA can define user roles and access requirements, while cybersecurity experts implement secure authentication and authorization systems.
6.	**Security Awareness Training**	Implement security awareness programs for employees. BA can help design training materials, and cybersecurity experts can deliver training sessions and assess the effectiveness of the training.
7.	**Vulnerability Management**	Work together to identify and address vulnerabilities in service systems. BA can assist in the prioritization of vulnerabilities based on business impact, while cybersecurity experts can execute remediation efforts.
8.	**Compliance and Regulatory Alignment**	Collaborate to ensure that services meet regulatory and compliance requirements related to cybersecurity. BA can identify compliance gaps, and cybersecurity experts can implement the necessary controls and documentation.
9.	**Security Auditing and Testing**	Conduct security audits and penetration testing of service systems. BA can ensure that testing aligns with business goals and that identified vulnerabilities are addressed promptly.
10.	**Data Privacy and GDPR Compliance**	Ensure compliance with data privacy regulations, such as GDPR. BA can help identify personal data usage within services, while cybersecurity experts can implement the necessary controls for data protection.
11.	**Threat Intelligence and Monitoring**	Collaborate on the collection and analysis of threat intelligence. BA can assess the business impact of emerging threats, while cybersecurity experts monitor and respond to threats in real-time.
12.	**Security Incident Reporting and Documentation**	Define procedures for reporting and documenting security incidents. BA can assist in creating incident reporting templates and workflows, ensuring thorough documentation for future analysis and reporting to authorities if required.
13.	**Key Performance Indicators (KPIs) for Security**	Create security KPIs and metrics to assess the performance of security measures. The BA can specify the business goals related to security, and cybersecurity professionals can offer the information and analysis.
14.	**Continual Improvement**	Foster a culture of continual improvement in security practices. BA can analyze security incidents and identify opportunities for process enhancements, while cybersecurity experts implement necessary changes.

By integrating BA with Cybersecurity Technologies in the service industry, organizations can proactively identify and address security risks, protect sensitive data, and ensure the reliability of their services. This collaboration is crucial for maintaining customer trust and complying with increasingly stringent data protection regulations.

7.6 Integration of BA with Internet of Things (IoT) Technologies in Service Industry:

Integrating Business Analysis (BA) with Internet of Things (IoT) technologies in the service industry can lead to enhanced service offerings, improved efficiency, and new revenue streams. Table 21 depicts how these two areas can be integrated:

Table 21 : Integration of BA with Internet of Things (IoT) Technologies in Service Industry

S. No.	Aspects	Description
1.	**Identifying Business Goals**	Collaborate to define business goals and objectives related to IoT implementations. BA can help ensure that IoT initiatives align with the organization's broader service strategy.

2.	**Customer Experience Enhancement**	Gain insights into consumer behavior and preferences with IoT data. BA specialists can use this data to analyses potential for improving customer satisfaction and personalizing offerings.
3.	**Cost-Benefit Analysis**	Conduct cost-benefit analyses of IoT implementations. BA can assess the ROI of IoT projects, considering factors such as cost savings, revenue generation, and improved service quality.
4.	**Data Integration**	Integrate IoT-generated data with existing business systems and processes. BA can help design data integration strategies to ensure that IoT data is accessible and actionable for decision-making.
5.	**Service Innovation**	Collaborate on the development of new IoT-driven service offerings. BA can identify market needs and business opportunities that IoT technologies can address.
6.	**IoT Device Management**	Work together to define procedures for managing IoT devices and sensors. BA can ensure that device management aligns with business objectives, including scalability and reliability.
7.	**Data Security and Privacy**	Address IoT data security and privacy concerns. BA can help define policies and procedures for securing IoT data and ensuring compliance with data protection regulations.
8.	**Performance Metrics**	Define key performance indicators (KPIs) for IoT initiatives. BA professionals can identify metrics that measure the success of IoT projects and their impact on service delivery.
9.	**Predictive Maintenance**	Leverage IoT data for predictive maintenance of service equipment and assets. BA can assess the business impact of reduced downtime and maintenance costs.
10.	**Process Optimization**	Analyze IoT data to identify areas for process optimization. BA can work with operational teams to streamline processes and improve resource allocation.
11.	**Scalability and Reliability**	Ensure that IoT solutions are scalable and reliable to meet changing service demands. BA can assess the scalability requirements and help plan for future growth.
12.	**Regulatory Compliance**	Collaborate on ensuring that IoT implementations comply with industry regulations and standards. BA can identify compliance gaps and work with IoT teams to address them.
13.	**User Experience (UX) Design**	Design user-friendly interfaces and experiences for IoT-driven services. BA can ensure that IoT interactions are intuitive and align with service industry goals.
14.	**Change Management**	Develop change management strategies to facilitate the adoption of IoT technologies within the organization. BA can identify potential resistance points and design strategies to address them.
15.	**Data Analytics and Machine Learning**	Utilize advanced analytics and machine learning on IoT data to gain deeper insights and predict future trends. BA can work with data scientists to develop models that inform service decisions.

By integrating BA with IoT technologies in the service industry, organizations can unlock the full potential of IoT for improving service quality, reducing costs, and creating innovative offerings that meet the evolving needs of customers. This collaboration ensures that IoT initiatives are aligned with business objectives and customer expectations.

7.7 Integration of BA with 3D Printing Technologies in Service Industry:

Integrating Business Analysis (BA) with 3D Printing Technologies in the service industry can lead to innovative service offerings, improved cost-efficiency, and enhanced customer experiences. Here's how these two areas can be integrated:

Table 22: Integration of BA with 3D Printing Technologies in Service Industry

S. No.	Aspects	Description
1.	**Identifying Business Opportunities**	Collaborate to identify potential business opportunities that 3D printing can offer. BA can conduct market research and analyze customer needs to identify areas where 3D printing can add value.
2.	**Market Analysis**	Conduct market analysis to understand the competitive landscape and demand for 3D-printed products and services. BA can assess market trends and identify target customer segments.
3.	**Cost-Benefit Analysis**	Evaluate the cost-benefit of 3D printing implementations. BA can analyze the ROI of 3D printing projects, considering factors such as material costs, production speed, and service quality.
4.	**Service Design**	Collaborate on designing new services that leverage 3D printing technology. BA can help define service specifications, pricing models, and quality standards.
5.	**Supply Chain Optimization**	Use 3D printing to optimize the supply chain. BA professionals can analyze supply chain processes to identify opportunities for reducing lead times, inventory costs, and transportation expenses.
6.	**Prototyping and Product Development**	Work together on rapid prototyping and product development using 3D printing. BA can gather user feedback and iterate on designs to meet customer expectations.
7.	**Customization and Personalization**	Leverage 3D printing for customized and personalized products and services. BA can identify customer preferences and design experiences that allow for individualized creations.
8.	**Quality Control**	Define quality control processes for 3D-printed products. BA can ensure that quality standards align with service industry requirements and customer expectations.
9.	**Regulatory Compliance**	Collaborate on ensuring that 3D printing implementations comply with industry regulations and standards. BA can identify compliance gaps and work with 3D printing teams to address them.
10.	**Inventory Management**	Analyze the impact of 3D printing on inventory management. BA can work with logistics teams to determine optimal inventory levels and storage solutions.
11.	**Scalability and Resource Planning**	Ensure that 3D printing solutions are scalable to meet increasing demands. BA can assess the scalability requirements and help plan for resource allocation.
12.	**User Experience (UX) Design**	Design user-friendly interfaces and experiences for customers interacting with 3D printing services. BA can ensure that the ordering, customization, and tracking processes are intuitive.
13.	**Change Management**	Develop change management strategies to facilitate the adoption of 3D printing technologies within the organization. BA can identify potential resistance points and design strategies to address them.

14.	**Training and Skill Development**	Identify the skills and training needed for employees to work effectively with 3D printing technology. BA can ensure that the workforce can adapt to and utilize new technologies.
15.	**Data Analytics**	Utilize data analytics to gather insights from 3D printing operations. BA can analyze data to identify trends, customer preferences, and areas for improvement.

Integrating BA with 3D Printing Technologies in the service industry enables organizations to unlock the potential of additive manufacturing for creating customized products, streamlining supply chains, and improving cost-efficiency. This collaboration ensures that 3D printing initiatives are aligned with business objectives and customer needs.

7.8 Integration of BA with Mobile Communication & Marketing Technologies in Service Industry:

Integrating Business Analysis (BA) with Mobile Communication and Marketing Technologies in the service industry can lead to more effective customer engagement, targeted marketing campaigns, and improved service delivery. Table 23 depicts how these two areas can be integrated:

Table 23: Integration of BA with Mobile Communication & Marketing Technologies in Service Industry

S. No.	Aspects	Description
1.	**Customer Needs Analysis**	Collaborate to understand customer needs and preferences using data from mobile interactions. BA can analyze customer behavior and feedback to identify opportunities for service improvement and personalization.
2.	**Mobile App Development**	Work together on the development of mobile apps that enhance the customer experience. BA can define app requirements and functionalities based on business goals and user needs.
3.	**User Experience (UX) Design**	Design user-friendly mobile interfaces and experiences. BA can ensure that mobile interactions are intuitive and align with the service industry's goals and customer expectations.
4.	**Data Analytics and Personalization**	Utilize data analytics to personalize marketing messages and service offerings. BA professionals can work with marketing teams to create targeted campaigns based on customer profiles and behavior.
5.	**Mobile Payment Solutions**	Integrate secure mobile payment options into service offerings. BA can define payment processes and ensure they align with industry regulations and customer security expectations.
6.	**Location-Based Services**	Leverage location-based technologies for targeted marketing and service promotions. BA can identify opportunities to engage customers based on their geographic location and preferences.
7.	**Cross-Channel Marketing**	Coordinate marketing efforts across various mobile channels (e.g., SMS, email, push notifications). BA can help design integrated marketing strategies that ensure consistent messaging and customer engagement.

8.	**Performance Metrics**	Define key performance indicators (KPIs) for mobile marketing and service initiatives. BA can identify metrics that measure the success of mobile campaigns and their impact on service quality.
9.	**Mobile Content Strategy**	Collaborate on content strategies for mobile communication. BA can help ensure that content aligns with the brand's messaging and customer expectations.
10.	**Data Privacy and Compliance**	Address data privacy and compliance concerns related to mobile marketing and communication. BA can work with legal and compliance teams to ensure that data collection and usage adhere to regulations.
11.	**Testing and quality control for mobile apps**	To ensure that apps are error-free and user-friendly, work together on testing and quality assurance for mobile applications. Testing standards and user acceptance testing (UAT) procedures can be specified by BA.
12.	**Customer Feedback and Surveys**	Collect customer feedback through mobile channels and analyze it for insights. BA can design surveys and feedback mechanisms that provide valuable data for service improvement.
13.	**Cross-Device Compatibility**	Ensure that mobile communication and marketing efforts are compatible with various mobile devices and screen sizes. BA can work with development teams to optimize content and design for different devices.
14.	**Change Management**	Develop change management strategies to facilitate the adoption of mobile communication and marketing technologies within the organization. BA can identify potential resistance points and design strategies to address them.
15.	**Competitive Analysis**	Analyze competitors' mobile strategies and offerings. BA can provide insights on how to differentiate services and gain a competitive edge through mobile technologies.

Integrating BA with Mobile Communication and Marketing Technologies in the service industry can lead to more personalized, efficient, and engaging customer experiences. This collaboration ensures that mobile initiatives align with business objectives, regulatory requirements, and customer expectations.

7.9 Integration of BA with Information Storage Technologies in Service Industry:

Integrating Business Analysis (BA) with Information Storage Technologies in the service industry is crucial for efficient data management, enhanced decision-making, and improved customer experiences. Table 24 depicts how these two areas can be integrated:

Table 24 : Integration of BA with Information Storage Technologies in Service Industry

S. No.	Aspects	Description
1.	**Data Needs Assessment**	Collaborate to assess the data needs of the service industry. BA can work with stakeholders to identify critical data sources, storage requirements, and data access needs.

2.	**Data Governance Framework**	Create a data governance structure including guidelines for data ownership, data quality requirements, and data security measures. With BA, data governance will be in line with corporate goals and legal standards.
3.	**Data Storage and Infrastructure Selection**	Work together to select appropriate data storage technologies, such as databases, data lakes, or cloud storage solutions. BA can analyze business needs and scalability requirements to inform technology choices.
4.	**Data Integration and ETL Processes**	Integrate data storage technologies with other systems and processes. BA can define data integration requirements and design efficient Extract, Transform, Load (ETL) processes.
5.	**Data Security and Access Control**	Collaborate on data security and access control mechanisms. BA can define user roles and access requirements, while IT and security teams implement secure data storage and access protocols.
6.	**Data Backup and Recovery**	Define data backup and recovery strategies to ensure data resilience. BA can help assess business continuity requirements and recommend data recovery mechanisms.
7.	**Scalability and Performance Optimization**	Ensure that data storage solutions are scalable to accommodate growing data volumes. BA can work with IT teams to optimize database performance and storage infrastructure.
8.	**Data Retention Policies**	Collaborate on data retention policies to determine how long data should be stored and when it should be archived or deleted. BA can align data retention with regulatory requirements.
9.	**Business Intelligence and Analytics**	Utilize stored data for business intelligence and analytics. BA can work with data scientists and analysts to define analytical requirements and key performance indicators (KPIs).
10.	**Data Quality Assessment**	Define data quality standards and assessment processes. BA can help identify data quality issues and recommend data cleansing and validation procedures.
11.	**Compliance and Regulatory Alignment**	Collaborate to ensure that data storage and management comply with industry regulations and standards, such as GDPR or HIPAA. BA can identify compliance gaps and work with compliance teams to address them.
12.	**Data Migration**	Plan and execute data migration projects when transitioning to new storage technologies. BA can ensure that data migration aligns with business goals and data integrity.
13.	**Emergency Preparedness Planning**	Make data storage technology recovery plans for emergencies. The BA can collaborate with the IT teams to define the RTOs and RPOs (recovery point goals).
14.	**Change Management**	Develop change management strategies to facilitate the adoption of new data storage technologies and processes within the organization. BA can identify potential resistance points and design strategies to address them.

15.	**Cost Management**	Monitor and optimize data storage costs. BA professionals can analyze data storage spending patterns, identify cost-saving opportunities, and recommend adjustments to storage resources and services.

Integrating BA with Information Storage Technologies in the service industry ensures that data is effectively managed, secured, and leveraged to support business objectives, analytics, and customer experiences. This collaboration enhances data-driven decision-making and contributes to overall operational efficiency.

7.10 Integration of BA with Ubiquitous Education Technologies in Service Industry:

Integrating Business Analysis (BA) with Ubiquitous Education Technologies in the service industry is crucial for providing effective training, enhancing employee skills, and improving overall service quality. Table 25 depicts how these two areas can be integrated:

Table 25: Integration of BA with Ubiquitous Education Technologies in Service Industry

S. No.	Aspects	Description
1.	**Training Needs Analysis**	Collaborate to identify training needs within the service industry. BA can assess skill gaps, compliance requirements, and emerging trends to inform the development of training programs.
2.	**Learner Analytics**	Utilize data analytics to gather insights from ubiquitous education technologies. BA professionals can analyze learner data to measure training effectiveness and identify areas for improvement.
3.	**Content Development**	Work together on the development of training content. BA can define content requirements, learning objectives, and key performance indicators (KPIs) for measuring the impact of training.
4.	**User Experience (UX) Design**	Design user-friendly interfaces and experiences for ubiquitous education platforms. BA can ensure that the learning experience is engaging and aligned with industry goals.
5.	**Technology Selection**	Choose the best mobile learning apps, virtual reality (VR), augmented reality (AR), or learning management systems (LMS) combined. BA may evaluate the particular needs of the service sector in order to select the optimum technology.
6.	**Gamification and Interactive Learning**	Explore gamification and interactive learning techniques to engage learners. BA can help design gamified learning experiences that motivate employees to participate actively in training.
7.	**Assessment and Certification**	Define assessment criteria and certification processes for training programs. BA can ensure that assessments align with learning objectives and are meaningful for career development.
8.	**Scalability and Accessibility**	Ensure that ubiquitous education technologies are scalable and accessible to a diverse workforce. BA can assess scalability requirements and accessibility standards.

9.	**Learning Pathways**	Collaborate to design personalized learning pathways for employees. BA can help define career progression goals and recommend learning paths that align with service industry roles.
10.	**Feedback Mechanisms**	Implement feedback mechanisms for learners to provide input on training content and effectiveness. BA can analyze feedback data to make continuous improvements to training programs.
11.	**Compliance and Regulatory Training**	Ensure that training programs address compliance and regulatory requirements specific to the service industry. BA can identify compliance gaps and recommend training modules.
12.	**Change Management**	Develop change management strategies to facilitate the adoption of new education technologies within the organization. BA can identify potential resistance points and design strategies to address them.
13.	**Cost-Benefit Analysis**	Conduct cost-benefit analyses of education technology implementations. BA can assess the ROI of training initiatives, considering factors such as improved service quality and employee retention.
14.	**Skills Gap Analysis**	Collaborate on skills gap analyses to identify areas where additional training is needed to meet evolving service industry demands. BA can help align training programs with identified skill gaps.
15.	**Data Security and Privacy**	In respect to educational technology, identify and address privacy and data security risks. In order to guarantee student data protection and compliance with privacy rules, BA can work with IT and security teams.

Integrating BA with Ubiquitous Education Technologies in the service industry ensures that training programs are effective, aligned with business goals, and capable of improving service quality. This collaboration also fosters a culture of continuous learning and skill development among employees.

7.11 Integration of BA with Virtual & Augmented Reality Technologies in Service Industry:

Integrating Business Analysis (BA) with Virtual and Augmented Reality (VR/AR) technologies in the service industry can lead to enhanced customer experiences, improved training, and innovative service offerings. Table 26 depicts how these two areas can be integrated:

Table 26: Integration of BA with Virtual & Augmented Reality Technologies in Service Industry

S. No.	Aspects	Description
1.	**Needs Assessment**	Collaborate to assess the needs of the service industry that can benefit from VR/AR technology. BA can identify areas such as employee training, customer engagement, or product visualization where VR/AR can add value.
2.	**Commercial Impact Analysis**	Examine the potential effects of VR and AR implementation on business. BA specialists may evaluate the ROI of VR/AR initiatives by taking into account things like cost reductions, enhanced service quality, and customer pleasure.

3.	**User Experience (UX) Design**	Work together to design user-friendly VR/AR interfaces and experiences. BA can ensure that VR/AR interactions align with service industry goals and customer expectations.
4.	**Content Development**	Collaborate on the development of VR/AR content, such as training modules or product simulations. BA can define content requirements, learning objectives, and key performance indicators (KPIs) for measuring the impact of VR/AR content.
5.	**Technology Selection**	Help select appropriate VR/AR hardware and software solutions. BA can analyze the specific needs of the service industry to make informed technology choices.
6.	**Training and Simulation**	Utilize VR/AR for training and simulations. BA can work with training experts to design immersive training scenarios that replicate real-world service situations.
7.	**Product Visualization**	Implement VR/AR for product visualization and customization. BA can help define product presentation requirements and tailor VR/AR experiences to showcase services or products effectively.
8.	**Customer Engagement**	Explore VR/AR applications for enhancing customer engagement and interaction. BA can identify opportunities for creating immersive customer experiences that align with service goals.
9.	**Feedback Mechanisms**	Implement feedback mechanisms within VR/AR experiences to gather user input on content and usability. BA can analyze feedback data to make continuous improvements.
10.	**Accessibility and Inclusivity**	Ensure that VR/AR solutions are accessible and inclusive to a diverse audience. BA can assess accessibility requirements and compliance with relevant standards.
11.	**Security and Privacy**	Address security and privacy concerns related to VR/AR technologies. BA can work with IT and security teams to ensure that user data within VR/AR experiences is protected and compliant with privacy regulations.
12.	**Change Management**	Develop change management strategies to facilitate the adoption of VR/AR technologies within the organization. BA can identify potential resistance points and design strategies to address them.
13.	**Cost-Benefit Analysis**	Conduct cost-benefit analyses of VR/AR implementations. BA can assess the ROI of VR/AR initiatives, considering factors such as improved service quality, reduced training costs, and enhanced customer engagement.
14.	**Data Analytics and Reporting**	Utilize data analytics to gather insights from VR/AR interactions. BA can analyze user behavior, performance metrics, and feedback data to inform decision-making and content improvements.
15.	**Regulatory Compliance**	Collaborate to ensure that VR/AR implementations comply with industry regulations and standards. BA can identify compliance gaps and work with compliance teams to address them.

Integrating BA with Virtual and Augmented Reality Technologies in the service industry ensures that VR/AR initiatives are strategically aligned with business objectives, customer needs, and regulatory requirements. This collaboration enhances service delivery, training effectiveness, and customer engagement through immersive experiences.

7.12 Integration of BA with Quantum Computing Technologies in Service Industry:

Integrating Business Analysis (BA) with Quantum Computing Technologies in the service industry can potentially revolutionize various aspects of service delivery, including data analysis, optimization, and security. While quantum computing is still in its early stages, it's important to understand how it may impact the service industry in the future. Table 27 depicts how BA can be integrated with quantum computing technologies:

Table 27: Integration of BA with Quantum Computing Technologies in Service Industry

S. No.	Aspects	Description
1.	**Identification of Quantum Opportunities**	Collaborate to identify areas within the service industry where quantum computing can bring significant advantages. BA can assess business processes and data challenges that quantum computing might address.
2.	**Business Case Development**	Work together to develop business cases for quantum computing projects. BA can help quantify the potential benefits, including improved efficiency, faster data analysis, and cost savings.
3.	**Data Analysis and Optimization**	Leverage quantum computing for complex data analysis and optimization problems. BA can identify specific data analysis challenges and optimization tasks where quantum algorithms can provide advantages.
4.	**Algorithm Development**	Collaborate on the development of quantum algorithms tailored to service industry needs. BA can work with quantum scientists and programmers to design algorithms that address specific business objectives.
5.	**Security Enhancement**	Utilize quantum computing for advanced encryption and decryption methods to enhance data security. BA can assess security requirements and help implement quantum-safe encryption solutions.
6.	**Supply Chain and Logistics Optimization**	Explore quantum computing's potential for optimizing supply chain and logistics operations. BA can analyze supply chain processes and identify areas where quantum computing can improve efficiency.
7.	**Customer Insights and Personalization**	Utilize quantum computing to process large datasets and extract valuable customer insights. BA can work with data scientists to design algorithms that enable personalized service recommendations and marketing strategies.
8.	**Risk Analysis and Portfolio Optimization**	Collaborate on using quantum computing for risk analysis and portfolio optimization in financial services. BA can identify risk management challenges and design quantum algorithms to address them.
9.	**Healthcare and Drug Discovery**	Explore quantum computing's role in healthcare services, including drug discovery and disease modeling. BA can assess healthcare-related challenges that quantum computing can help solve.

10.	**Energy and Resource Optimization**	Leverage quantum computing to optimize energy consumption and resource allocation in service industries with substantial energy needs. BA can identify opportunities for quantum-enhanced resource management.
11.	**Regulatory Compliance**	Collaborate on ensuring that quantum computing implementations comply with industry regulations and standards. BA can identify compliance requirements related to quantum technologies.
12.	**Change Management**	Develop change management strategies to facilitate the adoption of quantum computing within the organization. BA can help address potential resistance points and ensure a smooth transition.
13.	**Cost-Benefit Analysis**	Conduct cost-benefit analyses of quantum computing implementations. BA can assess the ROI of quantum projects, considering factors such as improved performance and competitive advantages.
14.	**Data Integration**	Integrate quantum computing results with existing data analysis processes. BA can design data integration strategies to ensure that quantum-generated insights are incorporated into decision-making.
15.	**Education and Skill Development**	Identify the skills and training needed for employees to work effectively with quantum computing technology. BA can ensure that the workforce is prepared for quantum advancements.

While quantum computing is still emerging, it holds the potential to transform the service industry by solving complex problems more efficiently than classical computers. Collaborating with BA professionals will help ensure that quantum computing initiatives are aligned with business objectives and challenges.

8. ABCD ANALYSIS FRAMEWORK ON TECH-BUSINESS ANALYTICS IN TERTIARY INDUSTRY SECTOR FROM STAKEHOLDERS POINT OF VIEW :

8.1 ABCD ANALYSIS OF TBA IN SERVICE INDUSTRY AS FROM SUPPLIER POINT OF VIEW:

The ABCD analysis framework serves as a comprehensive method for evaluating diverse entities, be it systems, technologies, materials, strategies, products, or services. Its acronym encompasses four key dimensions: Advantages, Benefits, Constraints, and Disadvantages. This analytical tool systematically dissects the subject under consideration, examining its strengths (Advantages) and the positive outcomes it offers (Benefits), while also identifying limitations or barriers (Constraints) and potential drawbacks (Disadvantages). Through this structured approach, the ABCD analysis provides a holistic assessment, enabling a nuanced understanding of the entity being evaluated, aiding in decision-making, strategy formulation, or assessing potential implementations or innovations. ABCD analysis is made in four forms as (i) ABCD listing, (2) ABCD stakeholder analysis, (3) ABCD factor and elemental analysis, and Quantitative ABCD analysis. The simplest form of ABCD analysis called ABCD listed is used for analysis in many scholarly articles [161-206]. The following section contains ABCD listing of Tech-business Analytics in Tertiary industry sector:

8.1.1 Advantages on Tech-business Analytics in Tertiary industry sector from supplier point of view:

In the tertiary industry sector, tech-business analytics has a number of benefits, as listed in table 28:

Table 28: Advantages on Tech-business Analytics in Tertiary industry sector from supplier point of view

S. No.	Aspects	Description
1.	Better ability to make decisions	Tech-business analytics empowers organisations to make data-driven decisions that are founded on analysis and factual insights rather than hunches or speculation. Better decisions are made as a result, and results are enhanced.
2.	Efficiency of operations	Business process inefficiencies can be found using tech-business analytics, which enables organisations to reorganise their processes and cut expenses. Increasing competition and profitability for businesses can be facilitated by this.
3.	Personalised encounters	To give clients a personalised experience, tech-business analytics can be leveraged. Along with higher sales and revenue, this may also result in more devoted and content customers.
4.	Superiority over rivals	Tech-business analytics can give firms a competitive edge by helping them to spot new opportunities and create cutting-edge goods and services.
5.	Control of risk	Cyber threats, fraud, and challenges with regulatory compliance are just a few of the risks that may be identified and mitigated using tech-business analytics.
6.	Enhanced consumer insights	Tech-business analytics can give companies insightful data about customer behaviour and preferences. This can assist firms in creating more successful marketing plans and enhancing the consumer experience.
7.	Innovation	Technology-based business analytics can help companies innovate by spotting emerging patterns and possibilities. This can help firms expand and keep one step ahead of the competition.

Hence, tech-business analytics has a number of advantages for the tertiary industrial sector, enabling businesses to improve customer experiences, streamline processes, and promote innovation and growth.

8.1.2 Benefits on Tech-business Analytics in Tertiary industry sector from supplier point of view:

The Tertiary Industry sector can gain from tech-business analytics in a variety of ways, including the benefits listed in table 29:

Table 29: Benefits on Tech-business Analytics in Tertiary industry sector from supplier point of view

S. No.	Aspects	Description
1.	Increased efficiency and productivity	Tech-business analytics may assist organisations with process optimisation and operational efficiency improvement, which in turn boosts productivity.

2.	Better decision-making	Businesses can benefit from tech-business analytics by getting insights that help them make wise decisions, which leads to better results, lower risks, and higher performance.
3.	Enhanced customer experience	Business can benefit from using tech-business analytics to better understand the preferences and actions of their clients, allowing them to offer more individualised services and boost client happiness.
4.	Improved competitiveness	Tech-business analytics can allow companies to keep ahead of the competition and strengthen their competitive position by offering insights into market trends, customer behaviour, and the competitive environment.
5.	Innovation	Tech-business analytics can help companies find new opportunities and create cutting-edge goods and services, increasing sales and market share.
6.	Risk management	Tech-business analytics can assist organisations in identifying and minimising risks, such as fraud, security threats, and compliance difficulties, therefore decreasing the possibility of unfavourable consequences.
7.	Cost savings	Tech-business analytics can help companies cut expenses and increase profitability by discovering inefficient and wasteful areas.

Because of this, the advantages of tech-business analytics in the Tertiary industrial sector are substantial, allowing firms to better customer experiences, improve operations, and spur growth and innovation.

8.1.3 Constraints on Tech-business Analytics in Tertiary industry sector from supplier point of view:

There are several benefits to using tech-business analytics in the Tertiary Industrial Sector, but there are also certain difficulties that firms may face, as listed in table 30.

Table 30: Constraints on Tech-business Analytics in Tertiary industry sector from supplier point of view

S. No.	Aspects	Description
1.	Data quality	Accurate and trustworthy data are crucial to tech-business analytics. The analysis's findings can be erroneous or deceptive if the data used is inaccurate, obsolete, or incomplete.
2.	Lack of skilled professionals	Data analysis, statistics, and programming are just a few of the specialised talents needed for tech-business analytics. Businesses may have trouble locating personnel with the appropriate skills to integrate tech-business analytics successfully.
3.	Data privacy and security	Privacy issues may arise from the gathering and processing of customer data. Businesses must ensure that they adhere to data protection rules and regulations, such as the GDPR, and take precautions to secure the data from cyber-attacks.

4.	Cost	Investments in technology, software, and qualified personnel are often necessary for the implementation of tech-business analytics, which can be costly. The expenditures of applying tech-business analytics may be difficult for smaller companies to afford.
5.	Resistance to change	The application of tech-business analytics requires a cultural shift towards data-driven decision-making. Employees who are used to making decisions based on intuition or past experience may be resistant to change.
6.	Complexity:	Tech-business analytics can be challenging and necessitate complex statistical models and advanced algorithms. To make sure that staff can utilise the technology efficiently, businesses may need to spend in training and assistance.

Thus, despite the fact that tech-business analytics has numerous advantages, firms must be aware of these limitations and take action to overcome them if they hope to successfully apply tech-business analytics in the Tertiary industrial sector.

8.1.4 Disadvantages on Tech-business Analytics in Tertiary industry sector from supplier point of view:

Tech-business analytics in the Tertiary industrial sector has some drawbacks, as listed in table 31:

Table 31: Disadvantages on Tech-business Analytics in Tertiary industry sector from supplier point of view

S. No.	Aspects	Description
1.	Dependence on technology	With so much reliance on technology, tech-business analytics can cause operations to be disrupted by system crashes, technical difficulties, or downtime for organisations.
2.	Limited scope	Only the data that is now accessible can be used to generate insights in tech-business analytics. The analysis's conclusions could be constrained if the data are missing pieces or are incomplete.
3.	Human error	The possibility of human error always exists, notwithstanding the accuracy and dependability of tech-business analytics. Erroneous conclusions may stem from improper data entry or a misinterpretation of the results.
4.	Lack of transparency	Businesses may find it challenging to explain how they arrived at particular results since the algorithms employed in tech-business analytics are frequently sophisticated and challenging to comprehend.
5.	Ethical concerns	There may be ethical issues with the gathering and analysis of customer data. Businesses must make sure that the way they use customer data is honest and moral.
6.	Over-reliance on data	While relying too heavily on data can prevent creativity and innovation, it can also provide insightful information. Decision-making that is informed by facts must be balanced with creative and intuitive thinking in business.

Thus, despite the fact that tech-business analytics has many benefits, companies must be aware of these drawbacks and take action to address them if they are to successfully deploy tech-business analytics in the Tertiary industrial sector.

8.2 ABCD Analysis of TBA IN SERVICE INDUSTRY AS producer Points of View:

8.2.1 Advantages on Tech-business Analytics in Tertiary industry sector from producer point of view:

Tech-business analytics in the tertiary industry sector (services sector) can provide several advantages from the producer's point of view. These advantages can help organizations improve their operations, enhance customer experiences, and make data-driven decisions. Table 32 identifies some of the key advantages:

Table 32: Advantages on Tech-business Analytics in Tertiary industry sector from producer point of view

S. No.	Aspects	Description
1.	**Improved Customer Understanding**	Tech-business analytics allow producers to gain deeper insights into customer behavior and preferences. They can analyze customer data to understand buying patterns, demographics, and needs, enabling them to tailor services to individual customers.
2.	**Personalization of Services**	With the insights derived from analytics, producers can personalize their services. They can offer customized recommendations, promotions, and experiences that cater to each customer's specific preferences, increasing customer satisfaction and loyalty.
3.	**Enhanced Marketing and Sales Strategies**	Analytics can help producers refine their marketing and sales strategies. By analyzing data on customer interactions, producers can optimize advertising campaigns, target the right audience, and improve conversion rates.
4.	**Efficient Resource Allocation**	Analytics enable better resource allocation. Producers can use data to allocate staff, time, and resources efficiently, reducing operational costs and improving service quality.
5.	**Predictive Maintenance**	In industries with physical assets, such as hospitality or transportation, analytics can predict when equipment or facilities might fail. Producers can schedule preventive maintenance, reducing downtime and saving on repair costs.
6.	**Inventory Optimization**	For service providers with inventory, analytics can help optimize inventory levels. This ensures that they have the right amount of stock on hand, reducing storage costs and preventing stock outs or overstock situations.
7.	**Fraud Detection and Prevention**	Analytics can identify unusual patterns or anomalies in transactions, helping producers detect and prevent fraud or security breaches, which is especially important in industries like banking and insurance.
8.	**Competitive Advantage**	Utilizing analytics can provide a competitive advantage. Producers can use data insights to stay ahead of market trends, respond quickly to changing customer needs, and outperform competitors.

9.	**Cost Reduction**	Analytics can identify areas where costs can be reduced. This could involve optimizing supply chains, streamlining processes, or automating routine tasks, leading to significant cost savings.
10.	**Real-time Decision Making**	In dynamic service industries like e-commerce or hospitality, real-time analytics enable quick decision-making. Producers can respond to customer inquiries, monitor service quality, and adjust operations on the fly.
11.	**Compliance and Risk Management**	Analytics can help producers monitor compliance with industry regulations and manage risks effectively. They can identify compliance gaps and take proactive measures to mitigate risks.
12.	**Improved Service Quality**	By analyzing customer feedback and service data, producers can continuously improve service quality. This leads to higher customer satisfaction and better reviews, attracting more customers.
13.	**Revenue Growth**	Ultimately, tech-business analytics can drive revenue growth. Through data-driven insights, producers can identify cross-selling and upselling opportunities, expand into new markets, and introduce innovative services that resonate with customers.
14.	**Long-term Strategic Planning**	Analytics aids in long-term strategic planning. Producers can use historical data to make informed decisions about future investments, expansions, and partnerships.

Thus, tech-business analytics in the tertiary industry sector offers a multitude of advantages for producers, ranging from enhanced customer experiences to cost reduction and strategic growth. Leveraging data effectively allows organizations to stay competitive and adapt to the ever-changing demands of the service industry.

8.2.2 Benefits on Tech-business Analytics in Tertiary industry sector from producers points of view:

From the perspective of a producer, tech-business analytics in the tertiary industry sector, which focuses mostly on the delivery of services rather than tangible commodities, offers numerous important advantages. These advantages can improve business operations, client satisfaction, and general results. Table 33 identifies few significant benefits:

Table 33: Benefits on Tech-business Analytics in Tertiary industry sector from producer point of view

S. No.	Aspects	Description
1.	**Data-Driven Decision Making**	Tech-business analytics empower producers to make informed decisions based on data rather than intuition or guesswork. This leads to more accurate strategic planning and resource allocation.
2.	**Enhanced Customer Insights**	Analytics provide deeper insights into customer behavior and preferences. Producers can better understand their target audience, allowing for the customization of services and more effective marketing efforts.
3.	**Improved Customer Satisfaction**	By tailoring services to individual customer needs, producers can increase customer satisfaction and loyalty. Personalized experiences and recommendations contribute to positive customer experiences.

4.	**Cost Optimization**	Analytics help identify inefficiencies in operations and resource allocation. Producers can streamline processes, reduce waste, and optimize staffing, leading to cost savings.
5.	**Risk Mitigation**	Analytics can help producers better evaluate and manage risks. This is especially helpful in fields where risk analysis is essential, including banking and insurance.
6.	**Competitive Advantage**	Utilizing analytics can give producers a competitive edge. They can respond faster to market trends, outperform competitors, and stay agile in a rapidly changing business environment.
7.	**Marketing Effectiveness**	Producers can measure the effectiveness of marketing campaigns and adjust strategies accordingly. This leads to more efficient spending and higher ROI on marketing efforts.
8.	**Revenue Growth**	Through data-driven insights, producers can identify cross-selling and upselling opportunities. This not only boosts revenue but also fosters long-term customer relationships.
9.	**Process Improvement**	Analytics can pinpoint areas of improvement within service delivery processes. Producers can optimize workflows, reduce bottlenecks, and enhance overall service quality.
10.	**Real-Time Monitoring**	In industries like hospitality and e-commerce, real-time analytics enable producers to monitor service quality and customer interactions in real-time. This allows for immediate issue resolution and adjustments to service delivery.
11.	**Fraud Detection**	In sectors such as banking and insurance, analytics can help detect fraudulent activities and security breaches by identifying unusual patterns or anomalies in transactions.
12.	**Data Security**	Analytics can be employed to strengthen data security measures, safeguarding sensitive customer information and business data.
13.	**Compliance Management**	For industries with regulatory requirements, analytics can ensure compliance with industry standards and regulations, reducing the risk of fines and penalties.
14.	**Continuous Improvement**	Producers can use analytics to track and measure performance metrics over time, fostering a culture of continuous improvement and innovation.
15.	**Strategic Planning**	Historical data and predictive analytics aid in long-term strategic planning. Producers can make informed decisions about market expansion, investments, and partnerships.
16.	**Resource Allocation**	Analytics help optimize resource allocation, ensuring that budgets are allocated to initiatives that will yield the greatest return on investment.
17.	**Trend Identification**	Producers can identify emerging industry trends and adapt their services and strategies accordingly to stay ahead of the competition.

Thus, tech-business analytics offer numerous benefits to producers in the tertiary industry sector. These advantages encompass improved decision-making, enhanced customer experiences, cost reduction, risk mitigation, and the ability to remain competitive and responsive to market dynamics.

8.2.3 Constraints on Tech-business Analytics in Tertiary industry sector from producer point of view:

Although tech-business analytics in the tertiary industry sector have many benefits, producers may also confront a number of limitations and difficulties. Table 34 identifies a few of the main restrictions:

Table 34: Constraints on Tech-business Analytics in Tertiary industry sector from producer point of view

S. No.	Aspects	Description
1.	**Data Quality and Availability**	Limited access to high-quality data can hinder effective analytics. Producers may struggle with data that is incomplete, inaccurate, or inconsistent, making it difficult to draw meaningful insights.
2.	**Data Privacy and Security**	Privacy regulations (e.g., GDPR, CCPA) and security concerns can restrict the collection and use of customer data. Compliance with these regulations requires careful handling of personal information, which can be complex and costly.
3.	**Data Integration**	Businesses in the tertiary sector may have a variety of old systems and uncooperative data sources. Because of the potential for data silos, it might be difficult to get a complete picture of operations and customer interactions.
4.	**Lack of Analytical Talent**	There may be a shortage of skilled data analysts, data scientists, and data engineers who can effectively manage and interpret data. Attracting and retaining talent in this competitive field can be a constraint.
5.	**Technological Infrastructure**	Outdated or inadequate technological infrastructure can limit the ability to collect, store, and analyze data efficiently. Upgrading systems to support analytics can be costly and time-consuming.
6.	**Cost of Implementation**	Investing in analytics tools, software, and training can be expensive. Smaller producers may struggle to allocate sufficient resources for analytics initiatives.
7.	**Resistance to Change**	Resistance to adopting analytics-driven decision-making within the organization can be a significant constraint. Employees and management may be reluctant to embrace new processes and technologies.
8.	**Complexity of Analytics**	Advanced analytics techniques like machine learning and predictive modeling can be complex to implement and interpret. Producers may lack the expertise to leverage these technologies effectively.
9.	**Ethical Concerns**	The use of analytics can raise ethical concerns, particularly in industries that handle sensitive information. Producers need to ensure that their analytics practices align with ethical guidelines and societal values.

10.	**Scalability Issues**	As the volume of data grows, scalability becomes a concern. Producers may face challenges in scaling their analytics infrastructure to handle larger datasets and increased processing demands.
11.	**Regulatory Compliance**	The tertiary sector often faces complex and evolving regulatory environments. Ensuring that analytics practices comply with these regulations can be challenging.
12.	**Interpretation and Communication**	Extracting actionable insights from data is one thing; effectively communicating those insights to decision-makers is another challenge. Misinterpretation of data or ineffective communication can lead to poor decision-making.
13.	**Cultural Change**	Transforming an organization's culture to become data-driven can be difficult. Resistance to this cultural shift from employees and leadership can impede progress.
14.	**Overemphasis on Short-Term Goals**	Producers may prioritize short-term goals over long-term strategic planning. This can lead to a focus on immediate results rather than sustained analytics efforts.
15.	**ROI Uncertainty**	Demonstrating a clear return on investment (ROI) for analytics initiatives can be challenging. Producers may struggle to quantify the financial benefits of analytics projects.

Despite these constraints, many producers recognize the value of tech-business analytics and are actively working to overcome these challenges. Effective analytics can provide a competitive advantage and drive business growth in the tertiary industry sector, making it a worthwhile investment despite the obstacles.

8.2.4 Disadvantages on Tech-business Analytics in Tertiary industry sector from producer point of view:

Tech-business analytics in the tertiary industry sector, while advantageous, also come with disadvantages and challenges from the producer's point of view. These disadvantages can affect the adoption and implementation of analytics strategies. Table 35 identifies some key disadvantages:

Table 35: Disadvantages on Tech-business Analytics in Tertiary industry sector from producer point of view

S. No.	Aspects	Description
1.	**Cost of Implementation**	Implementing robust tech-business analytics systems can be expensive. Producers need to invest in data collection, storage, software, and skilled personnel, which may strain budgets.
2.	**Complexity of Data Integration**	The tertiary sector often has diverse data sources and legacy systems. Integrating these disparate data sets into a unified analytics platform can be complex and time-consuming.
3.	**Data Privacy and Security Concerns**	Handling and storing customer data raise privacy and security concerns. Producers must navigate regulatory compliance (e.g., GDPR, HIPAA) and invest in strong security measures to protect sensitive information.

4.	**Data Quality Issues**	Poor data quality, including incomplete or inaccurate data, can lead to flawed insights and decisions. Producers may need to invest in data cleansing and validation processes.
5.	**Skills Gap**	There may be a dearth of qualified data scientists and analysts on the employment market. It could be difficult for producers to recruit and keep people with the requisite skills.
6.	**Resistance to Change**	Implementing analytics-driven decision-making can face resistance within the organization. Employees and management may be hesitant to embrace new processes and technologies.
7.	**Overemphasis on Short-Term Goals**	Producers might prioritize short-term goals over long-term strategic planning. This can result in a focus on immediate results rather than sustained analytics efforts.
8.	**Technological Infrastructure**	Outdated or inadequate IT infrastructure can hinder data collection and analysis efforts. Upgrading systems to support analytics can be costly and time-consuming.
9.	**Scalability Challenges**	As data volume grows, scalability becomes a concern. Producers may face difficulties in scaling their analytics infrastructure to handle larger datasets and increased processing demands
10.	**Misinterpretation of Data**	Misinterpreting data or drawing incorrect conclusions can lead to poor decision-making. Producers must ensure that data is analyzed accurately and insights are correctly interpreted.
11.	**Cultural Change**	Transforming an organization's culture to become data-driven can be challenging. Resistance to this cultural shift from employees and leadership can slow down progress.
12.	**Ethical Concerns**	The use of analytics can raise ethical concerns, especially in industries that handle sensitive information. Producers must ensure that their analytics practices align with ethical guidelines and societal values.
13.	**ROI Uncertainty**	Demonstrating a clear return on investment (ROI) for analytics initiatives can be challenging. Producers may struggle to quantify the financial benefits of analytics projects.
14.	**Regulatory Compliance**	The tertiary sector often faces complex and evolving regulatory environments. Ensuring that analytics practices comply with these regulations can be challenging.
15.	**Data Overload**	Having access to vast amounts of data can lead to data overload, making it difficult to extract actionable insights and prioritize key information.
16.	**Lack of Expertise**	Some producers may lack the expertise to leverage advanced analytics techniques such as machine learning, limiting their ability to derive valuable insights from their data.

Despite these disadvantages, many producers recognize the potential benefits of tech-business analytics and are actively working to overcome these challenges. Over time, as technology evolves and organizations adapt, some of these disadvantages may be mitigated, making analytics an increasingly valuable tool in the tertiary industry sector.

8.3 ABCD Analysis of Tech Business Analytics IN SERVICE INDUSTRY FROM CONSUMERs Points of view:

8.3.1 Advantages on Tech-business Analytics in Tertiary industry sector from consumer point of view:

From the perspective of the consumer, tech-business analytics in the tertiary industrial sector offer a number of benefits that improve their overall experience and happiness with the services they receive. Several of the main benefits are listed in table 36:

Table 36: Advantages on Tech-business Analytics in Tertiary industry sector from consumer point of view

S. No.	Aspects	Description
1.	**Personalized Services**	Tech-business analytics enable service providers to better understand individual customer preferences and behaviors. This leads to more personalized services and recommendations that cater to each consumer's unique needs and preferences.
2.	**Improved Service Quality**	Analytics help service providers identify areas for improvement within their operations. This often translates into better service quality, shorter waiting times, and more efficient problem resolution.
3.	**Enhanced Customer Support**	Analytics-driven customer support allows for quicker response times and issue resolution. Consumers benefit from faster and more effective assistance when they have questions or encounter problems.
4.	**Tailored Offers and Promotions**	Tech-business analytics enable providers to offer targeted promotions and discounts. Consumers receive offers that are more relevant to their interests and needs, resulting in potential cost savings.
5.	**Convenience and Efficiency**	Consumers can enjoy more convenient and efficient experiences thanks to analytics. For example, e-commerce platforms use analytics to optimize search results, making it easier for consumers to find what they're looking for quickly.
6.	**Faster Service Delivery**	In sectors like transportation and logistics, analytics help optimize routes and schedules, leading to faster and more reliable service delivery. This benefits consumers by reducing delivery times and enhancing reliability.
7.	**Cost Savings**	Consumers can benefit from cost savings indirectly as businesses optimize their operations through analytics. This can lead to lower prices or more competitive pricing in the market.
8.	**Improved Product Recommendations**	In e-commerce and content streaming services, analytics algorithms provide consumers with better product or content recommendations, helping them discover new items or shows that match their interests.

9.	**Transparent Pricing**	Analytics can promote pricing transparency. Consumers can compare prices and make more informed purchasing decisions, leading to a fairer marketplace.
10.	**Predictive Maintenance**	In sectors like utilities and home services, predictive analytics can help providers schedule maintenance and repairs before issues become major problems. This reduces downtime and inconvenience for consumers.
11.	**Shorter Queues and Wait Times**	In sectors such as healthcare and entertainment, analytics can optimize appointment scheduling and queuing systems. Consumers spend less time waiting for services.
12.	**Access to Real-Time Information**	Real-time analytics provide consumers with up-to-date information, such as traffic conditions, stock availability, or flight delays, allowing them to make better-informed decisions.
13.	**Enhanced Customer Feedback**	Analytics enable businesses to collect and analyze customer feedback more effectively. This means that consumer input is used to drive continuous improvements in products and services.
14.	**Data Security and Privacy**	Analytics can help businesses identify and address security threats, protecting consumer data. This enhances consumer confidence in sharing personal information.
15.	**Personal Financial Management**	In the financial sector, consumers can benefit from analytics tools that help them manage their finances more effectively, including budgeting and investment recommendations.
16.	**Improved Healthcare**	Analytics can lead to better healthcare outcomes by enabling personalized treatment plans and predictive disease modeling, ultimately benefiting the health and well-being of consumers.

Thus, tech-business analytics in the tertiary industrial sector improve the customer experience by customizing services, raising the standard of excellence, enhancing ease, and providing cost savings. More client loyalty and satisfaction result from these benefits.

8.3.2 Benefits on Tech-business Analytics in Tertiary industry sector from consumer point of view:

Tech-business analytics in the tertiary industry sector provide several significant benefits from a consumer's point of view. These advantages improve the overall consumer experience, enhance convenience, and offer tailored services. Table 37 gives some key benefits:

Table 37: Benefits on Tech-business Analytics in Tertiary industry sector from consumer point of view

S. No.	Aspects	Description
1.	**Personalized Services**	Tech-business analytics enable service providers to understand individual consumer preferences and behaviors. This leads to more personalized services, recommendations, and offerings that align with the consumer's specific needs and interests.
2.	**Enhanced Customer Experience**	Analytics-driven improvements in service quality and efficiency result in a more enjoyable customer experience. Consumers

		encounter fewer issues, shorter wait times, and smoother interactions when dealing with service providers.
3.	**Convenience**	Analytics help service providers optimize processes, reducing the effort required from consumers. This includes streamlined checkouts, quicker issue resolution, and simplified service access, all of which enhance convenience.
4.	**Tailored Offers and Discounts**	Consumers receive offers and discounts that are more relevant to their preferences and purchasing history. This personalization can lead to cost savings and a higher perceived value of services.
5.	**Faster Responses and Issue Resolution**	Tech-business analytics enable faster response times and more efficient problem-solving. Consumers benefit from quicker customer support and issue resolution, reducing frustration.
6.	**Product and Content Recommendations**	In sectors like e-commerce and entertainment, analytics algorithms provide consumers with personalized product or content recommendations. This helps consumers discover new items or shows that match their interests.
7.	**Transparency**	Pricing and service details become more transparent through analytics. Consumers can easily compare prices, terms, and features, making it easier to make informed decisions.
8.	**Predictive Maintenance**	In sectors like transportation and utilities, predictive analytics can lead to more reliable services. Consumers experience fewer disruptions due to proactive maintenance and repairs.
9.	**Shorter Wait Times**	In healthcare, entertainment, and other sectors with queues, analytics can optimize scheduling and reduce wait times. Consumers spend less time waiting for appointments or services.
10.	**Real-Time Information**	Consumers have access to real-time information, such as traffic updates, stock availability, or service status. This enables them to make timely decisions and adjustments.
11.	**Improved Customer Feedback**	Analytics-driven feedback mechanisms allow consumers to provide input more easily and see their suggestions taken into account. This helps businesses make continuous improvements.
12.	**Data Security and Privacy**	Analytics can enhance data security and privacy practices, reassuring consumers that their personal information is handled responsibly and protected from security threats.
13.	**Personal Financial Management**	In finance, consumers benefit from analytics tools that offer insights into their spending habits, budgeting advice, and investment recommendations, helping them manage their finances more effectively.
14.	**Health and Well-being**	In healthcare, analytics can lead to better health outcomes. Consumers receive personalized treatment plans and early disease detection, contributing to their overall well-being.
15.	**Energy Efficiency**	In utilities, consumers may benefit from reduced energy consumption through analytics-driven suggestions for optimizing energy usage in homes and businesses.
16.	**Transparent Billing**	Consumers receive clearer and more accurate bills, reducing billing disputes and ensuring they only pay for services they've used.

Hence, tech-business analytics in the tertiary industry sector empower consumers with more personalized, efficient, and transparent services. These benefits contribute to a higher level of satisfaction and engagement with service providers.

8.3.3 Constraints on Tech-business Analytics in Tertiary industry sector from consumer point of view:

Consumers in the tertiary industry sector may also encounter constraints and challenges related to tech-business analytics. While these analytics can provide benefits, they can also raise concerns and limitations from the consumer's perspective. Table 38 lists some of key constraints:

Table 38: Constraints on Tech-business Analytics in Tertiary industry sector from consumer point of view

S. No.	Aspects	Description
1.	**Privacy Concerns**	Customers can be concerned about how much of their personal information is gathered, saved, and utilized for analytics. Data breaches or the improper use of personal information could raise issues.
2.	**Data Security**	Security breaches and data hacks can compromise consumer data, leading to identity theft or financial losses. Consumers may question the security measures in place to protect their information.
3.	**Transparency Issues**	Lack of transparency regarding data collection and usage practices can be a concern. Consumers may not fully understand how their data is being used for analytics, leading to mistrust.
4.	**Opt-Out Challenges**	Some consumers may find it difficult to opt out of data collection or personalized services if they desire more privacy. Complex opt-out processes can be frustrating.
5.	**Over personalization**	While personalization can be beneficial, excessive personalization may feel invasive to some consumers. They may prefer a balance between tailored recommendations and privacy.
6.	**Bias and Discrimination**	Consumers may worry that analytics algorithms incorporate biases that result in discriminatory outcomes. This can be especially concerning in sectors like finance, healthcare, and hiring.
7.	**Unwanted Marketing**	Overly personalized marketing efforts can lead to information overload and a perception of intrusiveness. Consumers may receive excessive promotional emails or ads based on their online activity.
8.	**Misinterpretation of Data**	Consumers may be concerned about businesses misinterpreting their data, leading to incorrect assumptions about their preferences or needs.
9.	**Loss of Human Touch**	In service sectors like healthcare or customer support, consumers may feel that analytics-driven automation reduces the human touch and empathy in interactions.
10.	**Limited Control**	Consumers may feel that they have limited control over the data collected about them and how it's used. Lack of control can lead to feelings of powerlessness.
11.	**Complexity**	Some consumers may find the complexity of analytics-driven systems overwhelming. They may struggle to understand how algorithms make decisions or recommendations.

12.	**Inaccurate Recommendations**	Consumers may receive inaccurate or irrelevant recommendations due to limitations in the analytics algorithms. This can lead to frustration and reduced trust in the system.
13.	**Stigmatization**	In healthcare and insurance, consumers may fear that their data could lead to stigmatization or higher costs if they are identified as high-risk individuals.
14.	**Lack of Alternatives**	Consumers may have limited alternatives to using services that rely heavily on tech-business analytics. They may feel compelled to accept data collection and personalization as a trade-off for access to these services.
15.	**Regulatory Concerns**	Consumers may be concerned about the adequacy of regulations to protect their rights and privacy in the context of analytics. Changes in regulations can also be confusing for consumers.
16.	**Misuse of Predictive Analytics**	In sectors like criminal justice or credit scoring, consumers may be concerned about the potential misuse of predictive analytics, which could lead to unfair treatment.

Consumers' perspectives on tech-business analytics in the tertiary sector can vary widely, with some individuals valuing personalized services and others expressing concerns about privacy and ethical considerations. Balancing the benefits of analytics with these constraints is an ongoing challenge for businesses and regulatory bodies.

8.3.4 Disadvantages on Tech-business Analytics in Tertiary industry sector from consumer point of view:

Tech-business analytics in the tertiary industry sector, while offering numerous benefits, can also present several disadvantages from a consumer's point of view. These disadvantages may raise concerns and impact the consumer experience. Table 39 identifies some of the key disadvantages:

Table 39: Disadvantages on Tech-business Analytics in Tertiary industry sector from consumer point of view

S. No.	Aspects	Description
1.	**Privacy Concerns**	Concerns over how much personal data is gathered, saved, and used for analytics purposes may arise from consumers. An example of this may be worries about data breaches or unauthorized access to their data.
2.	**Data Security Risks**	A major worry is the safety of customer data. Cyberattacks and data breaches can make personal and financial information vulnerable, which may result in identity theft or financial loss.
3.	**Transparency Issues**	Lack of transparency regarding data collection and usage practices can lead to mistrust. Consumers may not fully understand how their data is being used for analytics, which can create concerns.
4.	**Opt-Out Challenges**	Some consumers may find it difficult to opt out of data collection or personalized services. Complex and confusing opt-out processes can be frustrating and may lead to a sense of powerlessness.
5.	**Over personalization**	While personalization can enhance the consumer experience, excessive personalization can feel invasive. Consumers may prefer a balance between tailored recommendations and maintaining their privacy.

6.	**Bias and Discrimination**	Consumers may worry that analytics algorithms incorporate biases that result in discriminatory outcomes. This can be especially concerning in sectors like finance, healthcare, and hiring.
7.	**Unwanted Marketing**	Overly personalized marketing efforts can lead to information overload and a perception of intrusiveness. Consumers may feel bombarded with promotional emails or ads based on their online activity.
8.	**Misinterpretation of Data**	Consumers may be concerned about businesses misinterpreting their data, leading to incorrect assumptions about their preferences or needs. This can result in irrelevant recommendations or offers.
9.	**Loss of Human Interaction**	In service sectors like healthcare or customer support, consumers may feel that analytics-driven automation reduces the human touch and empathy in interactions, leading to a less satisfying experience.
10.	**Complexity**	Some consumers may find the complexity of analytics-driven systems overwhelming. They may struggle to understand how algorithms make decisions or recommendations, which can lead to frustration.
11.	**Inaccurate Recommendations**	Consumers may receive inaccurate or irrelevant recommendations due to limitations in the analytics algorithms. This can lead to dissatisfaction with the service.
12.	**Lack of Control**	Consumers may feel that they have limited control over the data collected about them and how it's used. Lack of control can lead to feelings of vulnerability.
13.	**Stigmatization**	In sectors like healthcare and insurance, consumers may fear that their data could lead to stigmatization or higher costs if they are identified as high-risk individuals.
14.	**Misuse of Predictive Analytics**	In sectors like criminal justice or credit scoring, consumers may be concerned about the potential misuse of predictive analytics, which could result in unfair treatment or profiling.
15.	**Regulatory Concerns**	Consumers may worry about the adequacy of regulations to protect their rights and privacy in the context of analytics. Changes in regulations can also be confusing for consumers.
16.	**Limited Alternatives**	In some cases, consumers may have limited alternatives to using services that rely heavily on tech-business analytics. They may feel compelled to accept data collection and personalization as a trade-off for access to these services.

These disadvantages highlight the need for businesses to prioritize consumer privacy, data security, and transparency in their analytics practices. Striking a balance between the benefits of analytics and consumer concerns is essential for maintaining trust and providing a positive consumer experience.

9. IMPLEMENTATION, AND IMPACT OF TECH -BUSINESS ANALYTICS ON EFFICIENCY OF TERTIARY INDUSTRY SECTOR :

A wide range of businesses, including companies in business, administration, transportation, finance, real estate, business and personal services, as well as in education, health, TBA, and social work, are included in the tertiary sector. The main endeavour in the tertiary sector of the economy is the rendering of services. Tasks completed on behalf of clients are referred to as services. Among the companies in the tertiary sector are theatres, banks, supermarkets, and hair salons. The tertiary sector, also referred to as the service sector, consists of businesses in the transportation, banking, tourist, hotel, insurance, business, tech-business analytics, and other service-related sectors. The tertiary industry in India thus includes TBA.

9.1 Implementation of Tech-Business in Tertiary Industry Sector:

The tertiary industry sector's use of tech-business analytics involves the processes listed in table 40:

Table 40: Implementation of Tech-Business in Tertiary Industry Sector

S. No.	Aspects	Description
1.	Define the problem or objective	Decide what business issue or goal tech-business analytics may help with, such as enhancing customer experience, decreasing expenses, or improving operational efficiency.
2.	Data collection and preparation	Gather and prepare the data needed for Tech-business analytics, making sure it is accurate, dependable, and pertinent to the issue or goal.
3.	Select the appropriate Tech-business analytics tools	Choose the proper tech-business analytics tools, based on the issue or goal, such as data mining, predictive analytics, or machine learning.
4.	Build the Tech-business analytics model	Utilise the chosen tools and approaches to build the Tech-business analytics model, then validate it to make sure the output is accurate and trustworthy.
5.	Integrate Tech-business analytics with business processes	Make sure the Tech-business analytics model is integrated with business systems and processes so that it is in line with the goals and strategies of the company.
6.	Train employees	Provide employees with training on the usage of tech-business analytics to make sure they have the skills and knowledge needed to use the technology effectively..
7.	Monitor and evaluate performance	Analyse the performance of the tech-business analytics model and make any necessary improvements to make sure it keeps adding value to the company.

Hence, rigorous planning, data preparation, connection with business processes, continual monitoring and evaluation to make sure it adds value to the business, and deployment of tech-business analytics in the Tertiary industry sector are all necessary for success.

9.2 Impact of Tech-Business in Tertiary Industry Sector:

The tertiary sector, commonly referred to as the service industry, has been significantly impacted by the technology and business industries. The tech-business sector has influenced the tertiary sector in the following ways as given in table 41:

Table 41: Impact of Tech-Business in Tertiary Industry Sector

S. No.	Aspects	Description
1.	Digital Transformation	The digital transformation that has completely changed the service sector has been spearheaded by tech companies. Tech companies have developed new digital platforms and services that have changed the way services are provided, including online banking, e-commerce, cloud computing, and many other areas.
2.	Automation	Many tasks in the service sector, including customer support, data analysis, and inventory management, have been automated as a result of the use of technology. The industry now operates more productively and efficiently as a result.

3.	New Services	There are now new services available that were previously unavailable in the tertiary sector thanks to the tech-business sector. For instance, the way consumers buy food has altered as a result of the disruption of the traditional taxi sector by ride-hailing services like Uber and Lyft and the food delivery industry by apps like Uber Eats and Door Dash.
4.	Job Creation	Software developers, data analysts, and experts in digital marketing are just a few of the new positions that have been created in the tertiary sector as a result of the expansion of the tech-business industry.
5.	Increased Competition	As new digital platforms and services have entered the market, the technology business sector has boosted competition in the tertiary sector. This has spurred innovation and enhanced services for customers.

Thus, the tech-business sector has had a substantial impact on the tertiary sector, resulting in improved productivity, efficiency, and innovation in the service sector.

10. ABCD ANALYSIS OF INTEGRATION OF BA WITH ICCT UT IN SERVICE INDUSTRY:

10.1 ABCD of Integrating Business Analytics with AI & Robotics in Service Industry:

Table 42: ABCD Analysis of Integration of BA with AI & Robotics:

S. No.	Aspects	Description
Advantages:		
1	**Improved Decision-Making**	AI and robotics can analyze vast amounts of data quickly and accurately, aiding businesses in making data-driven decisions for service optimization.
2	**Enhanced Efficiency**	Automation through robotics reduces human errors and speeds up service processes, resulting in higher efficiency and productivity.
3	**Cost Reduction**	Automating routine tasks with robotics can lower labor costs, especially in industries with labor-intensive services.
4	**Personalized Services**	Artificial intelligence (AI)-driven analytics can offer insights into customer preferences, enabling organizations to provide personalized offerings that may boost client pleasure and loyalty.
5	**24/7 Availability**	Robots and AI systems can operate around the clock, ensuring uninterrupted service availability, which is particularly beneficial for global businesses.
6	**Predictive Maintenance**	Analytics can predict when robots and machines require maintenance, reducing downtime and service disruptions.
Benefits:		
1	**Competitive Advantage**	Early adopters can gain a significant edge in service quality, cost-effectiveness, and innovation, giving them a competitive advantage in the market.
2	**Scalability**	Robotics and AI systems can be easily scaled to handle increased service demands without proportionally increasing labor costs.
3	**Data-Driven Insights**	Businesses can get more comprehensive understandings of consumer behavior, market trends, and operational effectiveness, enabling well-informed strategic planning.
4	**Customer Satisfaction**	Higher levels of customer satisfaction may result from quicker response times and personalized service offers.

5	**Risk Mitigation**	Real-time risk and issue identification through analytics enables companies to take preventative action to lessen them.
Constraints:		
1	**High Initial Costs**	Implementing AI and robotics systems can require significant upfront investments in technology, infrastructure, and training.
2	**Technological Dependence**	Over-reliance on technology can be risky, as system failures or cyberattacks can disrupt service delivery.
3	**Job Displacement Concerns**	The automation of tasks can lead to concerns about job displacement and workforce adjustments, which may require careful management and retraining.
4	**Data Privacy and Security**	Strong data privacy and security procedures are needed to handle sensitive consumer data and integrate AI in order to prevent breaches and compliance difficulties.
5	**Complex Implementation**	Integrating AI and robotics into existing service processes can be complex and may require careful planning and execution.
Disadvantages :		
1	**Loss of Human Touch**	Over-automation can result in a loss of the human touch, which may be critical in certain service sectors, such as healthcare and customer support.
2	**Ethical Concerns**	AI algorithms can introduce biases and ethical dilemmas, which need to be addressed, especially in decision-making processes.
3	**Maintenance Costs**	While predictive maintenance can reduce downtime, maintaining AI and robotics systems can be costly.
4	**Resistance to Change**	Employees and customers may resist the integration of AI and robotics, leading to implementation challenges.
5	**Regulatory Hurdles**	Service industries may face regulatory barriers and compliance challenges when implementing AI and robotics, especially in highly regulated sectors.

As a result, combining business analytics with AI and robotics in the service sector has many advantages, including better decision-making, more efficiency, and lower costs. However, it also has drawbacks and limitations in terms of prices, worries about employment displacement, moral dilemmas, and regulatory difficulties that organizations must carefully evaluate and handle during implementation.

10.2 ABCD of Integrating Business Analytics with Blockchain in Service Industry:

Table 43: ABCD Analysis of Integration of BA with Blockchain

S. No.	Aspects	Description
Advantages:		
1	**Enhanced Data Security**	Data security and integrity are guaranteed by the decentralized, immutable ledger of blockchain, which lowers the possibility of data breaches.
2	**Transparency**	The transparency and auditability of transactions and data provided by blockchain increases confidence between service providers and clients.

3	**Efficiency**	Smart contracts on blockchain can automate and streamline service-related processes, reducing manual intervention and associated errors.
4	**Cost Reduction**	Eliminating intermediaries and automating processes can lead to cost savings in transactions and service delivery.
5	**Traceability**	Blockchain enables end-to-end traceability of products and services, which is valuable for quality control and compliance.
Benefits:		
1	**Data Analytics Accuracy**	Blockchain's high-quality data can be leveraged for more accurate and insightful analytics, aiding in data-driven decision-making.
2	**Immutable Records**	Immutable blockchain records ensure the accuracy and reliability of historical data, improving the reliability of business analytics.
3	**Fraud Prevention**	Blockchain can help in detecting and preventing fraudulent activities through real-time monitoring and verification.
4	**Global Collaboration**	Blockchain allows for secure data sharing and collaboration across service providers and customers globally.
5	**Regulatory Compliance**	Blockchain's transparent ledger can simplify compliance with industry regulations and standards.
Constraints:		
1	**Scalability**	Blockchain networks can face scalability challenges when handling a large volume of transactions, impacting performance.
2	**Complexity**	Implementing and integrating blockchain technology can be complex, requiring specialized expertise.
3	**Energy Consumption**	Some blockchain networks, like Bitcoin, can consume significant energy, raising environmental concerns.
4	**Interoperability**	Ensuring compatibility with existing systems and standards can be challenging when integrating blockchain
5	**Privacy Concerns**	Striking a balance between transparency and privacy can be difficult, especially in industries with sensitive data.
Disadvantages:		
1	**Cost of Implementation**	Implementing blockchain technology can be expensive due to development, infrastructure, and training costs.
2	**Lack of Regulation**	The regulatory landscape for blockchain is still evolving, creating uncertainty and potential compliance challenges.
3	**User Adoption**	Users and stakeholders may be hesitant to embrace blockchain technology due to its relative novelty and complexity.
4	**Data Recovery**	Data on a blockchain is immutable, which means that recovering lost or erroneous data can be extremely challenging.
5	**Centralization Risk**	While blockchain is designed to be decentralized, in practice, some networks can become centralized due to mining or validation concentration.

Thus, integrating business analytics with blockchain in the service industry offers advantages such as enhanced data security, transparency, and efficiency. However, challenges related to scalability, complexity, and regulatory concerns must be carefully considered. Overall, successful implementation can provide a foundation for improved data analytics, efficiency, and trust in service-related processes.

10.3 ABCD of Integrating Business Analytics with Cloud Computing in Service Industry:

Table 44: ABCD Analysis of Integration of BA with Cloud Computing

S. No.	Aspects	Description
Advantages:		
1	**Scalability**	Businesses can effectively handle variable workloads thanks to cloud computing's flexibility to scale analytical resources up or down in response to demand.
2	**Cost-Efficiency**	Pay-as-you-go models are frequently used by cloud services, which eliminates the need for substantial upfront expenditures on infrastructure and software.
3	**Accessibility**	As they can be viewed from any location with an internet connection, cloud-based analytics encourage collaboration between remote teams.
4	**Real-Time Data**	Cloud-based analytics can process and analyze real-time data, enabling quicker decision-making and more timely responses to service-related issues.
5	**Automatic Updates**	Cloud providers handle infrastructure updates and maintenance, ensuring that analytics tools are up to date and secure.
Benefits:		
1	**Improved Data Processing**	Cloud platforms can handle large volumes of data, facilitating complex analytics and generating valuable insights.
2	**Data Integration**	Analytics are improved in terms of quality and depth thanks to the integration of data from diverse sources made possible by cloud services.
3	**Enhanced Collaboration**	Cloud-based analytics tools can be easily shared among teams, fostering collaboration and knowledge sharing.
4	**Disaster Recovery**	Cloud providers offer robust backup and disaster recovery solutions, safeguarding critical service-related data.
5	**Global Reach**	Cloud computing enables service providers to reach a global audience by hosting services and analytics tools in multiple regions.
Constraints:		
1	**Security Concerns**	Secure data storage practices and compliance observance may be required if sensitive service-related data is stored in the cloud.
2	**Data Transfer Costs**	Large volumes of data transfer between on-premises systems and the cloud can incur additional costs.
3	**Data Privacy**	Complying with data privacy regulations, especially in international markets, can be complex when using cloud services.
4	**Vendor Lock-In**	Businesses may face challenges if they become too dependent on a single cloud provider, making it difficult to switch providers or integrate with other services.
5	**Latency**	Latency issues can arise when accessing cloud-based analytics, affecting the speed of data retrieval and analysis.

Disadvantages:		
1	**Downtime Risk**	Cloud outages can disrupt service operations and analytics processes, leading to downtime and potential business losses.
2	**Limited Control**	Businesses may have limited control over the underlying infrastructure, which can be a disadvantage when customizing analytics environments.
3	**Data Ownership**	Clarifying data ownership and responsibility between the business and the cloud provider is essential to avoid conflicts and data loss.
4	**Data Transfer Speed**	Uploading large volumes of data to the cloud for analysis can be time-consuming and impact operational efficiency.
5	**Cost Overruns**	Without careful monitoring and management, cloud costs can escalate beyond budgeted amounts.

Thus, integrating business analytics with cloud computing in the service industry offers scalability, cost-efficiency, and accessibility benefits. However, it also presents challenges related to security, data privacy, and control. Successful implementation involves careful planning, security measures, and compliance considerations to leverage the advantages while mitigating the constraints and disadvantages.

10.4 ABCD of Integrating Business Analytics with Cyber Security in Service Industry:

Table 45: ABCD Analysis of Integration of BA with Cyber Security

S. No.	Aspects	Description
Advantages:		
1	**Early Threat Detection**	To find abnormalities and potential cybersecurity problems before they become serious, business analytics may analyze enormous amounts of data.
2	**Improved Incident Response**	Analytics can enhance the speed and accuracy of incident response by providing real-time insights into cyberattacks or breaches.
3	**Data Protection**	Analytics can monitor data access and usage patterns, helping businesses protect sensitive customer and company data.
4	**Risk Assessment**	By analyzing historical data, businesses can better assess their cybersecurity risks and make informed decisions about resource allocation.
5	**Compliance Management**	Analytics can aid in ensuring compliance with cybersecurity regulations and standards by providing evidence of security measures and practices.
Benefits:		
1	**Customized Security**	Analytics can help tailor cybersecurity measures to specific service industry needs, enhancing protection and reducing false positives.
2	**Cost Reduction**	Early threat detection and efficient incident response can reduce the financial impact of cyberattacks and breaches.
3	**Proactive Defense**	Predictive analytics can anticipate cyber threats, allowing businesses to proactively fortify their defenses.

4	**Improved User Experience**	Enhanced security through analytics can lead to increased customer trust and satisfaction in service delivery.
5	**Data-Driven Decision-Making**	Data analytics can guide decisions on cybersecurity investments and strategies for maximum effectiveness.
Constraints:		
1	**Data Privacy**	Handling cybersecurity data raises privacy concerns, requiring careful management to avoid breaches and regulatory issues.
2	**Complex Implementation**	Integrating analytics with cybersecurity can be complex and may require specialized skills and technologies.
3	**False Positives**	Overreliance on analytics can result in false alarms or misinterpretation of data, potentially diverting resources from real threats.
4	**Resource Intensive**	Effective analytics often require substantial computing power and data storage resources.
5	**Skill Gap**	A shortage of skilled cybersecurity analysts and data scientists can be a constraint in implementing advanced analytics solutions.
Disadvantages:		
1	**Cost**	Implementing and maintaining advanced analytics for cybersecurity can be expensive, particularly for smaller service businesses.
2	**Complexity**	Analyzing vast amounts of data can introduce complexity, making it challenging to extract actionable insights quickly.
3	**False Negatives**	While analytics can help detect threats, no system is foolproof, and false negatives can lead to security breaches.
4	**Dependency on Technology**	Overreliance on analytics can create a false sense of security and may neglect the importance of human expertise in cybersecurity.
5	**Scalability**	Scaling up analytics to handle increasing data volumes and evolving threats can be challenging.

Hence, integrating business analytics with cybersecurity in the service industry provides early threat detection, improved incident response, and customized security measures. However, it also comes with constraints related to data privacy, complexity, and resource requirements. Effective implementation requires a balance between technology, human expertise, and compliance considerations.

10.5 ABCD of Integrating Business Analytics with Internet of Things (IoT) in Service Industry:

Table 46: ABCD Analysis of Integration of BA with Internet of Things (IoT)

S. No.	Aspects	Description
Advantages:		
1	**Real-Time Insights**	IoT devices provide a continuous stream of data, enabling real-time analytics for quicker decision-making.
2	**Predictive Maintenance**	Analytics can predict when service equipment needs maintenance, reducing downtime and improving reliability.

3	**Cost Reduction**	By optimizing resource allocation and maintenance schedules, businesses can achieve cost savings.
4	**Enhanced Customer Experience**	IoT-powered analytics can lead to improved service quality and personalization, enhancing customer satisfaction.
5	**Efficiency**	Automation through IoT and analytics streamlines service processes, reducing manual effort and errors.
Benefits:		
1	**Data-Driven Decisions**	IoT analytics enables data-driven decision-making, allowing businesses to optimize service operations and improve service delivery.
2	**Customized Services**	IoT data can be used to tailor services to individual customer needs, leading to higher customer retention rates.
3	**Competitive Advantage**	Early adopters of IoT analytics can gain a competitive edge by offering more efficient and innovative services.
4	**Resource Optimization**	Analytics can help optimize the allocation of service personnel and equipment, improving resource efficiency.
5	**Proactive Issue Resolution**	IoT data and analytics can identify service issues in real time, allowing for proactive resolution.
Constraints:		
1	**Data Security**	IoT devices and data streams can be vulnerable to cyberattacks, requiring robust security measures.
2	**Data Privacy**	Handling vast amounts of data from IoT devices can raise privacy concerns, necessitating compliance with regulations.
3	**Integration Complexity**	Integrating IoT devices and data into existing systems and analytics platforms can be complex.
4	**Scalability**	As IoT deployments grow, managing and scaling analytics infrastructure becomes more challenging.
5	**Cost of Implementation**	Deploying IoT sensors and setting up analytics systems can be costly, particularly for smaller businesses.
Disadvantages :		
1	**Reliability**	IoT devices can experience technical failures or connectivity issues, affecting the accuracy of analytics.
2	**Data Overload**	Managing and analyzing vast amounts of IoT data can be overwhelming, potentially leading to information overload.
3	**Dependency on Technology**	Overreliance on IoT and analytics may neglect the importance of human expertise in service delivery.

4	**Regulatory Compliance**	IoT data handling must adhere to regulations, which can be complex and vary by region.
5	**Complexity in Decision-Making**	Interpretation of IoT data and analytics can be complex, requiring skilled analysts.

Therefore, combining business analytics with the Internet of Things (IoT) in the services sector offers real-time insights, preventative maintenance, and cost savings. It does, however, also bring up issues with cost, complexity, data privacy, and security. Technology, security precautions, and compliance issues must all be balanced for implementation to be successful.

10.6 ABCD of Integrating Business Analytics with 3D Printing in Manufacturing Industry:

Table 47: ABCD Analysis of Integration of BA with 3D Printing

S. No.	Aspects	Description
Advantages:		
1	**Cost Reduction**	Analytics can optimize 3D printing processes, reducing material waste and operational costs.
2	**Customization**	Data-driven insights can enable highly customized 3D-printed products to meet specific customer requirements.
3	**Efficiency**	Analytics can streamline production workflows, improving the speed and accuracy of 3D printing.
4	**Inventory Management**	Businesses can reduce inventory levels by 3D printing parts on-demand, leading to lower storage costs.
5	**Quality Control**	Analytics can monitor and ensure the quality of 3D-printed products, reducing defects and rework.
Benefits:		
1	**Improved Product Design**	Analytics can inform product design by analyzing performance data, resulting in better, more efficient designs.
2	**Sustainability**	Data analytics can identify eco-friendly materials and printing methods, promoting sustainable manufacturing.
3	**Rapid Prototyping**	Analytics-driven 3D printing enables rapid prototyping, speeding up product development cycles.
4	**Supply Chain Resilience**	On-demand 3D printing can reduce reliance on complex supply chains, enhancing resilience.
5	**Competitive Advantage**	Businesses adopting advanced analytics with 3D printing gain a competitive edge through cost-effectiveness and innovation.
Constraints:		
1	**Data Security**	Protecting sensitive design and production data from cyber threats is critical.

2	**Intellectual Property Concerns**	Sharing 3D printing files and data analytics may raise intellectual property and copyright issues.
3	**Initial Investment**	Implementing analytics and 3D printing technology can involve significant upfront costs.
4	**Skilled Workforce**	Skilled personnel are needed to manage and interpret the data and oversee 3D printing operations.
5	**Regulatory Compliance**	Manufacturing regulations may not fully accommodate 3D printing, requiring adaptation and compliance efforts.
Disadvantages:		
1	**Limited Material Options**	Compared to traditional manufacturing methods, 3D printing materials are somewhat limited in diversity.
2	**Speed Constraints**	3D printing can be slower than conventional manufacturing for large-scale production runs.
3	**Complexity**	Integrating data analytics and 3D printing can be complex and may require customized solutions.
4	**Quality Control Challenges**	Ensuring consistent quality in 3D-printed products can be challenging due to variations in material and technology.
5	**Dependency on Technology**	Overreliance on technology may overlook the importance of human expertise in manufacturing.

Hence, integrating business analytics with 3D printing in the manufacturing industry offers advantages such as cost reduction, customization, and improved efficiency. However, it also poses challenges related to data security, intellectual property, and initial investment. Successful implementation involves balancing technology with security measures, compliance, and workforce skill development.

10.7 ABCD of Integrating Business Analytics with Mobile Communication in Service Industry:

Table 48: ABCD Analysis of Integration of BA with Mobile Communication

S. No.	Aspects	Description
Advantages:		
1	**Real-Time Data Access**	Mobile communication enables access to real-time data, allowing service providers to make informed decisions on the go.
2	**Improved Customer Engagement**	Mobile apps and messaging platforms enable direct and personalized communication with customers, enhancing engagement.
3	**Enhanced Efficiency**	Business analytics can optimize mobile workflows, reducing response times and increasing service efficiency.
4	**Location-Based Services**	Mobile analytics can utilize location data for targeted marketing, service recommendations, and improved logistics.
5	**Cost Savings**	By streamlining processes and improving resource allocation, mobile analytics can lead to cost reductions.

Benefits:		
1	**Customer Insights**	Analytics on mobile interactions provide valuable insights into customer behavior, preferences, and needs.
2	**Personalized Service**	Mobile analytics enables tailored services and recommendations, increasing customer satisfaction and loyalty.
3	**Competitive Advantage**	Businesses with mobile analytics can respond quickly to market changes and customer demands, gaining a competitive edge.
4	**Data-Driven Marketing**	Analytics can inform mobile marketing strategies, optimizing ad targeting and increasing conversion rates.
5	**Remote Management**	Mobile communication allows remote monitoring and management of service operations, reducing the need for physical presence.
Constraints:		
1	**Privacy Concerns**	Collecting and analyzing mobile data must adhere to strict privacy regulations to protect customer information.
2	**Data Security**	Ensuring the security of mobile data and communications is essential to prevent data breaches.
3	**Device and OS Fragmentation**	Analytics integration and app creation may be made more difficult by the variety of mobile devices and operating systems.
4	**Technical Challenges**	Mobile analytics may face challenges related to network connectivity, device compatibility, and data synchronization.
5	**User Adoption**	Encouraging customers and employees to use mobile apps and services for data collection can be a hurdle.
Disadvantages:		
1	**Dependency on Connectivity**	Mobile analytics depend on network connectivity, and disruptions can impede data access and decision-making.
2	**Data Volume**	Handling large volumes of mobile data for analysis can be resource-intensive.
3	**Data Accuracy**	Mobile data can sometimes be inaccurate or incomplete, leading to potential errors in analytics.
4	**Implementation Costs**	Developing and maintaining mobile analytics solutions can be costly, especially for small businesses.
5	**Data Overload**	The abundance of mobile data can lead to information overload, making it challenging to extract actionable insights.

Hence, integrating business analytics with mobile communication in the service industry offers real-time insights, personalized services, and cost savings. However, it also presents challenges related to privacy, security, technical complexity, and user adoption. Successful implementation requires a balance between data-driven decision-making and safeguarding customer privacy and data security.

10.8 ABCD of Integrating Business Analytics with Information Storage Technology in Service Industry:

Table 49: ABCD Analysis of Integration of BA with Information Storage

S. No.	Aspects	Description
Advantages:		
1	**Data Accessibility**	Information storage technology provides quick and easy access to vast amounts of data, facilitating analytics.
2	**Data Retention**	Storage solutions can retain historical data, enabling trend analysis and long-term decision-making.
3	**Scalability**	As data volumes grow, storage technology can scale to accommodate the increasing data storage needs of analytics.
4	**Data Integration**	Information storage technology allows the consolidation of data from various sources, enhancing the quality of analytics.
5	**Cost Efficiency**	Efficient storage systems can reduce the cost of storing and managing large datasets for analysis.
Benefits:		
1	**Informed Decision-Making**	Analytics on stored data provide valuable insights for informed and data-driven decision-making.
2	**Predictive Analytics**	Historical data stored in these systems can be used for predictive analytics, anticipating future service trends and demands.
3	**Efficiency Optimization**	Analysis of stored data can help identify areas for process improvement and resource optimization.
4	**Customer Insights**	Analytics on historical customer data can lead to better understanding and targeting of customer needs and preferences.
5	**Compliance and Audit Trails**	Information storage technology can maintain detailed records for compliance purposes and auditing.
Constraints:		
1	**Data Security**	Protecting sensitive data stored in these systems is paramount to prevent unauthorized access and data breaches.
2	**Data Privacy**	Managing customer data requires compliance with data privacy regulations, adding complexity to storage and analytics.
3	**Cost of Implementation**	Deploying and maintaining information storage technology and analytics tools can be expensive.
4	**Complexity**	Integrating diverse data sources and formats from storage systems can be technically complex.
5	**Scalability Challenges**	Scaling storage and analytics infrastructure to handle growing data volumes can be challenging.
Disadvantages:		
1	**Data Overload**	Storing vast amounts of data can lead to information overload, making it challenging to extract meaningful insights.
2	**Maintenance Complexity**	Maintaining and managing complex storage and analytics systems can be resource-intensive.

3	**Data Redundancy**	Without proper data governance, information storage systems can lead to data redundancy and inconsistencies.
4	**Dependency on Technology**	Overreliance on storage technology may neglect the importance of human expertise in data analysis.
5	**Initial Investment**	Implementing advanced storage and analytics solutions can require significant upfront investments.

Hence, integrating business analytics with information storage technology in the service industry provides data accessibility, informed decision-making, and predictive analytics. However, it also poses challenges related to data security, complexity, and compliance. Successful implementation involves a balance between technology, data governance, and cost considerations.

10.9 ABCD of Integrating Business Analytics with Ubiquitous Education Technology in Service Industry:

Table 50: ABCD Analysis of Integration of BA with Ubiquitous Education

S. No.	Aspects	Description
Advantages:		
1	**Data-Driven Training**	Business analytics can provide insights into employee training needs, ensuring that staff have the right skills for optimal service delivery.
2	**Performance Monitoring**	Ubiquitous education technology allows continuous performance monitoring, enabling analytics-driven feedback and improvement.
3	**Personalized Learning**	Analytics can tailor educational content to individual employee needs, enhancing the effectiveness of training programs.
4	**Efficient Resource Allocation**	By analyzing training data, businesses can allocate resources more efficiently, reducing training costs.
5	**Competitive Workforce**	A well-trained workforce can provide a competitive advantage by delivering high-quality services.
Benefits:		
1	**Improved Employee Skills**	Analytics-driven education technology ensures that employees have the skills and knowledge necessary to excel in their roles.
2	**Higher Service Quality**	A well-trained workforce delivers higher-quality services, leading to increased customer satisfaction.
3	**Cost Savings**	Targeted training based on analytics can reduce training costs and improve the return on investment for education technology.
4	**Scalable Learning**	Ubiquitous education technology allows businesses to scale training programs easily to accommodate growth.
5	**Adaptive Learning**	Analytics can identify areas where employees struggle and adapt training content to address those challenges.
Constraints:		
1	**Data Privacy**	Handling employee training data requires compliance with data privacy regulations, adding complexity to data management.
2	**Technology Dependence**	Overreliance on technology may neglect the importance of in-person or hands-on training methods.

3	**Resource Intensive**	Implementing education technology and analytics systems can be costly, particularly for smaller businesses.
4	**Skill Gap**	A lack of skilled personnel to manage and interpret training data and analytics can be a constraint.
5	**Resistance to Change**	Employees may resist the adoption of new training technologies and methods, requiring change management efforts.
Disadvantages:		
1	**Technical Challenges**	Integrating education technology with analytics can be complex, requiring compatibility and data integration efforts.
2	**Content Quality**	Poor-quality training content can result in ineffective education, even when analytics are applied.
3	**Data Overload**	Collecting and analyzing a vast amount of training data can lead to information overload, making it challenging to extract actionable insights.
4	**Initial Investment**	Implementing advanced education technology and analytics solutions can require significant upfront investments.
5	**User Experience**	The user experience of education technology may not always be optimal, affecting its effectiveness.

Hence, integrating business analytics with ubiquitous education technology in the service industry provides data-driven training, improved service quality, and cost savings. However, it also presents challenges related to data privacy, technology dependence, and employee resistance. Successful implementation requires a balance between technology, change management, and data governance considerations.

10.10 ABCD of Integrating Business Analytics with Virtual and Augmented Reality Technology in Service Industry:

Table 51: ABCD Analysis of Integration of BA with Virtual and Augmented Reality

S. No.	Aspects	Description
Advantages:		
1	**Enhanced Customer Experience**	Virtual and augmented reality can provide immersive and interactive experiences, improving customer engagement and satisfaction.
2	**Data Visualization**	Business analytics can turn complex data into visual representations in VR/AR, making it easier for users to comprehend and analyze information.
3	**Training and Simulation**	VR/AR can be used for realistic training simulations, and analytics can monitor employee performance and learning progress.
4	**Remote Assistance**	AR can enable remote experts to provide real-time assistance, and analytics can track the effectiveness of such support.
5	**Product Demonstrations**	VR/AR can facilitate detailed product demonstrations and analytics can measure customer interest and interactions.
Benefits:		
1	**Improved Decision-Making**	Analytics in VR/AR environments can provide decision-makers with real-time data and insights for more informed choices.

2	**Personalized Experiences**	Analytics can tailor VR/AR experiences based on user behavior and preferences, leading to higher engagement.
3	**Cost Savings**	VR/AR can reduce the need for physical prototypes and travel for demonstrations, resulting in cost savings.
4	**Efficient Training**	VR/AR analytics can identify areas where employees struggle in training scenarios, allowing for targeted improvements.
5	**Competitive Advantage**	Businesses using VR/AR analytics can gain a competitive edge through innovation and improved service quality.
Constraints:		
1	**Cost of Implementation**	Deploying VR/AR technology and analytics systems can involve significant upfront and ongoing expenses.
2	**Technical Complexity**	Integrating analytics into VR/AR platforms can be technically complex, requiring specialized skills.
3	**Data Privacy**	Handling user data in VR/AR environments must adhere to data privacy regulations, adding complexity to data management.
4	**User Adoption**	Some users may be hesitant to embrace VR/AR technology, requiring change management and training efforts.
5	**Content Quality**	Poor-quality VR/AR content can lead to ineffective user experiences and data analysis.
Disadvantages:		
1	**Dependency on Technology**	Overreliance on VR/AR technology may neglect the importance of traditional service delivery methods.
2	**Technical Limitations**	VR/AR technology may not always be capable of delivering the desired level of immersion or interactivity.
3	**Data Overload**	Collecting and analyzing vast amounts of VR/AR data can lead to information overload, making it challenging to extract actionable insights.
4	**User Experience Issues**	Technical glitches or discomfort in using VR/AR can result in negative user experiences
5	**Regulatory Challenges**	Navigating regulations and standards for VR/AR data and content can be complex.

Thus, integrating business analytics with virtual and augmented reality technology in the service industry offers enhanced customer experiences, improved decision-making, and cost savings. However, it also presents challenges related to cost, technical complexity, data privacy, and user adoption. Successful implementation requires a balance between technology, content quality, and data governance considerations.

10.11 ABCD of Integrating Business Analytics with Quantum Computing Technology in Service Industry:

Table 52: ABCD Analysis of Integration of BA with Quantum Computing

S. No.	Aspects	Description
Advantages:		
1	**Unprecedented Speed**	Quantum computing can perform complex analytics computations exponentially faster than classical computers, enabling real-time decision-making.

2	**Complex Problem Solving**	Quantum computing can tackle highly complex analytical problems that were previously unsolvable or required excessive time and resources.
3	**Advanced Data Processing**	Quantum computing can process vast datasets efficiently, providing deeper insights and improving predictive analytics.
4	**Optimization**	Quantum computing can optimize service operations, such as resource allocation and supply chain logistics, leading to cost savings.
5	**Competitive Advantage**	By using the capability of quantum computing for analytics, early adopters can obtain a huge competitive advantage.
Benefits:		
1	**Improved Decision-Making**	Quantum computing enables faster and more accurate decision-making based on highly sophisticated analytics.
2	**Enhanced Personalization**	Quantum computing can analyze intricate customer data for hyper-personalized service offerings.
3	**Resource Efficiency**	Quantum computing can optimize resource utilization, reducing waste and operational costs.
4	**Innovative Service Models**	Quantum-powered analytics can drive innovation in service delivery, opening new revenue streams.
5	**Scientific Breakthroughs**	In research-intensive service industries, quantum computing can facilitate breakthroughs and discoveries.
Constraints:		
1	**High Costs**	Quantum computing technology is expensive to develop, implement, and maintain, limiting its accessibility.
2	**Technical Complexity**	Quantum computing requires highly specialized expertise, and finding skilled professionals can be challenging.
3	**Limited Availability**	Quantum computing resources are limited and may not be readily available to all businesses.
4	**Security Concerns**	Quantum computing can potentially break existing encryption methods, raising security and privacy concerns.
5	**Integration Challenges**	Integrating quantum computing with existing IT infrastructure and analytics tools can be complex.
Disadvantages :		
1	**Dependency on Emerging Tech**	Relying on quantum computing technology involves risks associated with its experimental nature and evolving capabilities.
2	**Data Volume**	Quantum computing can generate enormous amounts of data, which may be challenging to manage and analyze.
3	**Regulatory Hurdles**	Regulatory frameworks for quantum computing in various industries may be unclear or underdeveloped.

4	**Resource Allocation**	Quantum computing resources may be limited, and competition for access can be fierce.
5	**Education Gap**	Training staff in quantum computing and analytics may require significant time and investment.

Hence, integrating business analytics with quantum computing technology in the service industry offers unprecedented speed and analytical capabilities. However, it also presents challenges related to cost, technical complexity, security, and resource availability. Successful implementation requires careful planning, investment, and consideration of potential risks and benefits.

11. POSTULATES & SUGGESTIONS :

In the context of tech business analytics (TBA) in the tertiary industry sector, postulates can be thought of as fundamental assumptions or principles, while suggestions are recommendations or ideas for how to effectively implement TBA in this sector. Here are some postulates and suggestions related to TBA in the tertiary industry sector:
(1) Data-Driven Decision Making: The successful implementation of TBA in the tertiary industry sector relies on the principle of making decisions based on data insights rather than intuition alone.
(2) Data Quality and Integrity: Accurate and high-quality data is essential for meaningful analysis. Postulate that data should be consistently collected, cleaned, and maintained to ensure reliable results.
(3) Continuous Learning: Embrace the concept that TBA is an ongoing process. Regularly update and refine analysis techniques to adapt to evolving customer behaviours and industry trends.
(4) Cross-Disciplinary Collaboration: Recognize the need for collaboration between technical analysts, business experts, and domain specialists to translate data insights into actionable strategies.
(5) Ethical Considerations: Acknowledge the importance of ethical data usage, respecting customer privacy, and adhering to data protection regulations.
(6) Clearly Define Objectives: Start by defining clear business objectives for implementing TBA. Determine what you aim to achieve, such as improving customer satisfaction, optimizing resource allocation, or enhancing operational efficiency.
(7) Choose Relevant Metrics: Select key performance indicators (KPIs) that align with your objectives. These metrics will guide your analysis and provide a focus for your efforts.
(8) Invest in Data Collection Tools: Explore modern tools for data collection, such as customer relationship management (CRM) software, online analytics platforms, and feedback mechanisms, to gather relevant data efficiently.
(9) Implement Predictive Analytics: Utilize predictive analytics to forecast future trends and outcomes. For example, predict customer demand patterns to optimize inventory management.
(10) Leverage Machine Learning: Integrate machine learning algorithms to uncover complex patterns in large datasets, enabling more accurate predictions and personalized customer experiences.
(11) Real-Time Analysis: Consider real-time data analysis to make rapid decisions in response to changing market dynamics or customer preferences.
(12) Visualize Insights: Use data visualization tools to present insights in a visually engaging manner, facilitating better understanding and communication among stakeholders.
(13) A/B Testing: Implement A/B testing for marketing campaigns or service offerings to evaluate which strategies yield the best results.
(14) Invest in Training: Provide training to employees involved in TBA processes to ensure they have the necessary skills to analyse data effectively and derive actionable insights.
(15) Feedback Loop: Establish a feedback loop between data analysis and business operations. Regularly assess the impact of data-driven decisions and adjust strategies accordingly.
(16) Experimentation: Encourage a culture of experimentation, where new ideas and strategies are tested and refined based on data insights.
(17) Benchmarking: Compare your TBA efforts with industry benchmarks to assess your performance and identify areas for improvement.

12. CONCLUSION :

Thus, the tertiary industry sector has been significantly impacted by the application of tech-business analytics. The way services are provided and consumed has changed as a result of tech-business analytics, including digital transformation, automation, the development of new services, and job opportunities. Businesses in the tertiary sector can learn about customer behaviour, reorganise workflows, and develop specialised services that cater to client needs by leveraging the power of data and technology. The tertiary sector has seen greater competitiveness as a result of the tech-business analytics integration, which has sparked innovation and enhanced service delivery. Technology will continue to flourish, and the tertiary industry sector's use of tech-business analytics will only expand. This will result in further developments and advantages for both enterprises and consumers.

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