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Modeling and Simulation for Enterprise Decision-Making: Successful Projects and Approaches

Ramadan, Noha; Ajami, Racha ; Mohamed, Nader; Lazarova-Molnar, Sanja

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Noha Ramadan, Racha Ajami, Nader Mohamed

College of Information Technology
UAE University
Al Ain, UAE
{noha-ramadan, rashaaj, nader.m}@uaeu.ac.ae

Sanja Lazarova-Molnar

Centre for Smart Energy Solutions
University of Southern Denmark
Odense, Denmark
slmo@mmmi.sdu.dk

Abstract—**Decision-making in enterprises holds different possibilities for profits and risks. Due to the complexity of decision making processes, modeling and simulation tools are being used to facilitate them and minimize the risk of making wrong decisions in the various business process phases. In this paper, we highlight the role of modeling and simulation in enhancing decision-making processes in enterprises. In addition, we show some techniques that helped enterprises in reaching effective and efficient decisions by adopting modeling and simulation tools.**

Keywords: Decision making process, enterprise systems, modeling and simulation, Cloud computing.

I. INTRODUCTION

Decision-making is a complex dynamic multipurpose process; however, in enterprises with integrated structures and goals; decision-making processes become even further complicated. In such situations adequate actions should be taken to minimize the risks of making wrong decisions in the various business process phases, such as setting enterprise goals, analyzing and selecting the best strategies, implementing the selected strategies, monitoring performance and progress and analyzing final results.

Technological improvements play an important role in ensuring enterprise development. Business process simulation is a powerful tool to analyze business processes, and provide continuous improvement [1]. Simulation models are typically used to mimic the behavior of different systems and observe the possible outcomes based on the selected conditions. However, there are some challenges to be addressed while introducing simulation models to enterprises. Staff acceptance, availability of useful data, and high management expectations are examples of the challenges faced when implementing such technology. Simulation and modeling can be introduced successfully if all of these challenges have been addressed, managed and controlled by the introducers [2].

This paper highlights the most recent approaches that use simulation for decision making in enterprises. In Section II we introduce some of the basic decision making tools. Section III includes modeling and simulation for decision making which includes the background of decision making in enterprises. In Section IV we discuss the simulation models'

capabilities and limitations. In Section V we offer a discussion on the existing simulation approaches for decision-making. Section VI provides some discussions while Section VII concludes the paper.

II. DECISION MAKING PROCESSES IN ENTERPRISES

Decision-making is the process of analyzing several alternatives, products or ideas to take the right actions to achieve desired outcomes [16]. There is a relationship between problem solving and decision making; problem solving tools are used to assist in recognizing the problem, generating variety of choices to support decision makers and to evaluate the effectiveness of the applied solution. There are a plenty of common decision-making tools aid in making an efficient and effective decisions. Here are some examples of these tools:

- Pareto's Analysis Tool [17] is a simple technique used for resolving different possible problems. It prioritizes possible changes by identifying problems that will be resolved by making these changes. Sometime this technique is called "80/20 Rule" which means that 20 percent of causes generate 80 percent of results or trying to find 20 percent of efforts which will generate 80 percent of results.

- Stepladder Tool [18] is used to manage how members can be a part of a decision making group. It encourages members to contribute in an individual level before being convinced by others. It helps in accurately evaluating members so they will not be overpowered or stepped-on by stronger group members.

- "Five Why's" Technique [19] is another example of problem-solving techniques that directly deals with the main cause of a given problem. It is being adopted by Toyota Production System since 1970. The Five Why's technique involves looking at any problem and asking: "Why?" and "What caused the problem?", The answer of each "Why?" will trigger the next "Why?" etc.

- Root Cause Analysis technique [20] is used to help in answering the question of why the problem occurred in the first place, it seeks to identify the origin of a problem.

It uses a specific set of steps with associated tools to find the primary cause of the problem.

There are many other decision-making tools used to decide on the most appropriate solution for a number of situations and problems. New trends are emerging to support decision-making in enterprises as cloud-computing and the use of Internet provide a richer source of data.

III. MODELING AND SIMULATION FOR DECISION MAKING

Many enterprises are applying modeling and simulation in the decision-making processes. There are lots of documented examples. In the following, we describe some of the more relevant successful examples.

A. Ural's Industrial Group (UIG) in Russia

Ural's Industrial Group (UIG) [14] in Russia, got the most benefit out of using modeling and simulation in their decision making process. BPsim.MAS tool was used because of its efficiency in overcoming many of the disadvantages raised from other tools. BPsim.MAS overcomes the disadvantages of Visual problem-oriented multi-agent tools as AnyLogic and ARIS. BPsim.MAS overcomes complexity in defining models, weak resources, lack of supporting the Russian language and not providing intelligent agent library. After implementing BPsim.MAS tool in UIG and applying a series of experiments based on different scenarios; UGI was able to increase their market share from 6.6% to 20-22%, and reach $ 1.9 million saving rate per year.

B. University of Bradford in England

Several researchers from University of Bradford in England have developed a new simulation model which reduces the required development time and cost of adjusting new cars' engines up to 80% [15]. The simulation model has been developed to increase the speed of penetrating new markets by car manufactures, to calculate the most beneficial decisions in a number of manufacturing scenarios, and to easily transfer different engines within the same family. Engine control units (ECUs) are being used in modern engines to manage the fuel/air ratio and to enhance performance while minimizing fuel consumptions and pollution. In such model, it is required to take into account the exact procedures occurring within the engine in order to generate the required output. This simulation model will be helpful in fast data generation that will be adapted by any kind of engines with different features. This physics-based model can produce data for transient behavior which will allow manufacturers to ensure that they meet new rules and regulations without exponentially increasing the time and costs required for changes and adjustments. This simulation model is easily applicable with any car manufacturer for industrial uses.

C. Grantec Engineering Consultants Inc. in Canada

Grantec Engineering Consultants Inc. in Canada [22] provides engineering designs and analysis services to clients that develop complex structures in manufacturing and industry. Richard M., company's founder and president, found that there is a need for flexible, strong, and reasonable set of analysis tools to meet different engineering challenges, and to provide the efficient services with effective costs [22] [23]. SolidWorks Simulation Premium [23][24][25] and Solid Work Motion [23][26] have been selected to achieve company's goal. After using the afore-mentioned simulation approaches, the company has enhanced analysis productivity by a factor of 40, enlarged its analysis abilities range, enhanced its compatibility with customer design data, and improved its communication of analysis results to customers.

IV. SIMULATION CAPABILITIES AND LIMITATIONS

Simulation models have been built to observe systems' behavior; they are powerful tools for modeling operations in different industries. However, there are also many challenges that can be faced at various stages of simulation modeling process (SMP) [2] such as staff acceptance, staff availability to describe various business processes, availability of useful data and unrealistic management expectations that result in considering modeling and simulation as a very expensive tool.

There are several advantages and capabilities in using Simulation [2]:

- Built models can be used repeatedly for different analysis.
- Simulation methods are usually easier to apply than analytic methods.
- Simulation data is cheaper than the data derived from real systems.
- Simulation can estimate performance measures and evaluate the effects of any changes that may occur to the system operational parameters.

On the other hand, there are some disadvantages and limitations of using simulation in enterprises [2]. Here are some examples of these disadvantages:

- Building simulation models is costly and requires lots of runs for one model to achieve reliable results.
- Simulation cannot optimize system's performance, but it can just describe different scenarios and "what-if" question results.
- Accurate results cannot be given if the inputs are inaccurate.
- Problems cannot be solved by simulation; it can only provide information that helps getting or deriving solutions.

Challenges faced at various stages of Simulation Modeling Process (SMP) should be addressed and managed timely in order to promote success [2]. First, by assigning a simulation-studies champion to link between external consultants and internal project manager. Secondly, they need to be addressed by establishing clear objectives and assigning strategies to achieve these objectives. Thirdly, a realistic timeline should be developed and each step should be reviewed, examined, and assessed continuously during project development. Finally, a valuable training should be provided to staff to assure achieving assigned objectives.

V. Novel Simulations Approaches for Decision Making

Simulation is a valuable and helpful tool in enterprises. It can be used and applied in different enterprises' activities through giving the flexibility of testing the effect of any decision. There are many different simulation approaches that assist in decision making for enterprises. They vary in their features, performance levels, criteria and quality. In this section, a number of significant simulation approaches for decision making are presented and evaluated to explore their advantages and limitations.

A. Balanced Sourced (BSC) and System Dynamics (SD) in Decision Making

Operational decision-making in manufacturing is a complex and dynamic process with multiple goals. Ying [5] mentioned that operational decisions consist of multiple sub-decisions, such as those related to sales, production and purchase. That combination makes it hard to find a global solution; therefore, an integration method is necessary to link sub-decisions to reach a global solution for the whole process. There are a many of manufacturing enterprise operational activities such as operational strategies, process plans, product designs, facility locations, production plans and control, purchase, maintain, quality control, human resource management, and supply chain management. The integration of various business units' decisions can enhance performance of entire enterprise.

Balanced Sourced (BSC) [5] is a strategy management tool that uses cause-and-effect analysis key performance indicators that help in finding the relationships between different decision variables and set up the strategy map accordingly. Decisions in manufactures initially include at least four perspectives; finance, customer, productivity and development ability. Each one of these perspectives has a target and performance indicators that affect each other. Decision variables in BSC will be an input in the operation decision making simulation system as different variable values will lead to different enterprise performance. So any changes in a variable value will create new decision solution. Dynamic changes in operations can be analyzed by a good simulation tool called System Dynamics (SD) that provides a testing environment to study the effects of different decisions in different situations.

The enterprise operational decision making model [5] simulates several environments and analyzes different decisions in different situations and studies their effects to key performance indicator.

B. Assessment of Hybrid Rescheduling Methods

Many unexpected tasks and events may rise in manufacturing systems which cause a difficulty in selecting the most suitable scheduling algorithm for specific tasks. In this sub-section we will discuss the simulation in production systems and in scheduling decisions.

Pfeiffer et al. in [4] have proposed decision support architecture in an integrated module which can be applied for different purposes such as recognition of deviations in advance, validation of the calculated schedules, and analysis of possible taken actions effects. Digital factory concept can be considered as an integrated, synthetic manufacturing environment to enhance handling and controlling changes in production systems, planning processes and all levels of decisions. Simulation has been applied in Digital factory concept; it is a powerful tool applied to the design and analysis phase of complex systems. Decisions are made by constructing its computer models and generating experiments on the models. In order to build valid models and processes of complex systems, it is required to represent the system's discrete events evolution as well as the features of underlying continuous processes. The simulation model is a mirror of the real manufacturing system; it facilitates the integration between the simulation models, the production planning and scheduling systems. In addition, simulation systems can be combined with the enterprise production database, so they update the parameters in the model and support using the simulation parallel to the real manufacturing system and supporting decisions on the shop floor.

Rescheduling action has three main goals: making the schedule executable and feasible, improving efficiency of performance measures, minimizing the impact of disruptions induced by moving jobs during rescheduling events. The applied performance measurement is called stability measurement. The simulation model [4] is created from predefined model components (e.g. plant simulator, scheduler, production monitoring, manufacturing execution systems) by using the production data to simulate a real life production environment. The scheduler calculates the production schedules to be performed using the same database and the calculated production schedule is executed with the simulation. If disturbances occurred or rescheduling point is reached one of the decisions have to be taken either by completing the execution, repairing the schedule or by performing a rescheduling which may refer to as control action where decision can be supported by simulation based experiments. This proposed decision support architecture enables applying integrated simulation module for different purposes, especially analyzing the effect of possible taken actions and validating calculated schedules which helped in considering the architecture as a mirror for the real manufacturing systems.

C. Multi-criteria Optimization System for decision making

Many researchers pointed out that in order to make a good decision, it is essential to take into consideration the impacts of cultural, moral, social, legislative, demographic, economic, environmental, governmental, technological changes, and business world changes. Turskis et al. [3] used that idea to present the multi-criteria decision making methods which are closely related to the way of human decision making; it helps in making decisions in terms of choosing, ranking, and sorting actions or solutions. The basic setup of multi-criteria decision making method is very simple and consists of very basic elements which are a finite or infinite set of actions; two criteria, and one decision maker at least. The main steps of multi-criteria decision making are as follows: creating the

evaluation criteria that relate system abilities with goals, developing alternative systems for generating alternatives, evaluating alternatives, applying a normative multi criteria method for analysis, and accepting the preferable alternative. In case the final solution is unacceptable, new information needs to be gathered again for the next iteration of multi-criteria optimization.

Any problem that needs solution is represented by a matrix, the matrix rows represent the alternatives, whereas, columns represent the criteria. In multi-criteria evaluation, alternative is usually described by quantitative and qualitative criteria. The ratio of particular value has been used to avoid the difficulties caused by different criteria dimensions. The ratio of particular value has been described in many different theories, the values are mapped by applying the normalization of decision making matrix on interval [0; 1] or [0; ∞]. After completing the normalization, it is possible to evaluate the criteria with weighting factors and the sum of the weighting factors should be equal to 1.

The program LEVI 4 [3] has a logarithmic normalization method which allows finding solutions under risks and uncertainty conditions and comparing different results by applying different methods. It helps in evaluating the effect of various normalization methods of decision making matrix and the effect of the applied solution methods on numerical results. So some particular modules of LEVI 4 can be useful for creating decision making systems and providing more stable results in solving multi-criteria decision problems.

D. Employees in Social Networks

Social network websites are becoming a phenomenon that many companies are taking seriously and trying to understand all the possible benefits and risks caused by its use. When it comes to employees' level; employees might post some information about themselves that could negatively impact the organization they belong to. Leakage of information by employees is one of the risks that are rising with the increase of using social network sites. Squicciarini et al. in [7] proposed a methodology that helps decision makers assign the right level of social network use, possible risks and required investment options to reduce risks. However, information can be gathered indirectly from employees' profiles. Attackers can combine different pieces of information from users' profile in social network sites. Moreover, some social network sites provide some tools that hackers can use to gather important data, as the Polls on Orkut (www.orkut.com) they help collecting data about a certain topic, which can be used by an attacker to collect information about a certain project in an organization.

Documents such as ISO 2700x help decision makers to assess risks and choose the best security practices. Those documents, however, provide only general guidelines that need to be customized and interpreted to fit a certain organization or scenario. The proposed approach [7] considers four main key elements when creating the model, the employees' behaviors and attitudes towards social network, the social network websites with their applied security measures, and the attack agent. The last key element is "Levers", which are the methods that decision makers can use to change employees' behavior to reach a desired outcome, such as education, monitoring and technical control. The model measures the amount, type, and values of data that attackers can access based on their success rate. Model's illustration was implemented using the Anylogic modeling and simulation framework while Monte Carlo simulation was used to obtain statistically significant outcomes from the model over a predefined simulation period. The simulation ran over a period of three years over a population of 15,000 employees using social networks. Experiment results led to a number of conclusions. First, the success of an attacker depends on his/her motivation, skill and determining levels to be able to bypass the privacy measures set by the social network site. Second, the link between users' awareness and data disclosure affects information leakage rate, in which the more the user is aware of the threats associated with data disclosure the less they fall victims to attacks or reveal private information. Finally, in spite of the cost of using levers, applying the right combination of them reduces the amount of data loss. The proposed approach helps in setting the most suitable combination of Levers, knowing the required amount of forced policies on employees' social-network-use, and assigning the required level of training to increase staff awareness.

E. Decision in Information Technology investment

BAI et al. in [6] mentioned in their research paper the importance of information technology (IT) capability in offering a sustainable competitive advantage for enterprises. They have built a multi-agent simulation for the analysis of the evolution of enterprise IT capability based on Complex adaptive System (CAS) [9] and simulated by Swarm that provides a program framework for researchers to create system models [10]. The model is based on certain assumptions and defined with model agents. Model agents are enterprises that cannot find optimum strategy from the very beginning and need continuous learning and adaptation process.

The developers used a conceptual model for the evolution of enterprise IT capability. The model consists of three layers, conversion process layer, configuration process layer and the competitive process layer. The first layer is used to describe the change of IT investment into IT assets, the second layer shows the evolvement of IT assets to IT capability, and the third layer shows how IT capability influences the competitive advantage of an enterprise.

The model was initialized by describing the market place as a two dimensional grid X*Y with agents to occupy that market place. If the grid is not occupied, the agent will obtain the current market share, but if the grid is occupied, the agent will continue searching. The agents in the market space realize the importance of choosing IT investment through adaptive learning and gradual assessment, by setting and applying the learning algorithm in [11]. Analyzing simulation results made it clear that the number of agents, whose strategies are not to carry on IT investment, is declining sharply. The main reason was that the agents through

adaptive learning and assessment gradually began to realize the advantages of choosing IT investment under the assumption of limited rationality. Therefore, many agents decided to change their strategies.

F. Risk-Based Decision Making (RDM) for entrepreneurial team

Wu et al. in [8] discussed the problems of risk-based decision-making in the case of technological innovations from an entrepreneurial team point of view rather than the individual entrepreneur point of view. In their paper, they highlighted the idea of the importance of entrepreneurial activity in the success of a venture, and how an entrepreneurial team discussion improved a venture's performance when compared with those ran by individual ones. System Dynamic Model (SDM) was used to model the decision making problem and complex systems over time.

The Risk-Based Decision Making (RDM) in entrepreneurial team is created by the formation of feedback loops that connect different internal and external variables affecting entrepreneur decisions. Internal variables are created by the collection of information from different departments within a venture, whereas the external variables are those variables that a venture does not have control over, such as governmental regulations. Based on a manager (agent) preference and understanding of market risk, market manager agent makes the decision and assigns the investment scale. After assigning a preference to the selected decision, the team decision-making agent generates the final decision. To simulate the model, Vensim PLE SDM software was used by setting different risk parameters to test risk's effect on the willingness of investments. The model simulation is then used to design different mechanisms to achieve the preferred project that best fit different scenarios and entrepreneur team preferences. Developers introduced the multi-agent system due to the high level of uncertainties and conflicting information, and to allow an efficient communication among other agents.

G. Delphi Method in Decision Making

Delphi technique is a useful method in allocating previous probabilities in a decision to be made under uncertainty condition. It has been widely used in social and ecological scenarios along with marketing and economic works [13]. Wang et al. in [12] used Delphi method for structuring a group communication to allow an effective individual action in complex situations.

To use this technique, it is required to structure information flow by collecting the initial contribution from experts through filled questionnaires and comments. The panel director is being used to control the interactions among participants by processing the information and filtering out irrelevant content. The method helps in reducing negative effects of face-to-face panel discussions and solves problems raised in group dynamic discussion. However; regular feedback is required in this technique, such as participants' comment on forecasts, responses and progress of the whole panel.

Delphi technique holds many benefits. When using these technique earlier statements can be revised easily at any time, while in regular group meetings participants tend to stick to previously stated opinions and often conform to a group leader. Furthermore, in Delphi technique all participants are anonymous, their identity is not revealed even after the final report completion. Anonymity allows user to express their opinions easily, it encourages open analysis and revising earlier judgments. Moreover, Delphi technique reduces time consuming and argumentative meetings within the firm.

H. Agent Architecture Organism Model

There are a plenty of enterprise operational decision making problems, and any improper decision choice may result in a serious crises. These problems concentrate on policies selection during the enterprise's operational processes such as order processing policy, product pricing policy, material sourcing policy, and inventory control policy. All policies are interrelated and interacted with one another, each policy has several alternatives and it is required to decide which is the most suitable.

Tan et al. in [30] proposed a novel approach exploring problems from policy combination perspective to help enterprises in making globally ideal decision. To gain better understanding of these problems and to predict the real system's operating performance, a new agent architecture organism model is proposed by Tan et al. in [30]. In this model, enterprises are represented as a set of autonomous entities that make decisions, perform actions, interact according to defined rules, and learn from experiences. Through this approach, enterprise operational decision making problems from policy combination perspective can be explored since enterprise's decision is reflected by the choice of policies for all autonomous entities. Moreover, Decision Support Simulator for Enterprise Operations (DSSEO) tool has been implemented by Tan et al. [30] as a general and practical decision support tool for real world problems in order to perform a quantitative performance evaluation for every policy-combination alternatives.

I. Semi-Automated Decision Making Approach

Various Mechanisms are being employed by organizations to guide business process decision making. If there is no specific formal decision criteria to be followed, dependence will be on self-experience based knowledge for decision making. Accordingly, human selects the most suitable option for each situation to maximize the expected results of each process. Processes results could be assessed in two basic dimensions which are, firstly, binary results that specify whether hard goals has been achieved through the process or not, and secondly, Key Performance Indicators (KPI) or scale results which indicate whether business objectives have been achieved or not [31].

Ghattas et al. in [31] developed a semi-automated approach which enhances performance of business processes by deriving and learning decision criteria from the gained experiences through past processes performances and formulating that criteria as decision rules. Data mining

techniques have been used to identify the relationships between the followed actual path, the context or the situation in which execution took place, the achieved outcome and the business performance considering business processes' goals. Relationships between the mentioned three elements derive decision rules that imply high performance at a given context, imitating the way a human learns from experience. Therefore, this approach facilitates organizational learning, improves business performance through the generated decision rules, and transforms implicit knowledge possessed by individuals, into explicit knowledge shared by all, in the form of clear decision rules.

VI. DISCUSSION

A number of recent and significant modeling and simulation approaches for decision making in enterprises have been surveyed in Section V. These approaches will be evaluated and compared according to a number of predefined criteria and features such as: involved enterprise departments, results efficiency, tools and limitations. A summarized comparison is presented in Table 1.

Balanced Sources (BSC) [5] uses cause-and-effect analysis key performance indicators to find the relationships between different decision variables. The enterprise operational decision making model can be set by using System Dynamics (SD) [5]. It dynamically simulates different environments and studies the effect of different decisions to the key performance indicator. This approach can be applied to many enterprises in different departments, especially in sales, production and purchase. However, it does not prove the ability of providing enough complexities and decision solutions for dynamic environments.

Assessment of hybrid rescheduling methods [4] facilitates the integration between simulation models, the production planning and scheduling systems. This simulation model acts as a mirror of the real manufacturing system. It can be applied to time management systems for different departments in various kinds of enterprises. This approach, however, did not prove the ability of applying adaptive situation-dependent rescheduling threshold and stability factors in a dynamic scheduling environment

Multi-criteria optimization system [3] helps in making decisions in terms of choosing, ranking, and sorting actions or solutions. It is closely related to the way of humans' decision making. This approach can find solutions under risks and uncertain conditions. It is highly required for management and architecture sectors. In contrast, if the final resulted solution is unacceptable, it is required to gather new information from each iteration to reach multi-criteria optimization.

The approach by Squicciarini et al., presented in [7], helps in assigning the right level of social network use to prevent information leakage by employees. The approach helps in setting the most suitable combination of Leavers, knowing the required amount of forced policies on employees' social-network-use, and assigning the required level of training to increase staff awareness. Such approach is applied to human resources departments to support managing staff and related resources. However, it cannot prevent the indirect gathering of data from employees' profiles by attackers.

BAI et al. in [6] provided a Multi-agent simulation for the analysis of the evolution of enterprise IT capability. The model can be applied in Finance and IT investment. By using the model, enterprises in the market space realize the importance of choosing IT investment through adaptive learning and gradual assessment, by setting and applying the learning algorithm. However, the model is defined with certain assumptions and model agents, which cannot be applicable to all types of enterprises.

Risk-Based Decision Making (RDM) for entrepreneurial team [8] is Multi-agent simulation for a unified entrepreneurial team decision that can be an efficient tool for managers in business including entrepreneurial activities. RDM is used to design different mechanisms to achieve the preferred project that best fit different scenarios and entrepreneur team preferences. It overcome high level of uncertainties and conflicting information, and allows an efficient communication among agents. The main drawback of the model is that it depends on entrepreneur's experience to assign scenarios' preferences, which might reduce the decisions' efficiency.

Delphi method [12][13] allocates previous probabilities in a decision to be made under uncertain condition. It structures and manages a group communication process by panel director. This approach is efficient in allowing individuals to deal with complex problems and reducing time consuming in argumentative meetings. Delphi method is widely applicable to social, ecological, marketing and economic sectors. However, regular feedbacks and comments from individuals are required for the progress of the whole panel which is inefficient and time consuming.

Agent Architecture Organism Model [30] explores problems from policy combination perspective to help enterprises in making globally optimal decision. It is efficient in performing a quantitative performance evaluation for every policy-combination alternatives. Agent Architecture Organism Model is applicable to enterprises' operational processes and different managerial levels could access it. On the other hand; this approach does not provide an automatic search feature for enterprises' managers to allow them getting the optimal policy combination automatically.

Semi-Automated Decision Making Approach [31] is used to enhance business processes performance by deriving and learning decision criteria from the gained experiences through past processes performances and formulating that criteria as decision rules. This approach is efficient in facilitating organizational learning, improving business performance through the generated decision rules, transforming implicit knowledge possessed by individuals into explicit knowledge shared by all in the form of clear decision rules. However, exceptional situations or new lines of action could not be related without acquiring sufficient experience data.

Table1: Modeling and Simulation Approaches for Decision Making in Enterprises

Approach	Main Features	Application	Management Level	Efficiency	Tools	Limitations
BSC and SD in Decision Making	BSC use cause-and-effect analysis key performance indicators to find the relationship between different decision variables. The enterprise operational decision making model can be set up using SD	Sales, Production, and Purchases	Top-level Management And Middle-level Management	Simulates dynamically different environments and study the effect of different decisions to the key performance indicator.	- Balanced Sources (BSC) - System Dynamic (SD)	This model does not prove the ability of providing enough complexities and decision solutions for dynamic environments.
Assessment of Hybrid Rescheduling Methods	Facilitates the integration between the simulation models, the production planning and scheduling systems.	Management (Time Management Systems)	Middle-level Management	The used simulation model is a mirror of the real manufacturing system.	- Plant Simulator - Scheduler - Production Monitoring - Manufac-turing Execution Systems	This model does not prove the ability of applying adaptive situation-dependent rescheduling threshold and stability factors in a dynamic scheduling environment.
Multi-criteria optimization system for decision making	Helps in making decisions in terms of choosing, ranking, and sorting actions or solutions. It is closely related to the way of humans' decision making.	Management and construction design	Middle-level Management And Low-level Management	Finds solutions under risks and uncertain conditions.	- LEVI 4	Un-acceptance of the final solution, require gathering new information starting from the beginning for the next iteration of multi-criteria optimization.
Employees in Social Networks	Assigns the right level of social network use to prevent information leakage by employees	Human Resource Management	Middle-level Management And Low-level Management	Help in setting the most suitable combination of Leavers, knowing the required amount of forced policies on employees' social-network-use, and assigning the required level of training to increase staff awareness.	- Anylogic - Monte Carlo	Information can be gathered indirectly from employees' profiles.
Decision in IT investment	Multi-agent simulation for the analysis of the evolution of enterprise IT capability.	Finance and IT investment	Top-level Management	Enterprises in the market space realize the importance of choosing IT investment through adaptive learning and gradual assessment, by setting and applying the learning algorithm	- Swarm	The model is defined with certain assumptions and model agents, which can't be applicable for all types of enterprises.
Risk-Based Decision Making (RDM) for entrepreneurial team	Multi-agent simulation for a unified entrepreneurial team decision	Management	Top-level Management	Used to design different mechanisms to achieve the preferred project that best fit different scenarios and entrepreneur team preferences. It overcome high level of uncertainties and conflicting information, and allows an efficient communication among agents	- Vensim PLE SDM	Depends on entrepreneur experience to assign scenarios' preferences
Delphi Method in Decision Making	Allocates previous probabilities in a decision to be made under uncertainty condition. It structures and manages group communication by panel director.	Social, ecological, marketing and economic works	All Managerial Levels	Allows individuals to deal with complex problems and reduces time consuming in argumentative meetings.	- Panel Director	Regular feedbacks and comments from individuals are required for the progress of the whole panel.
Agent Architecture Organism Model	Exploring problems from policy combination perspective to help enterprises in making globally optimal decisions.	Enterprises' operational processes	All Managerial Levels	- Explore enterprise operational decision making problems from policy combination perspective. - Performs a quantitative performance evaluation for all policy-combination alternatives	Decision Support Simulator for Enterprise Operations (DSSEO)	It does not provide an automatic search feature for enterprises' managers to get the optimal policy combination automatically
Semi-Automated Decision Making Approach	Enhance business processes performance by deriving and learning decision criteria from the gained experiences through past processes performances and formulating that criteria as decision rules	Business Processes	All Managerial Levels	- Facilitates organizational learning. - Improve business performance through the generated decision rules. -Transform implicit knowledge possessed by individuals, into explicit knowledge shared by all as clear decision rules	- Data mining techniques	Inability to relate to exceptional situations or new lines of action before acquiring sufficient experience data.

Cloud-computing enables enterprises to enhance resources management [29]. Huge amount of data and applications are being processed and managed through cloud computing. It provides enterprises with secured and flexible on-demand resources at lower costs and enhances decision-making process.

VII. CONCLUSION

Modeling and Simulation provide basis for useful and powerful tools for decision making in diverse enterprises and among different departments. They provide the flexibility of simulating complex environments and testing the effects of certain decisions in multiple scenarios and under uncertainty to minimize the risk of making bad decisions.

Throughout this survey, we reviewed a number of recent and relevant approaches to using modelling and simulation for decision-making processes in various types of enterprises. These approaches evolved from different research communities and aim to solve different problems that could be faced during the decision making process. Although we have seen many examples of successful modelling and simulation approaches to decision-making; there are still many unsolved problems. The difficulties of solving those problems are due to the high uncertainty in enterprises' processes and having multiple entities involved and affected by any wrong decision. However, these challenges and open issues are attracting intensive efforts from a broad range of disciplines and variety of researchers.

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