SerViU: A Tool-Supported Method for Personalizing Telehealth Services

Oday Aswad

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Abstract

The personalization of telehealth services to accommodate patient preferences and interaction abilities could significantly improve patient adherence to telehealth treatment plans. Long-term adherence can be as low as 25% among chronic patients for reasons related to ease-of-use and personal preferences, which can be attributed to factors associated with the patient, physicians, and healthcare systems. Poor adherence in the long term can cause increased morbidity, poorer quality of life, a higher risk of mortality, and greater health care utilization. Poor adherence is partly driven by generic telehealth services that are not adapted to individual patients' lived experiences. Recent research calls for the personalization of telehealth services in a manner that addresses long-term adherence.

This thesis views the telehealth service context from a multilevel service systems perspective. This perspective enables the articulation of the contextual differences between standardized and personalized services. This thesis proposes a service design method (SerViU: pronounced Serv You) to support a continuous Use–Assess–Personalize process; this design method focuses on the patient personal service encounter level within a telehealth service. SerViU is anchored in the service-dominant logic concept of value-in-use, and it assesses the patient's individualized experiences with the telehealth service and accordingly recommends a suitable personalization.

SerViU guides decision-making about telehealth personalization by integrating an existing information communication technology (ICT) service personalization framework that identifies three types of ICT personalization: architectural, relational, and technological.

A design science research methodology (DSRM) was used to guide the research activities underlying the development and validation of SerViU. Within this methodology, the SerViU

Personalize Tool was selected to demonstrate SerViU's ability to personalize telehealth services by accounting for patient-related, service context-related, and technology-related factors. A multiple case study with embedded units of analysis was conducted at a Canadian hospital to simulate personalization decision-making using the SerViU Personalize Tool. The same participants were then asked to fill out a questionnaire to evaluate the tool's usefulness for decision-making, its relevance to the telehealth context, and whether it contained sufficient information to make personalization decisions. Results show that SerViU was relevant to telehealth contexts, useful for making personalization decisions, and provided sufficient information to make relevant decisions.

The collected data were analyzed using cross- and within-case analysis by comparing decisions in different telemonitoring service modes. The comparisons included personalization options, feature selection, scores, rationales, and resource-related information.

The results of this research provide a means to operationalize telehealth personalization as proposed in telehealth research. This study provides a method which can guide the transformation of generic telehealth services into personalized services. This research contributes to service design by differentiating between standard and personal service encounter levels, which is paramount for supporting the personalization of ICT-enabled services. This research contributes to the telehealth practice by presenting an ongoing telehealth personalization process that involves patients in decision-making throughout their treatment processes as a means to improving long-term adherence.

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List of Acronyms

Acronym	**Definition**
A	Agree to consider the option/component
AIS	Association for Information Systems
Anot	Agree NOT to consider the option/component
AP	Architectural Personalization
APA	American Psychological Association Writing style
ATA	American Telemedicine Association
BPM	Business Process Modelling
CD ROM	Compact Disc Read-Only Memory
CHF	Congestive Heart Failure
COPD	Chronic Obstructive Pulmonary Disease
D	Disagree
DSR	Design Science Research
DSRM	Design Science Research Methodology

eVisit	Virtual doctor appointment
ExpCSSD	Experience-based collaborative service system model
FP	Functional Personalization
GPRS	General Packet Radio Services transmission technology
GRL	Goal-oriented Requirement Language
HIPAA	Canada Health Information Privacy: regulated by the Personal Health Information Protection Act, or PHIPA.
ICT	Information Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IS	Information Systems
IT	Information Technology
jUCMNav	A graphical editor, analysis, and transformation tool for User Requirements Notation
KPI	Key Performance Indicator
LPO	List of Personalization Options
LTAD	Long-term Adherence factor
MARS	Morisky Medication Adherence Scale
Medispenser	smart pill dispenser device
MINDS	Management and Interaction Design For Services
MSD	Multilevel Service Design
NICE	National Institution for Health and Care Excellence
OTN	Ontario Telemedicine Network
P	Partially agree to consider the option/component
Pnot	Partially agree NOT to consider the option/component
PSS	Product-Service Systems
PubMed	Publications of biomedical literature from MEDLINE, life science journals, and ebooks
QFD	Quality Function Development
RedCap	Online secured research platform
RO	Research Objective
RP	Relational Personalization
S-D L	Service-Dominant Logic
SD4VN	Service dominant for value network
SerViU	Service design method anchored in the Value-in-Use ViU concept
SLR	Systematic Literature Review
SMS	Text Message Service
SOA	Service-Oriented Architecture
TAM	Technology Acceptance Model
TCPS 2	Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans
TH	Telehealth
TM	Telemonitoring
TRIZ	Theory of Inventive Problem-Solving
UCM	Use-Case Map
UML	Unified Modelling Language
URN	User-Requirements Language Notation

UX	User Interface
VBA	Visual Basic Applications coding language
VE	Value Expectation
ViU	Value-in-Use
VP	Value Proposition
WHO	World Health Organization

Chapter 1: Introduction

1.1. Motivation

Advances in telehealth technologies have proven to reduce hospitalization and emergency room usage mainly through remote monitoring and improved access to healthcare resources. However, a lack of patient adherence to telehealth services undermines these benefits and could increase mortality rates (Helsel et al., 2018). This behavior can be attributed to factors related to patients, physicians, and healthcare systems, such as privacy, resource accessibility, and technological complexity (Brown & Bussell, 2011). These factors significantly impact elderly patients who may intentionally stop taking prescribed medications or fail to follow daily telehealth reporting guidelines (McDonald et al., 2013). Most significantly, during treatment the abilities, perceptions, and expectations of patients change, resulting in nonadherence later on (Ranjan & Read, 2016). Nonadherence can thus become an intentional behavior for elderly patients (McDonald et al., 2013; Rand, 2005).

Nonadherence is generally associated with increased morbidity, poorer quality of life, a higher risk of mortality, and greater health care utilization (Hommel et al., 2015). Long-term adherence can be as low as 25% among chronic patients for reasons related to ease of use and personal preferences (Cruz et al., 2014; Helsel et al., 2018). Among US adult telehealth patients, 65–88% are non-adherent to treatment; nonadherence is estimated to cost $100–300 billion annually (Hommel et al., 2015). Yet, according to the World Health Organization (WHO, 2003), adherence to long-term therapies is a “primary determinant of treatment success. Poor adherence attenuates optimum clinical benefits and, therefore, reduces health systems’ overall effectiveness.”

Long-term illnesses have social, psychological, and physical effects on chronic and multimorbid patients; as a result, these patients become less able and willing to continue with their treatment (Jackson et al., 2012). This lack of adherence economically affects healthcare systems because of the resource-intensive nature of primary care services. Hospitals perform remote monitoring and try to develop patients' self-care abilities once they are discharged (Bernocchi et al., 2016; Scalvini et al., 2017).

Long-term adherence to telehealth is not only a reimbursement challenge; rather, any solution must accommodate continuous changes in the individual patient's status, abilities, and preferences due to condition and ability progression (Dinesen et al., 2016). In this sense, the literature in the field of telehealth (Dinesen et al., 2016; Hommel et al., 2015) emphasizes personalizing telehealth services as a means to accommodating continuous changes in the status, abilities, and preferences of individual patients. Based on this perspective, the personalization of telehealth is achieved by considering long-term adherence factors. Patient-related factors, for example, are relevant to the patient's individual mental and physical abilities to use the technology, communicate the status of their daily activities, perform the required tests, and understand instructions. Context-related factors can determine the nature of the telehealth service, such as different interests of stakeholders, availability and accessibility of healthcare resources, and jurisdictional restrictions. Both patient- and context-related factors could be supported by technology, whether by incremental (simple) or innovational improvements.

This thesis proposes the development of a tool-supported service design method that aims to guide the personalization of existing telehealth services in a manner that addresses long-term adherence factors; the service recipients referred to in this study are chronic and multimorbid patients. Design science research (DSR) was used to pursue the research objectives, as detailed in the research objectives section. A design science research methodology (DSRM) guided the research activities of this study in its development, demonstration, and evaluation of SerViU's applicability for personalizing existing telehealth services.

1.2. Problem Definition

Telehealth services are used by patients who have unique engagement dynamics and situations; therefore, the use of telehealth services is a personal experience (Ranjan & Read, 2016). The patient develops a unique personal experience during their introduction to the telehealth system; this can result in different perceptions and expectations before they use the telehealth system by themselves.

Previous attempts to address long-term adherence to telehealth have been limited because their focus was on technological improvements. Previous examples include ensuring that collected data includes patients' personal preferences and abilities, and improving system components for each patient group, including older patients (van der Aa et al., 2017); or designing devices and systems that can address different patient groups' needs (Lunde et al., 2018; Ramallo-Fariña et al., 2015).

While such approaches are in line with calls to personalize telehealth (Dinesen et al., 2016), they are incomplete because an improved personalization of telehealth services requires the consideration of a set of factors. These factors are not only technological, but also include patient-related factors (e.g., the patient's preferences and mental and physical interaction abilities) and context-related factors (e.g., a hospital's or clinic's technological capacity; (Dinesen et al., 2016; Hommel et al., 2015).

Health care service providers need to record and assess the experiences of individual patients in order to meet their expectations. Otherwise, the gap between the patient's initial and newly developed expectations can affect their attitude and, hence, their adherence. Patients develop knowledge about technological and contextual uncertainties, such as those relating to reporting their vitals and accessing clinicians, respectively. The recording of these experiences enables care providers to personalize services in line with the patient's evolving expectations (Haki et al., 2018).

Service-dominant (S-D) logic takes these issues into account because it emphasizes that value is determined by the beneficiary (the patient) and is collaboratively cocreated with other participants. The value being cocreated during the use of the service is called value-in-use (ViU) (Ranjan & Read, 2016; Stephen L Vargo & Robert F Lusch, 2004). From an S-D logic lens, the problem of patients' long-term adherence can be defined as a misalignment between the health provider's value proposition (VP), the pre-treatment service, and the patient's value expectations.

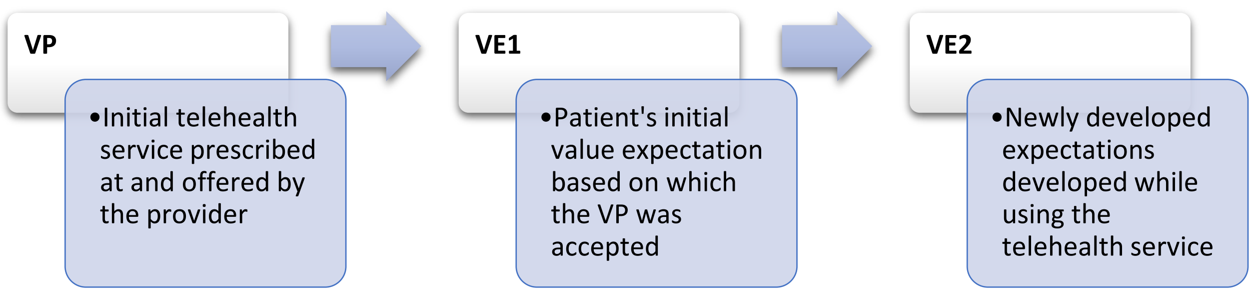
Figure 1.1 shows that providers, based on diagnosis outputs and the patient's historical health information, propose a telehealth service (a VP from an S-D logic perspective) intended to meet the patient's value expectations (VE). The patient initially accepts the telehealth service, which implies that it meets their expectations at that time.

During the service experience, the patient develops knowledge about the service, their disease condition, and their ability to use technology. Through this process, their physical and mental abilities may evolve, or they may change their perception of the telehealth service, resulting in a modified value expectation (VE2) (Zolnowski & Warg, 2018). For example, the patient might feel the need for more guidance, or they might experience physical improvement or deterioration. The patient loses interest in adhering to their telehealth service when the VP becomes unable to fulfill their evolving VE2 (Figure 1.1).

Therefore, the patient experience (while using the telehealth service) needs to be continuously assessed throughout the service process to help the providers continuously adjust services and cope with their patients' evolving expectations. Personalizing telehealth services is thought to help address this misalignment and improve long-term adherence.

Figure 1.1

Conflict between VP and VE



1.3. Research Objectives

The personalization of telehealth treatment has been proposed as a means to improve patients' long-term adherence; individualized telehealth services should be compatible with individual patients' needs, goals, and abilities (Dinesen et al., 2016). The knowledge needed for such individualization can only be developed by the patient experiencing use of a telehealth system. Determining whether the personalization process is relevant to long-term adherence requires consideration of patient-, context-, and technology-related factors (Dinesen et al., 2016). Therefore, this research aims to personalize telehealth services in a manner that addresses long-term adherence and, hence, accounts for patient-related, service context–related, and technology-related factors. Specifically, our research objective (RO) is defined as follows:

RO: To develop a service design method in a manner that accounts for patient-related, context-related, and technology-related factors.

To address this high-level objective, sub-objectives were identified. It was necessary to learn whether existing service design methods could address long-term adherence factors and which frameworks would be relevant for anchoring a method for personalizing telehealth services. Hence, the first research sub-objective can be defined as follows:

RO1: To assess the existing service design methods to determine whether they can guide telehealth personalization in a manner that accounts for long-term adherence.

Because long-term adherence factors simply express "what" is lacking for adherence to take place and not "how" these factors influence adherence, in this thesis I suggest adopting an ICT service personalization framework that enables articulation of how long-term adherence factors could be addressed (Fan and Poole (2006). Based on this framework, ICT-enabled services can receive three types of personalization support: relational (contextual), architectural (reallocation of resources, actors, and activities), and functional (technical improvement of patient's engagement with telehealth) support. The personalization support types are further expanded in Appendix 1.

Hence, development of an assessment tool was necessary to assess existing service design methods in terms of their ability to support telehealth personalization that addresses long-term adherence (Table A2.2, Appendix 2). I searched the recent service science literature via a systematic literature review (SLR). The purpose of this search was to identify existing service design methods and tools that could address the research objective. Each long-term adherence factor was assessed regarding personalization support types that the identified service design methods could provide. For example, assessing the outcomes of individual patients' experiences requires a capturing capability so that user-generated data can be used as a resource (i.e., stored, analyzed, and then used to make a decision).

In addition, I also looked for a service design method that could address the contextual complexity of telehealth, and I considered the implications of involving chronic/multimorbid patients in determining service value. Addressing the context should also consider stakeholders, including individuals and organizations. Therefore, the service design method should be able to identify, represent, and address the goals of different stakeholders and the accessibility of resources, given the complexity of healthcare services in terms of stakeholders' interests, operations, and resources. For example, architectural support should help integrate contextual resources across physical, temporal, organizational, and functional dimensions (Tien & Goldschmidt-Clermont, 2009).

The SLR results suggested the need to combine the functionalities of more than one service design method or expand them to appropriately address all long-term adherence factors.

A need for a theoretical framework that could appropriately combine such human, organizational, and technological interactions emerged. Hence, a second research sub-objective to develop such a framework was defined as follows:

RO2: To develop a method leveraging existing methods and relevant frameworks.

Different perspectives were needed to develop this framework. S-D logic helps address value cocreation with and determination by the patient; ViU—another S-D logic concept—enables patients to use the service to determine its value (Stephen L Vargo & Robert F Lusch, 2004). The Multilevel Service Design (MSD) systems perspective helps us understand resource integration between different service stakeholders and organizations at different service levels to cocreate the service value (Patrício, Fisk, Falcão e Cunha, et al., 2011). In this thesis, an additional service level was created to differentiate standard service from personal service (called the "personal service encounter level"), where the personalization process occurs and SerViU operates. Finally, an ICT service personalization framework was integrated into the design method to articulate personalization support (Fan & Poole, 2006). Accordingly, a service design method was proposed (SerViU) that could implement the proposed framework.

Telemonitoring (TM) services are remote monitoring services provided by care providers via information communication technologies (ICT; ATA, 2020). Because the telehealth service context includes interventions other than remote monitoring (such as consultation), TM services were selected. Chapter 5 details the development steps of the proposed service design method—SerViU—which is anchored in the ViU concept and operates at the lowest service system level in order to guide the continuous personalization of telehealth services based on individual patients' experiences. Thus, a third sub-objective was defined as follows:

RO3: To evaluate the applicability of the proposed method to personalize telehealth services.

A multiple case study setup guided by the DSRM helped to evaluate SerViU's applicability (Peffers et al., 2007).

1.4. Contributions

This research contributes to telehealth personalization research by providing a method that guides the transformation of generic telehealth services into personalized services; SerViU personalization accounts for patients' personal situations, service context constraints, as well as the technology adavancement.

SerViU goes beyond existing telehealth personalization research that focuses solely on technical or educational dimensions (Bal et al., 2016; van den Berg et al., 2012). Indeed, by drawing on the Fan and Poole (2006) ICT personalization framework and the core S-D logic concept of ViU (Stephen L Vargo & Robert F Lusch, 2004), SerViU provides guidance for telehealth providers and clinician both at the level of technologies and human experience and, hence, in a truly sociotechnical, patient-centered manner.

In terms of contribution to the service design research, SerViU introduced a new level of intervention for service design, separate from but interrelated with the level of generic service encounter design and higher-level contextual levels of service design (Patrício, Fisk, Falcão e Cunha, et al., 2011).

Practically, the suggested service design method enables ongoing personalization of telehealth services throughout the treatment period via the Use–Assess–Personalize process; this is meant to meet the patients' expectations, hence addressing long-term adherence factors (Dinesen et al., 2016; Hommel et al., 2015). SerViU empowers patients by involving them in the decision-making and personalization of their telehealth services throughout the service based on their evolving expectations and abilities—an ongoing Use-Assess-Personalize process that implements the ViU concept (Stephen L Vargo & Robert F Lusch, 2004).

1.5. Thesis Outline

The remainder of this thesis (which is formatted based on APA style, 7th edition) is organized as follows: Chapter 2 presents relevant background context about telehealth, chronic and multimorbid patients, and previous work that addresses long-term adherence to telehealth services. Factors that are recommended by the telehealth literature are defined and explained. These factors are expected to help personalize telehealth services. In this study, they are called long-term adherence factors. The last section of Chapter 2 defines the concepts and processes of personalization across different disciplines and presents an information systems (IS) framework that is anticipated to articulate how service design methods can support personalization and help improve long-term adherence. In this study, these are called ICT personalization support types. Definitions are available in Appendix 1.

Chapter 3: Literature Review, a systematic literature review of service design methods and tools to assess how they address long-term adherence factors. The identified design methods are first categorized into higher-level approaches based on their interpretation of the design problem and solution. The reason for this is to understand which long-term adherence factor is being addressed. The results of this review imply that combinations or extensions of existing service design methods are needed to personalize telehealth services in a manner that addresses long-term adherence factors. The results of the SLR are presented in Appendix 2.

In Chapter 4, the research methodology is explained. This thesis is situated within the DSR paradigm—a pragmatic, problem-solving paradigm that creates innovative artifacts. These design artifacts are helpful for and fundamental to understanding the problem to be solved (Hevner et al., 2004). The DSRM was selected to organize the research activities in line with DSR (Peffers et al., 2007). The DSRM guided the development, demonstration, and evaluation of SerViU. The DSRM enabled the identification of a research gap: no service design methods comprehensively addressed long-term adherence in telehealth.

In Chapter 5, a new service design method is proposed: SerViU is a tool-based method anchored in the ViU concept and situated at the personal service encounter level. SerViU consists of four phases (0–3), where Phase 0 is a once-off development of a list of personalization options (LPO). Phases 1 to 3 are iterative, since the patient's continued use of the telemonitoring plan could lead to further personalization. Care providers are assumed to prepare the LPO independent of patient engagement. The list is intended to supply Phase 3 with the information necessary to make a personalization decision. As elaborated in Chapter 4, this information includes telehealth components, clinical purposes, operational methods, and business and jurisdictional constraints. Patients start using the TM service in Phase 1 (called "Use") and develop their unique experiences. During this phase, the TM system records the patient's vitals and their usage while engaging with the service. Such information is verified and assessed in the following phase (Phase 2, called "Assess"). In Phase 2, the nurse responsible for this patient regularly meets and assesses the patient's wellbeing, abilities, and experiences with the TM and decides whether to personalize the patient's TM service and how. Once a decision is made to personalize the service, Phase 3 (called "Personalize") initiates. Utilizing a specific SerViU Tool in Phase 3, different personalization options—including technical, operational, and jurisdictional details—are weighed and prioritized to enable the nurse to select the most appropriate option. SerViU thus supports decision-making, but final decisions regarding if and how to personalize are taken to be clinical, hence to be the responsibility of the nurse or physician.

Chapter 6 presents the case study—a multiple case study with embedded units of analysis which simulates the use of the SerViU Personalize Tool in order to demonstrate its use and for clinician participant evaluation.

In Chapter 7, the case study results are presented in detail. Information about results and thematic analyses can be found in Appendixes 4 and 5.

Finally, Chapter 8 discusses results, limitations, and contributions. SerViU goes beyond existing telehealth personalization research studies that focus solely on technical dimensions in terms of their research contribution. This chapter also situates SerViU in the telehealth personalization body of research by discussing relevant works and opportunities for further improvement in future research.

Chapter 2: Background

2.1. Introduction

According to the World Health Organization, telehealth (also known as telemedicine) is "the practice of medical care using interactive audiovisual and data communications. This includes the delivery of medical care, diagnosis, consultation, and treatment, as well as health education and the transfer of medical data" (Global_Observatory_for_eHealth, 2016). Telehealth facilitates patient–provider interaction when the two are separated by distance. Such interactions can be in real-time (i.e., synchronous), such as via telephone and video link, or asynchronous (i.e., store-and-forward), such an answer that is submitted by the patient after a secure email prompt or request.

This definition demonstrates the complexity of the telehealth context; indeed, many telehealth research aspects are beyond the scope of this thesis, such as health education and inter-provider consultation. This thesis centers on the remote interaction and monitoring activities of telehealth by which multimorbid patients interact with their telehealth services, i.e., providers and technologies. Remote monitoring of patients' vital signs and the use of information communication technology (ICT) to interact, report, and implement a prescribed medication plan are features of telemonitoring (TM) services. TM, according to the American Telemedicine Association (ATA, 2020), is a telehealth approach that facilitates patients' remote monitoring via the "collection, transmission, evaluation, and communication of individual health data from a patient" to their healthcare provider using personal health technologies including wireless devices, wearable sensors, implanted health monitors, smartphones, and mobile apps. Remote patient monitoring can support ongoing monitoring of chronic disease conditions with synchronous or asynchronous management, depending upon the patient's needs and situation (ATA, 2020).

In a typical TM service, discharged patients are supplied with biosensor devices to measure vitals (e.g., wearables, blood pressure measuring device, one-lead electrocardiogram recorder, pulse oximeter, weighing scales). These devices can instantly transmit a patient's data to a central server via a secure data connection. Some providers offer videoconferencing, which a physician or nurse can use to follow up with and educate patients. A telehealth system can also include call centers that can remotely monitor and alert people when needed (Scalvini et al., 2017).

2.2. Long-Term Adherence Factors

The extant literature emphasizes several factors that should be addressed in the personalization of telehealth services as a means to addressing patients' long-term adherence. These factors are as follows: patient preferences, patient abilities, stakeholder interests, cross-sector integration, resource management, technology innovation, and technology improvement (Dinesen et al., 2016; Hommel et al., 2015). These factors are briefly explained below (for elaboration with examples, see Appendix 1).

2.2.1. Patient-Related Factors

This category refers to two individual patient factors: patient preferences and abilities. Patient preferences relate to patient goals and willingness to accept the treatment. Patients can choose not to accept the treatment. Such decisions are thought to be based on the patient's awareness of their disease and treatment (Dinesen et al., 2016). Patient abilities refer to the patient's physical and mental ability to interact with the telehealth system and can be considered when personalizing the telehealth treatment (Hommel et al., 2015). Patient-related factors are essential for designing a patient-centered service, especially the involvement of patients in decision-making about treatment processes (Boyd et al., 2012; NICE, 2016).

2.2.2. Context-Related Factors

This category pertains to telehealth sector challenges. This includes the roles and interests of different stakeholders, their methods of collaboration, and the efficient use of their resources. Stakeholder involvement is the first factor in this category; this is related to the interests and concerns of stakeholders who can economically and practically affect telehealth service offers and their delivery (Dinesen et al., 2016; Wherton et al., 2015). Cross-sector integration refers to collaboration among different healthcare sectors to act as a single organization: for example, the proper understanding of roles and responsibilities among participating parties affects task distribution and interaction efficiency during the treatment process (Hommel et al., 2015). Resource management and optimization concerns include the efficient use of healthcare resources, such as skilled human resources, data accuracy (e.g., the ubiquity and interpretability of information), and cost-efficiency, especially regarding the appropriate selection of technology (Dinesen et al., 2016).

2.2.3. Technology-Related Factors

This category addresses technological challenges where different digital systems and information resources contribute to the telehealth solution. The technology innovation factor refers to creating knowledge by integrating different existing technologies, such as multiple devices, platforms, and databases. This is thought to help provide personalized, convenient, and patient-centered treatment (Dinesen et al., 2016). Improving technology refers to the incremental enhancement of software and hardware components for convenience and better results (e.g., user-friendly dashboards, faster-capturing sensors; (Dinesen et al., 2016).

2.3. Related Attempts to Improve Long-Term Adherence to Telehealth

The existing literature posits solutions to the lack of long-term adherence to telehealth in relation to different aspects.

Technology effectiveness improvements is an example of a continuous effort, such as decision support systems that can respond to the needs of different patient groups (Lunde et al., 2018; Ramallo-Fariña et al., 2015). Such solutions are limited to improving the usability of the technology for certain categories of patients: e.g., improving the usability of system components for elderly and sight- or hearing-impaired patients (van den Berg et al., 2012).

The improvement of data collection methods, such as refining patients' health and wellbeing data to consider personal preferences and abilities (van den Berg et al., 2012), is aimed at developing algorithms that help to improve patients' outcomes after using telehealth systems. These are only partially helpful because they are often limited to certain disease conditions, durations, technologies, and patient categories.

Educational support methods were also enhanced to offer greater support for patients and their caregivers. Education was provided via different means—both synchronous (face-to-face meetings) and asynchronous (informational web pages)—and this could raise awareness about the disease and its treatment process with the aim of improving patient behavior and self-management (Bal et al., 2016; Wens et al., 2008). Nevertheless, the technology will still need to be adapted based on the patient's abilities, preferences, and disease condition.

Researchers and clinicians also need to develop and improve the methods used to measure patients' adherence. Indicators are needed to monitor, record, and follow up patients' compliance with medication, such as response rate and accuracy of wellbeing daily questionnaires (Elkjaer et al., 2010), the number of logins and resources used by each participant

(Helsel et al., 2018), number of doses or pills taken (Hommel et al., 2013), and a visual analog scale (de Jong et al., 2017). Examples of methods in use include the Medical Adherence Rating Scale (Thompson et al., 2000) and the Morisky Medication Adherence Score (Cross et al., 2012).

In addition to the limitations of these solutions, they could face implementation challenges related to economic sustainability: for example, a lack of reimbursement systems, poor interoperability between electronic patient record systems, and limited technological capacities in smaller hospitals, clinics, and patients' residences (Dinesen et al., 2016; Hommel et al., 2015). To this end, Dinesen et al. (2016) suggest in their research agenda that personalization of telehealth can improve long-term adherence by addressing all factors related to the patient, context, and technology (henceforth called "long-term adherence factors").

Moreover, there are challenges to combining such solutions. On the one hand, they belong to different national healthcare jurisdictions, which implies they would have different privacy and quality assurance standards. On the other hand, they would require a universal system to facilitate their integration in terms of exchanging resources, functional capabilities, and information.

2.4. Personalization

Personalization is used across different industries as a means to accommodate individual users' needs (van den Berg et al., 2012). It has been deemed essential for improving patients' long-term adherence to telehealth (Dinesen et al., 2016; Hommel et al., 2015). However, the way in which personalization is defined and achieved varies. Personalization can focus on a group of people, such as a specific patient population or an individual. It can be user- or system-driven, implicit or explicit (i.e., who performs the personalization; (Fan & Poole, 2006). For example, users can adjust their user interface appearance by themselves. Alternatively, this adjustment can be made using SmartWare attuned to user-generated information.

Personalization can also be understood from a technological perspective, where it means tailoring technologies to achieve specific outcomes, such as enhancing a web experience through a graphic user interface design. For business and market researchers, the term connotes managing customer relationships to deliver unique benefits to each customer (Fan & Poole, 2006).

In marketing literature, personalization refers to the uniqueness of the actual or perceived use process, where value is exclusively based on the individual's characteristics and interests (Ranjan & Read, 2016) and must be context-driven (Lee, 2013; Tam & Ho, 2006). The added value of involving the user in the value creation process, on the one hand, helps the user to learn how to use, repair, and maintain the service proposition but, on the other hand, enables the user to determine the value of that service proposition. Through engaging with the service, the users can update their value expectations (Ranjan & Read, 2016; Stephen L. Vargo & Robert F. Lusch, 2004).

Personalization of IT-enabled services requires different types of support. Indeed, in their systematic literature review, Fan and Poole (2006) classify personalization support types based on objectives. They identify four types: architectural, relational, functional, and commercial personalization (for definitions, please see Appendix 1). This study does not include the fourth support type (i.e., commercial personalization support) because it focuses on a Canadian patient-centered healthcare service where commercial goals are not applicable. This classification was achieved by posing three questions: Who personalizes (user or system driven)? To whom is it personalized (an individual or a category of people)? And what is being personalized (e.g., content, functionality, interface, channel, or access)?

2.5. Conclusions

Addressing long-term adherence factors can be challenging when designing and evolving telehealth services because they focus on “what” should be personalized but do not address “how” to support such personalization. Therefore, the personalization of telehealth services needs to consider the ICT nature of the telehealth services to support long-term adherence factors. ICT personalization types (Fan & Poole, 2006) guide the support of such personalization and can articulate how service design methods’ personalization support can be provided.

Accordingly, a service design method could support up to three types of personalization: architectural, relational, and functional (Fan & Poole, 2006). ICT architectural personalization enables the service design method to (re)allocate and (re)connect entities, goals, and resources with tasks and functions in a way that responds to a patient’s needs and improves their interaction with the telehealth system. ICT relational personalization enables the service design method to mediate individual patients’ needs and abilities and the service context where the telehealth is provided. ICT functional personalization enables the service design method to integrate tools that enhance patients’ ability to interact with the telehealth service system, such as algorithms that help patients better understand the system’s feedback and effectively comply with instructions. (For elaboration with examples, see Appendix 1. In the next chapter, I will discuss service design methods with such abilities from the existing service design literature.)

Chapter 3: Literature Review

3.1. Introduction

This literature review aims to assess whether extant service design methods can help design a personalized telehealth service by providing appropriate support for long-term adherence factors (LTADs). A comprehensive search was conducted through a number of databases and key service research journals using search keywords related to service design, service engineering, and design methods and tools. Articles focusing on describing the service design process and its components were included for data extraction and analysis.

Sixty-four unique service design methods were identified from the 72 selected papers (see Table A2.1, Appendix 2, for a list of service design methods and the publications in which they were identified). The identified service design methods were categorized as belonging to either multilevel methods (6), model-based methods (22), design-for-service methods (6), computational-based methods (16), or module-based methods (14). (See Appendix 2 for a detailed list of service design methods classified in each approach.)

The identified design methods were then assessed based on how they addressed each LTAD, as shown in Table A2.2 (Appendix 2). This table indicates which LTAD is addressed by each of the identified service design methods. By addressing an LTAD, I mean whether a service design method provided at least one ICT personalization support (i.e., architectural, relational, or functional; (Fan & Poole, 2006).

The ICT personalization support types are defined in Table A1.2 (Appendix 1) wherein each of the architectural, relational, and functional dimensions is explained as a personalization support type enabling service design methods to provide an ICT-enabled service such as telehealth.

As each identified service design method was assessed, the methods were grouped by similarity of approach to interpreting design problems. An approach is defined as a class of information systems and design methods that share common features, such as goals, guiding principles, and fundamental concepts that drive interpretations and actions (Haki et al., 2018). The identified approaches are multilevel, model-based, design-for-service, computational (mathematical and data-driven), and modular-based approaches. This categorization provided the opportunity to identify groups of design methods appropriate for addressing LTADs. For example, data-driven methods within the computational approach support relational personalization and help us understand changes in individual patient's willingness and abilities to interact with the treatment. In addition, within the computational approach, mathematical-based methods help to improve the quality of the captured information.

The identified service design methods, however, do not share a common design approach (e.g., a common objective, approach, or interpretation of the research problem) because each service design method adopts a perspective and/or priorities that are relevant to its specific context or research field (Haki et al., 2018). To this end, the identified design methods were categorized based on their common interpretation of the design problem and their support was mapped to LTADs (Haki et al., 2018). The approach-based view (Table 3.1) allows for a clearer comparison of service design methods. This helps in the choice (i.e., among service design methods within the same approach) of an appropriate alternative to better address LTADs. Moreover, the approach-based view allowed us to identify the focus of extant literature and the areas which needed to be addressed to improve patients' adherence in the long term.

Accordingly, the ability of service design methods to support LTADs is discussed from an approach-based view which helped to identify which factors needed greater attention and which method is more appropriate for providing the needed personalization support. Results presented in Tables A2.1—A2.4 (Appendix 2) show that no design method single-handedly addresses all LTADs. The recommendation based on this assessment is to combine service design methods in order to provide more comprehensive support for the personalization of telehealth services in line with the LTADs.

Table 3.1 shows which aspect of telehealth personalization is the most or least supported by existing service design methods; the horizontal axis shows which LTAD is supported by which service design method within a given design approach - Numbers in white cells represent the number of identified service design methods that was deemed supporting the LTADs.

Table 3.1

An Overview of Service Design Method Support Provided to Each Long-Term Adherence Factor

		Long-Term Adherence Factors For Telehealth Personalization																				
		Patient-Related						Service Context-Related									Technology-Related					
		Preferences			Abilities			Stakeholders			Cross-Sector			Resource			Innovation			Improvement		
Types of ICT Personalization		Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
Service Design Approaches	(1)	6	6	0	1	2	0	6	6	0	6	6	0	2	2	0	0	0	0	0	0	0
(2)	(2.a)	4	4	4	0	0	0	3	3	3	3	3	3	3	3	3	1	1	0	0	1	0
	(2.b)	9	11	1	1	2	0	12	12	2	8	9	1	5	5	1	3	1	0	2	3	2
	(3)	0	5	1	0	3	1	0	5	1	0	0	0	0	1	0	0	0	0	0	4	1
(4)	(4.a)	0	0	3	0	1	3	0	0	6	0	0	1	0	0	8	0	0	3	0	0	4
	(4.b)	1	5	4	0	2	2	2	4	3	0	0	0	1	3	2	0	3	3	0	4	3
	(5)	7	0	0	1	0	0	6	0	0	9	0	0	4	0	0	3	0	0	9	0	0
Subtotal		71			19			74			49			43			18			33		
Total		51						176									89					

Legend: multilevel (1); model-based (2); semi-formal language (2.a); graphic-based (2.b); design-for-service (3); computational (4); mathematical (4.a); data-driven (4.b); module-based (5)

In summary, the results show that the selected service design approaches have an uneven focus on LTADs. Moreover, no service design approach provided each LTAD with all types of ICT personalization support. The identified service design approaches mainly support personalization related to the service context (i.e., stakeholders' goals, resource accessibility, and cross-sector collaboration); stakeholder interests received the highest level of support.

Conversely, personalization related to patients' interaction abilities and technology innovation was least supported by existing service design methods.

The remainder of this chapter is organized as follows: Section 3.2 presents the literature search strategy, including databases, criteria, and results. Section 3.3 then presents personalization ability from a design approach point of view. Section 3.4 presents results from a long-term adherence point of view, including patient-, context-, and technology-related factors. The chapter concludes with a discussion about the identified gaps from the design approach point of view, followed by research limitations and recommendations for future work.

3.2. Search Strategy

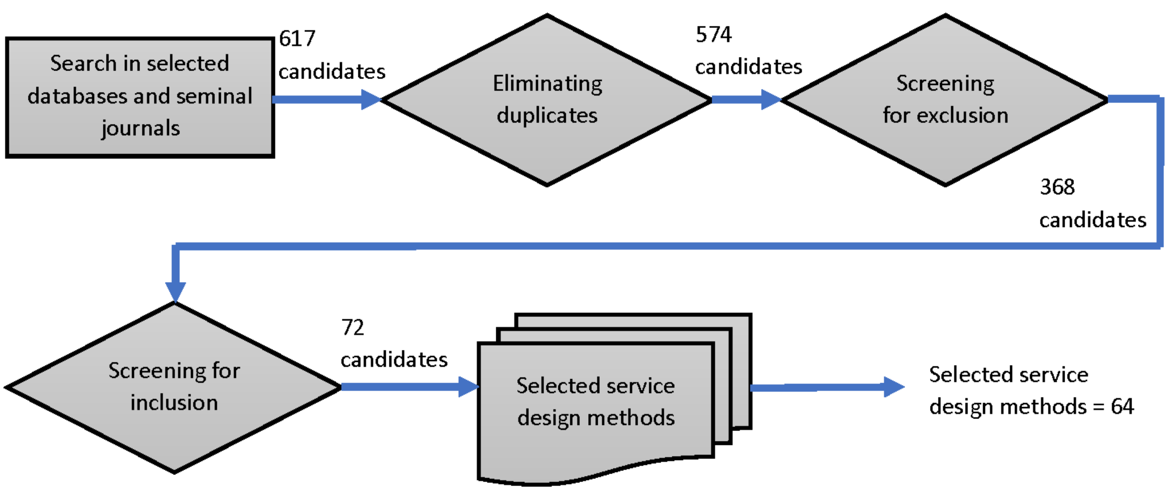
Service design methods and tools are used in different research fields, including managerial and engineering fields (Cardoso et al., 2014a). The service design process can exist as a phase within the service engineering approach; therefore, I looked for service design methods in both the service design and service engineering literature. Moreover, to reduce false positives, I eliminated results related to product–service systems (PSS). This was to avoid differentiating products from services (Beuren et al., 2016) because PSS relates to industrial contexts where service offerings are created from products such as mechanical equipment, and this context is not relevant to this study (Glushko & Nomorosa, 2012; Tien & Goldschmidt-Clermont, 2009).

3.2.1. Search Query and Databases

A comprehensive search of titles, abstracts, and keywords was conducted in databases and journals that frequently publish articles related to service design methods. The databases searched were AIS eLibrary, IEEE Xplore, ScienceDirect, SpringerLink, and PubMed. These databases were selected because they were most likely to index technology-related articles in the domain of health; nevertheless, this choice represents a limitation for the review since additional articles might have been identified using additional databases, for example Scopus. The journals *Service Science* and *Journal of Service Research* were also searched. The search query that was used to identify journal articles was as follows: ((“service design” OR “service engineering”) AND (“method” OR “tool”)) AND NOT (“product-service” OR “PSS”). However, the decision to use “NOT” may have limited the search results as potential methods might have been part of PSS-related articles. For conference proceedings, the keyword “tool” was removed from the search query in order to reduce the number of results.

Figure 3.1

Systematic Literature Review Flow Chart



The search query was also adapted for some of the databases. For example, it was only possible to search for titles and abstracts in PubMed. Moreover, the search query was divided for some databases (e.g., AIS eLibrary and SpringerLink) because the long query was not processed correctly. PSS was deemed beyond the scope of this review; hence, results related to PSS were filtered out using the database or journal's search tools, when possible, to reduce the number of false positives in the search results. The term "personalize" was also eliminated from the search query because it had minimal results.

3.2.2. Inclusion and Exclusion Criteria

The search was limited to peer-reviewed journals or conference proceedings when possible. The titles, abstracts, and keywords of search results were first screened to apply the exclusion criteria. Records were excluded if they were not in English or were not published in peer-reviewed journals or conference proceedings. The full text of the remaining articles were then screened to apply the inclusion criteria.

Articles were included if they described the purpose, components, and service participants of service design methods. This included explicit descriptions of the nature and roles of the service participants. For example, the article should describe whether participants were human (e.g., patients, nurses), organizational stakeholders (e.g., hospital, a third party provider, professional communities), and/or software agents (e.g., decision support systems). The article should also provide detail about the service activities and technologies. Articles other than full-text, English-language conference proceedings or peer-reviewed journal papers were excluded.

3.3. Design Approach View for Personalization Support

This section presents the types of ICT personalization service design methods, categorized as approaches provided to support LTADs. For example, data-driven methods are used by the service science field for contextual awareness, while the IT field uses them as an improvement function for design efficiency. This teaches us more about the capability of design methods to achieve different objectives. Some design methods consist of combinations of other design methods; these were considered to be two methods. For example, the Management and

Interaction Design For Services (MINDS) method (Grenha Teixeira et al., 2016) includes model-based affinity diagrams, but MINDS is also considered to be a multilevel approach. On the one hand, as a multilevel approach, MINDS interprets the context as a hierarchy of interacting service systems, which allows navigation of the service architecture to design service encounters. Affinity diagrams model the high-level stakeholders, representing their relationships and the accessibility of resources.

Methods within the model-based approach using semi-formal languages and within the module-based approach were both second-in-line regarding the number of ICT personalization types supported. Methods within the design-for-service approach were found to provide the least amount of ICT personalization support. Overall, service design methods were found to mainly support relational and architectural ICT personalization (120 and 118 methods, respectively), while functional ICT personalization was supported only 69 times by selected service design approaches (see Table A2.1).

Finally, the terms “methods,” “tools,” and “techniques” were used interchangeably in the selected literature (Cardoso et al., 2014b, p. 73; Tassi, 2009). To avoid inconsistency, only the word “method” was used to refer to all of these terms. In this sense, the term “application” is used to refer to computer and software applications (e.g., jUCMNav, MS Visio) that support design methods, as advised by (Alves & Jardim Nunes, 2013).

3.3.1. Multilevel Approach

The multilevel design approach responds to the complexity of the service context by means of a hierarchical perspective. This includes higher levels wherein regulations and laws need to be considered (e.g., healthcare institutions such as hospitals and third party providers who supply telehealth equipment). Such a perspective can help develop understanding about the differences between stakeholders regarding resource ownership and interests, and influences on the decision-making process; for example, this knowledge has been shown to underpin the operational design of service activities (Alter, 2012). This approach also supports the understanding of service architecture by facilitating information flow and interactions among entities within and across service systems. Such interactions can take place across academic disciplines (i.e., across sectors) and at different contextual levels, such as individuals, organizations, and specialties. Service design methods deemed to have a multilevel approach are Multilevel Service Design (MSD), MINDS, operational-based methods, three-dimensional methods, multiscale methods, and ExpCSSD (Atiq et al., 2017; Grenha Teixeira et al., 2016; Kao et al., 2016; Otake et al., 2011; Patrício, Fisk, Falcão e Cunha, et al., 2011).

Regarding ICT personalization support, multilevel methods help support relational ICT personalization, though architectural support varies (i.e., the allocation of service entities, their resources, and tasks), especially regarding the transition between different diagrams. This affects the ability to trace the way information is exchanged between multiple design methods (i.e., a multilevel method contains several methods). The MINDS method (Grenha Teixeira et al., 2016), for example, synthesizes management perspective models (i.e., creating new value propositions) with interaction design perspective models (i.e., technology's contextual usage). It provides relational ICT personalization support for high-level stakeholders (i.e., through affinity diagrams and stakeholder mapping) and a user experience. The latter is the lowest service level where user interactions are represented (i.e., service blueprinting). These are two different service layers and the transition between them is described as text with a visual representation. Tracing was not supported in MINDS, nor was navigation clearly defined. Functional support was not identified in this approach. This support could help to trace transitions between service levels.

3.3.2. Model-Based Approach

Modeling is the construction of computer-based symbol structures—a visual analogy that is utilized to capture the meaning of information and organize it to bridge the gap between real-world problems and solutions (Dubberly et al., 2008; Mylopoulos, 1998). This approach is employed in service design to demonstrate relationships and information exchange between service participants, including goals and roles (Patrício, Fisk, Cunha, et al., 2011).

Model-based methods are used for different purposes among the identified service design methods. Such purposes include understanding the service context (experience-based collaborative service system model; (Atiq et al., 2017); representing different perspectives (User Requirements Notation (URN) in terms of goals, values, and processes; (Weiss & Amyot, 2005); mapping stakeholders and actors who are participating or influencing the service (SD4VN; (Patrício et al., 2018); communicating the proposed design, such as to design teams, service stakeholders, or publication venues (co-production in practice; (Wherton et al., 2015); and emphasizing certain aspects in the design method (value cocreation, customer journey, or market segmentation; (Alves & Jardim Nunes, 2013; Løkkegaard et al., 2016); see Appendix 2.)

In this thesis, formal languages are design techniques that require an underlying system and functionality, such as software applications (Broy et al., 2007); informal languages are limited to the visual representation of service components, such as affinity diagrams; and semi-formal languages combine formalization with user interfaces where users can interact with the software systems. For example, Use Case Map notation models (part of the URN language) visually represent service actors and resources yet have the ability to provide inputs to validation activities, such as testing and performance analysis (Weiss & Amyot, 2007).

Informal methods were identified, including affinity diagrams, flow diagrams, stakeholder maps, resource maps, and persona modeling. Semi-formal methods were also identified, including URN, Unified Modelling Language (UML), Business Process Method (BPM), and i*(Alves & Jardim Nunes, 2013). Combined, they can provide a multifaceted view of the system or a graphical notation, where syntax and semantic constraints must be respected (Dascalu & Hitchcock, 2002). However, formalization, such as traceability capability, was not realized in the identified methods because many were not utilized in a detailed design phase. Methods are defined as systematic procedures, techniques, modes, or inquiries employed by or proper to a particular discipline or art. In that sense, a method may use modeling languages (Marriam-Webster 2022). Model-based approaches" include both articles focused on a modeling language (e.g., URN, UML) described as being used to support service design and articles focusing on a method integrating one or more modeling languages, such as e3Value (Efendioglu & Woitsch, 2017).

In this study, visual (graphics-based) schematics are considered to be a subset of the model-based approach that can provide one or more types of ICT personalization. For example, blueprinting can support relational ICT personalization by incorporating different contextual perspectives, including those of users. Architecturally, service interactions can be represented with sufficient details to implement them (Alves & Jardim Nunes, 2013). According to this understanding, the use of persona was found to support relational ICT personalization.

Model-based methods help support the ICT personalization of LTADs, both relational and architectural, through the modeling of nested relationships and facilitating resource allocation within the modeled service architecture. Functional ICT personalization support, in this approach, is an advantage whereby automated traceability and detection of deficiencies can be supported. This effectively helps the validation of the service design method. For instance, UML and URN modeling tools can interlink design components (i.e., actors, tasks, and resources) with goals and detailed processes in a way that allows measurement of progress toward different stakeholders' goals. Formalization functionalities were not fully exploited in the identified service methods because many of them were not utilized in the detailed design phase. Such functionalities could have helped to 1) trace information flow within a complex service architecture, 2) identify design conflicts, and 3) facilitate interoperability where service design methods are combined.

3.3.3. Design-for-Service

This approach is intended to find ways to engage stakeholders in creating new values, such as information about user preferences (Kimbell, 2011; Wetter-Edman et al., 2014); hence, it supports relational personalization. Examples include collaborative service design (Baek et al., 2018), designing and identifying (Gortzis, 2007), co-production in practice (Wherton et al., 2015), and the process approach method (Vassilakopoulou et al., 2016). The engagement of participants supports contextual understanding in a way that can help the technology to become usable and useful. For example, engagement can help tailor usable ICT-enabled services (Vassilakopoulou et al., 2016), develop design strategies (Baek et al., 2018), and involve the social networks of elderly patients in the design process because this patient category is reliant on their social network (Wherton et al., 2015). In this approach, the two other ICT personalization types were not found. Moreover, the continuous involvement of stakeholders implies that design processes can last for an unknown time. Such a characteristic increases the contextual uncertainty that might financially affect the planning process, though it could ensure a better personalization result (Garud et al., 2008).

3.3.4. Computational-Based Approach

This approach addresses computer-based solutions to conceptual problems (e.g., the variability of participants' contributions to the design process). In this approach, independent methods were found (Badinelli, 2012) because they provided the functional type of support or were combined with other methods that contributed to improving other support types (Wang et al., 2017). Two main sub-categories belong to this approach: mathematical-based and data-driven approaches. For example, to improve the quality of an actor's participation, ambiguity about their contribution capability can be reduced (Badinelli, 2012).

Mathematical-based methods use software algorithms and mathematical models to improve accuracy, enable problem-solving (Sheng & Kok-Soo, 2010), reduce ambiguity (Badinelli, 2012), and enhance the quality of service design and delivery (Akao, 1994). The identified design methods, including fuzzy logic modeling and variability management, can be used to reduce ambiguity about actors' abilities (Badinelli et al., 2012; Kannan & Proença, 2009). Quality Function Development (QFD) was independently used to measure performance (the speed of service delivery) and help to design a multi-shopping channel application (Simons & Bouwman, 2008). QFD can be integrated with fuzzy modeling to improve the service quality (Shaojing & Hong-Bin, 2016), and the Theory of Inventive Problem-Solving (TRIZ) can be used both independently and incorporated with other methods like QFD (Shaojing & Hong-Bin, 2016; Yan et al., 2016).

The functional ICT personalization support provided by mathematical-based methods in this approach can improve the flexibility of service offerings and capture and respond in real-time to patients' inquiries (Lee et al., 2015; Wang et al., 2017). However, relational and architectural support was not identified in methods within this approach, except when combined with other ones.

Data-driven service design facilitates the application of "data science," which is the study of extracting generalizable knowledge from data. This approach aims to understand usage patterns and improve efficiency and decision-making (Dhar, 2013). Data-driven methods, such as the environment-centered approach (Ohno et al., 2013), provide a kind of relational ICT personalization support that is different from methods belonging to other approaches: they provide real-time user-generated awareness that allows providers to personalize the service design and offers in an effort to make telehealth more adherable (Dinesen et al., 2016).

Data-driven methods capture end-users' requirements, changes, expectations, and satisfaction, and they support designing efficient and cost-effective services (Qiu, 2009). According to the healthcare literature, contextual knowledge using data-driven methods helps to improve the usability of service features for patients—i.e., generates an understanding of the abilities, personal usage, and preferences of individual patients (Yoo et al., 2015). Functional and architectural ICT personalization types were not identified in data-driven methods unless combined with other methods (Table A2.4, Appendix 2).

3.3.5. Module-Based Approach

Methods in this approach modularize different external (e.g., business interests and IT) and internal (e.g., functional algorithms) aspects of the service to improve contextual awareness, functionality, and reusability (Tuunanen & Cassab, 2011). This approach provides both relational and architectural support, but no functional support was identified. For example, modular service architecture provides relational support by considering external environmental requirements as architectural modules, such as marketplace and service roadmap. This allows further alignment with business interests and enhances service offerings by managing the interfaces between these modules (Aulkemeier et al., 2016; Tuunanen et al., 2011). However, it does not support functional personalization because of a lack of tools supporting traceability, data refinement, or decision-making.

Most of the identified methods in this approach are based on Service-Oriented Architecture (SOA). SOA is a software-based approach used to develop "systems that deliver application functionality, as a set of business-aligned services with well-defined and discoverable contracts" (Erradi et al., 2007, pp. 13-26). In the identified methods, SOA is used to achieve the reusability of software packages and to improve the shareability and cost-efficiency of software-based services (Stav et al., 2013).

SOA-based methods are commonly used in software development, especially in web services and online platforms (Chen et al., 2010; Erradi et al., 2007; Millard et al., 2009; Xu et al., 2011), which is beyond this study's scope. However, SOA methods provide architectural support which facilitates interactions among multiple design methods within the module-based approach. For example, the use of BPM, e3value, and KPI blocks helps to measure the performance of market-related blocks (activity), hence aligning with business interests (Efendioglu & Woitsch, 2017). This helps us understand the extent of the architectural support that can be used to develop a combination of service design methods.

3.4. Personalization Support for LTADs

This section explains the type of ICT personalization support each LTAD benefits from in each service design method and approach. An introduction is provided to common supports for each LTAD category of factors and details about each factor's support. Results of this assessment show that patients' individual abilities (i.e., mental, and physical abilities to interact with telehealth systems) received less focus in extant service design methods than technology improvement and participants' (i.e., patients and other stakeholders) interests (see Table A2.4) where the focus of each design approach is mapped using the service design method numbers belonging to that approach).

3.4.1. Patient-Related Adherence Factors

This category assesses whether knowledge about patients is being developed or if design methods can facilitate this development process (for definitions, see Table A1.1, Appendix 1). This includes patient-related information such as awareness, goals, willingness, and abilities (mental and physical). It is necessary to identify which service design methods within each approach support which type of ICT personalization for patient-related factors.

Patient preferences are addressed more frequently than patient abilities; this could be attributed to the notion that customers' interests are central to most service design approaches. However, this factor also includes patients' awareness (perception, experience with the disease, and ongoing development of knowledge), which affects their judgments (i.e., willingness to deal with the telehealth treatment). Addressing the patient's awareness can be achieved by assessing patients' abilities or providing education (Dinesen et al., 2016). Involving patients in the design process is another way to obtain contextual and functional information about patients' needs. For example, design-for-service and data-driven approaches capture actual real-time needs and preferences regarding certain service features. Facilitating the development of this kind of knowledge is a kind of ICT personalization support that both approaches can provide. Meanwhile, the model-based approach prominently represents service entities' interactions and the dependencies needed to develop architectural ICT personalization support. Indeed, involving the service beneficiary (i.e., the patient) in decision-making during the service design process helps to adapt the technological and procedural adjustments of the service features to make them more usable and, hence, adherable for patients (Kimbell, 2011; NICE, 2016).

The common ICT personalization support for the patients' abilities factor was functional: the data-driven approach provided the ability to capture real-time information about patient status, behavior, and context. Methods varied within this approach: from real-time to store-and-forward, from manual (performed by the user) to automated, from biomedical data of a patient's vital signs to a willingly answered questionnaire, and from conscious to subconscious capture of the patient's information (i.e., in sleep mode). Moreover, the data-driven approach also supported relational ICT personalization (Ohno et al., 2013). Such support is at the micro-level and can become complementary to other approaches (such as the multilevel approach) that provide macro- and mid-level relational support. This is because data-driven methods can capture real-time information about individual patients, which no other approach addresses.

There is a noticeable lack of attention to individual patients' abilities, and no design approach or method single-handedly provides all types of ICT personalization supports (see Table A2.4). Support is also limited to standard service users. Model-based methods address knowledge resources and relationships in a way that can explain the decision-making process, such as affinity diagrams (i.e., relational support). For example, the persona method, a model-based method, profiles service users by eliciting and representing their requirements (Ferreira et al., 2018). Additionally, Wärnestål et al. (2017) used persona modeling to design digital peer-support systems for childhood cancer survivors. The user-centeredness principle was applied because the service design process considered the contextual needs and abilities of children who were the service providers and beneficiaries. However, the relational ICT personalization support that persona modeling provided was at the category level (i.e., a group of participants that shares similar characteristics such as disease condition and age category).

Finally, the identified design methods were found to provide functional and architectural ICT personalization support. However, without appropriate relational ICT personalization support (i.e., micro, mid, and macro) the individual patient cannot be appropriately catered for (Fan & Poole, 2006). A combination of methods is required to provide such relational ICT personalization support.

3.4.2. Context-Related Adherence Factors

This category assesses whether design methods and approaches are able to provide ICT personalization support given the multi-sector and multi-stakeholder nature of the telehealth environment (see definitions in Table A1.1, Appendix 1). Except for resource management, this category can be addressed by a single design method. All ICT personalization support types across the service entities are represented in this LTAD category. Functional support is what differentiates the support provided by service design approaches. By definition, functional ICT personalization support is an automated (i.e., computerized) activity that helps to adjust the service for individual patients: e.g., providing traceability to links between entities in the URN (Weiss & Amyot, 2005), helping to select the best options in TRIZ (Chai et al., 2005), or improving the quality of the information in QFD (Shaojing & Hong-Bin, 2016).

Relational ICT personalization support is achieved by representing and explaining relationships between service entities (i.e., stakeholders, resources, and goals) and functions. Contextually, differentiation needs to be made between individuals and organizations regarding access to resources and their influence on decision-making. Almost all the identified service design methods address stakeholders' interests, and identification and mapping of stakeholders are the first steps; the the extent of stakeholder involvement varied. For example, in design-for-service, healthcare professionals, suppliers, and patients interactively and iteratively participate in the service design process until all parties are satisfied (Gortzis, 2007). Representation and classification of stakeholders are provided mainly through multilevel and model-based approaches. Their information is captured and optimized through computational and design-for-service approaches.

Model-based methods provide both relational and architectural ICT personalization support. This is achieved through the classification and allocation of relationships among stakeholders, their interests, and relevant resources (such as affinity diagrams and value-based methods) at different levels of detail. Sophisticated model-based methods, such as i* and users requirement notation goal-oriented requirement language (URN GRL), provide better support, such as intentional modeling that links actors, goals, and functions (Amyot, Becha, Braek, & Rossebo, 2008).

The second context-related LTAD, management of resources, is supported differently by the identified methods, especially in terms of usability and usefulness. This also applies to human resources: qualified, experienced personnel can manage patients' behavioral responses to treatment. On the provider side, a scarcity of skilled healthcare resources presents a concern and affects providers' decision-making regarding treatment plans and service offerings (Cusack et al., 2008; Hirani et al., 2017). In that sense, functional and relational ICT personalization support helps to improve the quality of resources. This is achieved by means of a computational approach (i.e., data-driven and mathematical-based approaches). For example, methods in this approach are utilized to reduce ambiguity about the customer's abilities (e.g., variability management method) and decision-making (e.g., TRIZ for problem-solving). Data-driven methods help collect real-time data about different stakeholders and resources, using different technologies for as long as needed (Lu & Hao, 2010; Yoo et al., 2015). The design-for-service approach supports functional ICT personalization by iterative improvement over time. This helps improve the usability and compatibility of service resources for both patients and providers (Vassilakopoulou et al., 2016).

Architecturally, module-based approaches provide another means to improve the usage and exchange of resources through interfaces between service aspects (e.g., market requirements and specialties).

The cross-sector collaboration factor mainly undergoes ICT personalization in the form of architectural and relational support (Fan & Poole, 2006). The highest number of contributions are multilevel and model-based approaches; the least is from the design-for-service and computational approaches. With regard to functional support, traceability and automated decision-making are not supported by most approaches, except for some model-based methods, such as URN (Weiss & Amyot, 2005) and UML (Alter, 2012). These methods can support navigation and traceability of service activities and detect relationships among entities and design deficiencies.

Architecturally, model- and modular-based approaches address interactions between service entities and between combined methods. In this sense, methods with unified languages facilitate interactions among entities, manage connectedness among other methods, and automate decision-making. For example, BPM is used as a metamodel that accommodates different functional blocks (using BPM language, an e3value block is used to analyse the cooperation across the service network, and KPI blocks evaluate outputs of other functional blocks) related to marketing and organizational activities using the same BPM environment (Efendioglu & Woitsch, 2017).

Regarding relational ICT personalization support to cross-sector LTADs, the model-based, module-based, and multilevel-based approaches contributed the most, while the other approaches focus on entities instead (Table A2.4). Such support is deemed necessary to address the complexity in the healthcare context, where resources interact and integrate to produce services (Tien & Goldschmidt-Clermont, 2009). For example, the service value is addressed by using value-chain (Patrício et al., 2011) and e3value (Godart et al., 2009). This cross-sector understanding considers aspects (e.g., business values and functionality), specialties (i.e., healthcare and IT), and stakeholders.

In summary, context-related factors are addressed mainly by multilevel and model-based approaches (Table A2.4). The former best provides the relational ICT personalization support needed to understand and mediate contextual entities' properties, and the latter provides the architectural ICT personalization support by which interactions, goals, and functions can be addressed and represented. Table A2.4 also shows the lack of functional ICT personalization support for the cross-sector factor. Only sophisticated model-based methods provide this support (e.g., URN, UML, and BPM) where traceability and navigation features are available.

Therefore, methods that belong to the multilevel and model-based approaches are, together, able to provide all kinds of ICT personalization support to this category. For example, MSD can best address contextual understanding, and URN provides the best model and validates the service design. MSD provides a clear definition of and differentiation between service levels, utilizes a service system-based framework, and states how to expand with new levels (Patrício, Fisk, Falcão e Cunha, et al., 2011). URN provides a unified language along the design process;

connects entities, goals, and scenarios; and provides consistency, traceability, and validating capabilities (i.e., from stakeholder goals to personal treatment scenarios). This helps to detect design deficiencies and conflicts (Amyot, Becha, Braek, & Rossebo, 2008).

3.4.3. Technology-Related Adherence Factors

This category assesses whether a design method can create or facilitate the creation of new knowledge through innovative combinations of technologies or improving existing technology for efficiency and usability. Computational (i.e., both data-driven and mathematical), modular (i.e., SOA), and design-for-service approaches support these objectives (Table A2.3).

Functionally, methods that address this category aim to enhance the service design and delivery in terms of efficiency, effectiveness, and usability. All ICT personalization support types are provided using combined service design methods. Context-related data, for instance, are collected using the data-derived approach (e.g., (Lu & Hao, 2010; Yoo et al., 2015); these are then functionally processed using mathematical approach methods like TRIZ and QFD (Wang et al., 2017). The newly generated information is architected and communicated through model-based methods, such as blueprinting, UML, and URN. For example, blueprinting has been used to understand ICT service users' TV-watching priorities, representing the flow of orders and facilitating new offers (Lim & Kim, 2014). Service blueprinting combined with TRIZ and QFD has been used to facilitate the creation of an intelligent restaurant menu based on historical customer preferences (Wang et al., 2017).

Table A2.4 shows that the technology innovation factor is the least supported, especially by design-for-service and multilevel approaches. This reflects the need for architectural and relational ICT personalization support for this factor. Indeed, creating new knowledge from different resources requires a design method that can understand connectivity among resources and relationships with stakeholders who own and are able to integrate such resources. Moreover, the proposed design method must provide tools to facilitate the reallocation of resources and entities as needed during the ICT personalization process (i.e., architectural ICT personalization support).

Most of the design approaches support the improvement of technology—all except the multilevel approach. Improving the quality of information is achieved by using QFD (Shaojing & Hong-Bin, 2016). Improvement activities are architected using the model- and modular-based approaches. For example, affinity diagrams, a model-based method, helped interconnect knowledge sources (i.e., ideas and constructs) and modeled the information flow (i.e., patient–provider communication; (Atiq et al., 2017).

Persona modeling is utilized to improve the usability of the user interface. For example, a peer-support application can facilitate medical web pages for children (Wärnestål et al., 2017). A layered persona method can improve contextual understanding by accommodating variables for different contexts (Marcengo et al., 2009). In the module-based approach, SOA-based methods help improve the capability of devices to capture patients' vital signs and interpret the captured information (Stav et al., 2013).

Despite the importance of technology-related factors in improving patients' long-term adherence, no single approach provides all types of ICT personalization support, especially concerning the innovation factor. Supporting technology-related factors, therefore, requires multiple approaches. For example, the sociotechnical systems engineering method (Drăgoicea et al., 2015) combined data-driven and model-based methods to provide all ICT personalization support types. This example and previous similar examples represent a suboptimal situation, in which the best methods of each approach are chosen, but minimum requirements are set about what is needed to harness the technology innovation benefits and foster improvements.

3.5. Implications for Personalizing Telehealth through Service Design Methods

All long-term adherence factors (LTADs) are addressed by at least one identified service design approach and method. However, LTADs receive different types and extents of ICT personalization support across service design methods. No method single-handedly addresses all factors or provides all ICT personalization types. Therefore, combining or extending methods or approaches is recommended to provide the required ICT personalization support for each LTAD. Combining methods can also provide additional functions necessary at different design phases, such as choosing the best option in a decision-making design process.

Combining multiple service design approaches, however, would require compatibility between selected service design methods. Future research could explore the combination of service design methods that belong to the model-based approach, particularly methods relying on semi-formal languages. URN, for example, provides mechanisms and tools to adapt the language to a given domain or to use it in combination with other conceptual modeling languages (Amyot, Becha, Braek, & Rossebo, 2008). The same applies to BPM, which facilitates combining multiple service design methods for better functionality (Alves & Jardim Nunes, 2013).

However, not all factors are sufficiently supported by the identified design methods. For example, patients' abilities and technology innovation factors are the least supported by the identified design methods and approaches. The proposed service design method recommends using a compatible collection of design methods where all ICT personalization support can be provided for any given LTAD.

During their telehealth services, patients develop their mental and physical abilities. When patients become more experienced with the treatment, they become more capable of assessing their own needs. Hence, they can better determine and cocreate the value of telehealth treatment. This information can become a knowledge source for personalizing treatment (Dinesen et al., 2016). For example, the data-driven approach (Ohno et al., 2013) can provide relational ICT personalization support, capturing personal use and preferences over time. This approach complements the relational ICT personalization support necessary for all factors, where the value network is understood. Therefore, it is recommended that data-driven methods be combined with other contextual-supporting methods, such as MSD (Patrício, Fisk, Falcão e Cunha, et al., 2011), to provide sufficient relational ICT personalization support needed to personalize the telehealth treatment.

Finally, the identified service design methods were classified in terms of their design approach (i.e., the way design problems and objectives were interpreted;(Haki et al., 2018). This classification helped identify five different approaches that shared a way of interpreting design problems and actions. Combining the LTADs and ICT personalization (architectural, relational, and functional ICT personalization) types into an assessment tool helped with the assessment of the ability of the identified design approaches to support personalization (see Table 3.1). This tool also helped identify weakly supported LTADs and missing ICT personalization types. Further details are available in Appendix 2.

Utilizing a tool that integrates ICT personalization and LTADs does not assume that all LTADs need all ICT types of personalization support; however, such a tool could be modified as needed to accommodate different telehealth delivery and operation modes. For example, some patients could be prescribed fully automated telemonitoring vests that enable patient monitoring while asleep, while self-management telehealth solutions would allow patients to authorize tests and record and send their biodata (NICE, 2016). Telehealth research, therefore, should aim to develop a further understanding of telehealth’s clinical specificities. The same applies to understanding the personalization requirements of different beneficiaries.

Chapter 4: Methodology

4.1. Introduction

This research adopts the design science research (DSR) paradigm to guide the design, development, and evaluation of an information systems (IS) artifact: the SerViU telehealth personalization service design method. The DSR paradigm is useful for this research because it addresses both behavioral science and design science; the former explains or predicts stakeholders' (human or organizational) behavior, and the latter helps to expand the capabilities of stakeholders by creating new and innovative artifacts, such as constructs, models, methods, and instantiations (Hevner et al., 2004).

Figure 4.1

Design Science Research Paradigm Adopted from (Hevner et al., 2004)

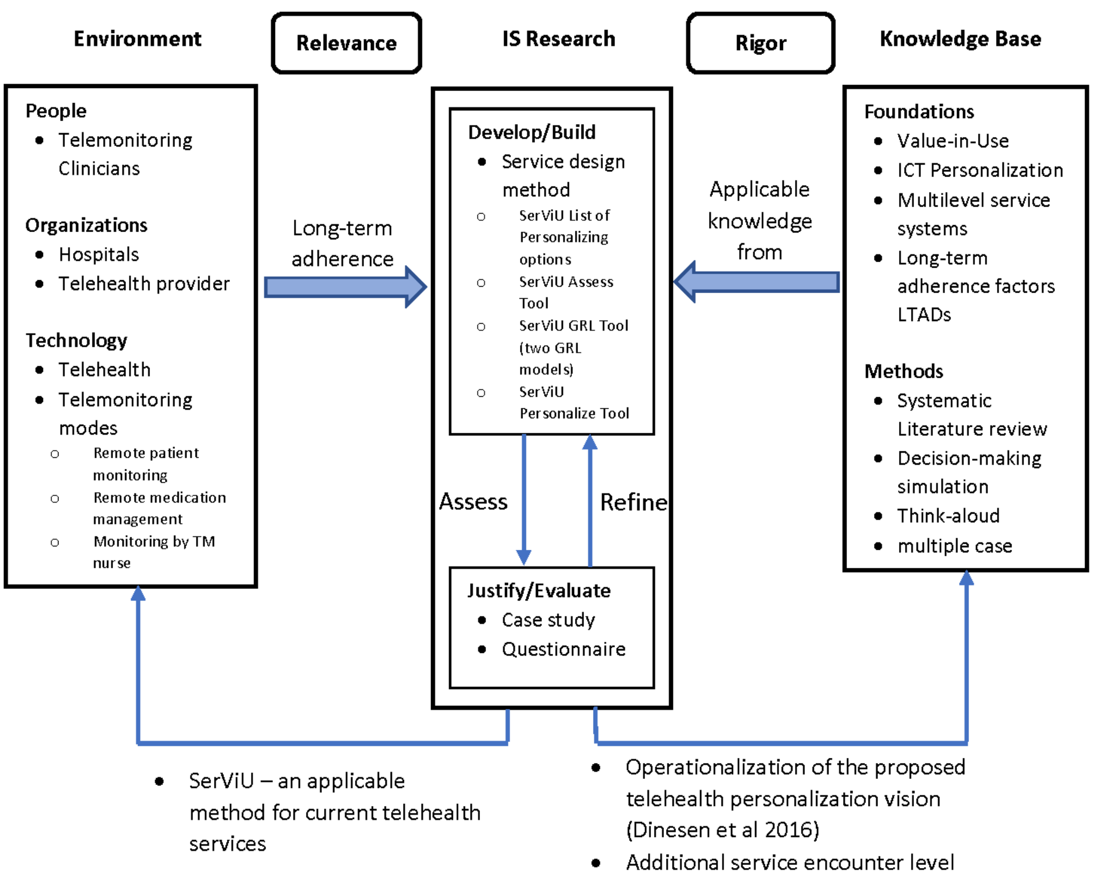


Figure 4.1, adopted from (Hevner et al., 2004), presents a conceptual framework for the understanding, execution, and evaluation of IS research. Figure 4.1 shows that business needs must be identified and justified through the application of relevant research and theories (i.e., value-in-use (ViU), information communication technology (ICT) personalization, Multilevel Service Design, and long-term adherence factors). An artifact is subsequently built and evaluated to meet the identified business needs.

In Figure 4.1, the environment refers to the problem space where the phenomenon of interest resides. In this research, the environment includes patients, clinicians, healthcare providers (i.e., hospitals, third party suppliers, and other healthcare organizations) who collaborate to provide long-term telehealth services for their patients. The need of the providers is the ability to offer telehealth services that patients with multimorbidity can adhere to in the long term. The telehealth literature deems the lack of long-term adherence to be a discipline-related problem that needs to be addressed. Personalization of telehealth services has been suggested as one solution that could improve patient adherence (Hommel et al., 2015). Recent literature emphasizes that telehealth personalization should consider patient-related aspects, service context-related aspects, and technology advancement (Dinesen et al., 2016).

The IS knowledge base provides research methods and frameworks that can help develop SerViU artifacts and design its functions. This research has drawn from the concept of ViU (Stephen L Vargo & Robert F Lusch, 2004) to help design the SerViU Use and Assess phases that record and assess patients' experiences.

First, the Multilevel Service Design (MSD) method provides a multilayered service systems understanding of the telehealth context where different stakeholder integrate their resources to cocreate services (Patrício, Fisk, Falcão e Cunha, et al., 2011). Second, an ICT-services framework can help articulate the ICT personalization types that SerViU could provide to address long-term adherence (Fan & Poole, 2006).

In this study, a multiple case study was used to simulate and demonstrate clinician decision-making related to the personalization of hypothetical scenarios. Clinicians were then asked to provide feedback on the use of the SerViU Personalize Tool, which is presented as the evaluation of the tool.

The case study context and research is elaborated in Chapter 6. The collected data was analyzed using within-case, cross-case, and thematic analysis techniques. Details of data collection, data analysis, and the SerViU method evaluation (the artifact) are provided in the following sections. The resulting artifact represents one possible solution to personalize telehealth services in a manner that accounts for patient-related, service context-related, and technology-related aspects; in addition, this study presents additional future research opportunities (see Figure 4.1).

In the remainder of this chapter, the design science research methodology (DSRM; (Peffers et al., 2007) and how it guides the thesis research activities. Data collection and data analysis are consequently explained. Threats to validity and ethical considerations are finally discussed.

4.2. Design Science Research Methodology (DSRM)

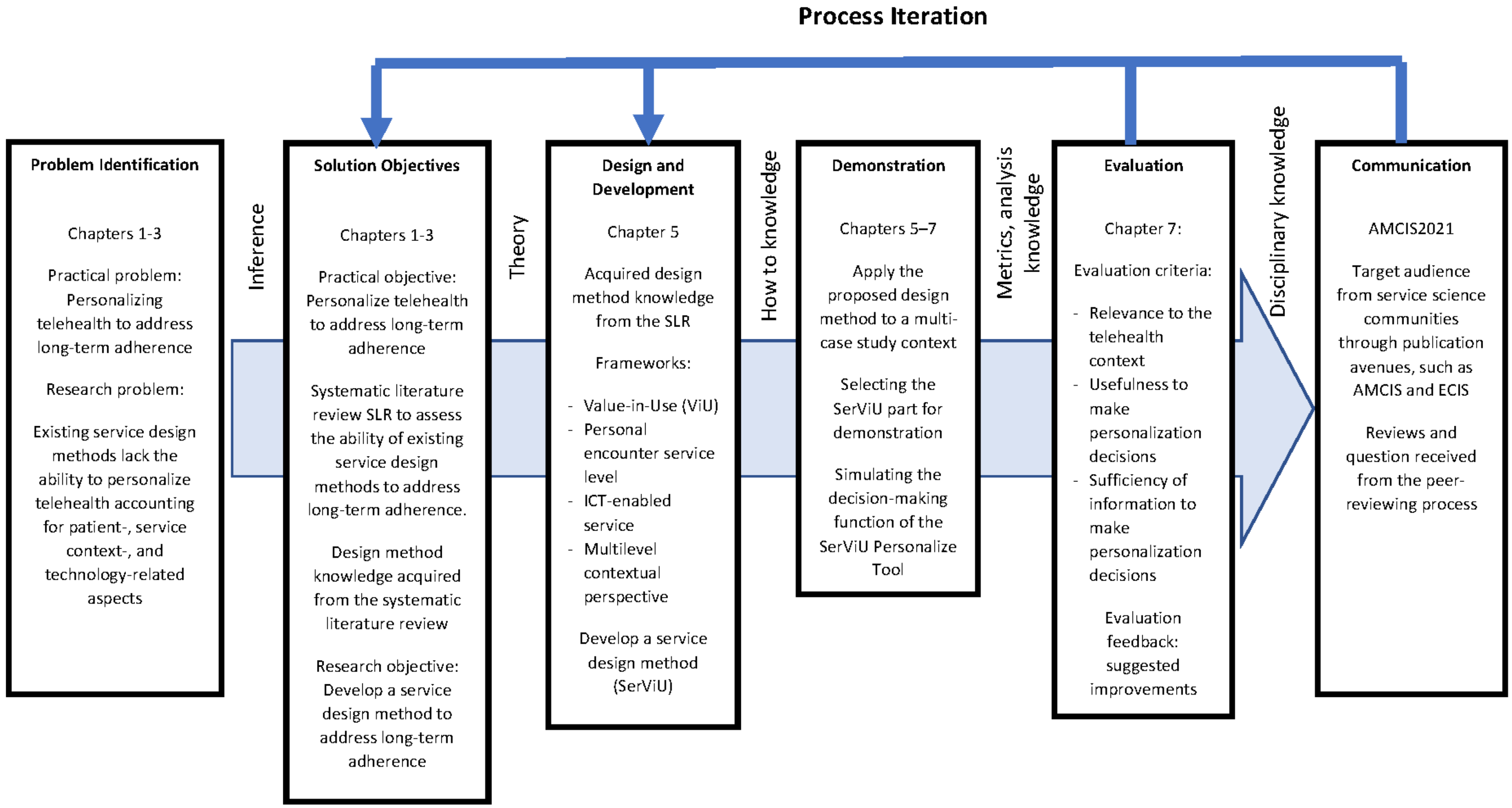
The DSRM (Peffers et al., 2007) was chosen to guide the thesis research activities. The DSRM is consistent with past DSR research that incorporates principles, practices, and procedures by providing a process and mental model that guides research activities in six steps: 1) problem identification and motivation, 2) define the objectives for a solution, 3) design and development, 4) demonstration, 5) evaluation, and 6) communication. Moreover, the DSRM provides multiple points for research entry—i.e., the research process could have a problem-centered entry, an objective-centered entry, a design and development–centered entry, or a client-/context-centered entry (Peffers et al., 2007). In this study, a problem-centered research entry point was selected as a means to design a service design method (artifact) that aims to address the research objective of this thesis.

Guided by the DSRM (Peffers et al. (2007), the thesis research activities were organized into six steps: 1) practical and research problems were identified, 2) solution objectives were determined, and 3) a demonstration method was chosen. Then, 4) a core part of SerViU was demonstrated via case study research, which 5) enabled the evaluation of SerViU, allowing 6) the communication of its applicability to personalize telehealth services (Eisenhardt et al., 2002; Runeson & Höst, 2008).

Figure 4.2 shows how the DSRM steps were applied in this thesis. It also shows the iterative nature of the DSRM; i.e., problem solutions are defined through reviewing and assessing the existing literature. SerViU was then developed by drawing on the ViU, MSD, and ICT personalization frameworks. A multiple case study research project supported the development of the core tool within SerViU—the SerViU Personalize Tool. A high-level description of SerViU and early results from the multiple case study have been published to communicate the research to IS and health science communities.

Figure 4.2

Application of DSRM to this Thesis—Adapted from (Peffers et al., 2007).



4.2.1. Defining the Problem and Its Solution

A problem stood out following the review of the first two quartiles of the telehealth and telemedicine literature: patients do not adhere to their telehealth services (care plans) in the long term. Recent telehealth research and research agendas (Dinesen et al., 2016) have called for personalizing telehealth services in a manner that accounts for patient-related, service context–related and technology-related aspects (i.e., long-term adherence aspects). The motivation for these calls is elaborated in Chapter 1.

In Chapter 2 (Background) I argued that previous attempts at telehealth personalization only partially address the long-term adherence aspects. To this end, in this thesis, service design methods have been suggested as an IS solution that could personalize telehealth services by addressing all the long-term adherence aspects.

In Chapter 3, a systematic literature review presents the methods that address this gap outlined in existing service design literature. Three methods stood out: MSD, which has multilevel service system understanding; User Requirements Notation (URN), which can support complex service architecture; and a user-generated method which captures real-time information. The identified service design method candidates were evaluated in terms of their ability to address long-term adherence, cope with the complexity of the telemonitoring (TM) context, and capture the contribution of service participants (i.e., patients).

None of these methods can support the personalization of TM systems in a manner that addresses long-term adherence. One explanation for this is that service design method personalization capabilities are needed for more than one dimension (i.e., individual patient, service context, and technology). SerViU addresses this gap by utilizing the Fan and Poole (2006) multidimensional framework of ICT service personalization with architectural, relational, and functional dimensions. This enables service design methods to personalize TM services and to utilize outcomes of patient involvement to address the lack of long-term adherence among particular patients and particular situations (i.e., personalization).

Accordingly, the solution's objective was defined as follows: to develop a service design method that can guide the personalization of telehealth services. The proposed service design method should consider not only technological improvements but also the service context, the contexts of individual patients, and their evolving situations; this objective is supported by existing health IT literature, such as studies by (Dinesen et al., 2016; Hommel et al., 2015).

4.2.2. Developing the Design Method

In Chapter 5, the development of SerViU is elaborated. The first design step consists of the development of a framework that considers the complexity of telehealth service context (i.e., stakeholders' interests, organizational capabilities, and resources), the advancement of technologies, as well as the involvement of individual patients in terms of their interaction abilities, disease conditions, and preferences. This was achieved through integrating and adapting multiple frameworks and concepts.

The essence of SerViU's contribution is its ability to benefit from the patient's experience using the service; hence, the concept ViU was adopted (Vargo & Lusch, 2004). An ICT-enabled service personalization framework was integrated into the design to help articulate the personalization support that SerViU could provide for each long-term adherence aspect (Fan & Poole, 2006). To this end, a multilevel service system perspective was adapted from Patrício et al. (2011). This perspective could accommodate a new service level—the personal encounter service level—where the proposed method operates.

The second step was to develop the SerViU service design method with an iterative personalization process. To this end, a multi-phased process of Use–Assess–Personalize (i.e., Phases 1, 2, and 3) was suggested. Hence, different tools were developed to assess and personalize the service in each phase. During the Assess phase (Phase 2), the patient's experiences are assessed using the SerViU Assess Tool which is utilized by the clinician to record the outcomes of the patient's experience. This tool considers the patient's developed perception of usefulness and ease-of-use of the service, their interaction abilities, compliance with the care plan, and progress of their disease condition. The tool is represented as an Excel spreadsheet that calculates the need to personalize the service based on the information mentioned above. This tool also helps the clinician to decide on an area of focus.

At this phase, SerViU provides another tool, the SerViU Goal-Oriented Requirement Language (GRL) Tool: an optional goal-oriented tool used by a service science professional (i.e., a TM team member). This tool helps identify personalization requirements through two GRL models by propagating the contribution of tasks and objectives belonging to different service actors (Weiss & Amyot, 2007). The jUCMNav application was utilized to develop the GRL models.

In the Personalize phase (Phase 3), the TM clinician chooses how to personalize the service, including the care plan components for a specific patient in a particular situation and disease condition. For that purpose, SerViU provides a special tool, the SerViU Personalize Tool, which calculates the applicability of each personalization option the clinician chooses and prioritizes them in a way that helps the clinician to choose the most appropriate one. This tool was represented in an interactive spreadsheet where the clinicians (case study participants) could select different personalization options and find which options had a higher priority.

The SerViU Personalize Tool utilizes a formula developed to consider the factors of ICT personalization applicability, resource accessibility, and patient's willingness to use the personalized plan. Moreover, this tool utilizes information that is assumed to be predeveloped by providers: a list of personalization options (LPO) in a catalog-based format. In this thesis, the LPO is a non-iterative phase (Phase 0) that precedes the Use–Assess–Personalize process. Hence, the LPO is embedded in the SerViU Personalize Tool and appears on the tool's interface when used by the clinician. See Table 4.1

Table 4.1 . List of SerViU Tools

SerViU Phase	SerViU Tool	Description
0 (LPO)	LPO form	A form to list the personalization options by the TM team
1 (Use)		
2 (Assess)	SerViU Assess Tool	A Spreadsheet to calculate the Need-to-personalize decision
	SerViU GRL-Assess Tool	A model-based tool using the Goal-oriented requirements language. Helps prioritizing the personalization options based on SerViU formula's score.
3 (Personalize)	SerViU Personalize Tool	An interactive spreadsheet to prioritize the personalization options
	SerViU GRL-VE	A model-based tool using the Goal-oriented requirements language. Helps verifying which personalization options better meets the patient's value expectations.

4.2.3. Demonstrating the Design Method

In order to demonstrate the applicability of SerViU, a multiple case study was conducted which focused on the decision-making aspect of SerViU. To this end, the SerViU Personalize Tool was chosen as it represents a core function in SerViU.

The decision-making process of the SerViU Personalize Tool was simulated for different telehealth service types and delivery modes, a multiple case study analysis (Yin, 2017) was conducted; each telehealth mode (TM service delivery mode) was deemed to be a case. Case study participants simulated the decision-making process in the SerViU Personalize Tool to personalize a TM service based on a hypothesized TM scenario. Each personalized service was deemed an analysis unit coded as (n, m), where n refers to the mode number and m refers to the scenario number. Four analysis units for each mode resulted in twelve analysis units (personalized TM services). See Table 6.2 for the distribution of analysis units.

The SerViU Personalize Tool was represented in an interactive spreadsheet with a familiar interface for the participants (clinicians) that contained a simplified LPO. The development and use of the interactive spreadsheet is elaborated in Chapter 6 and illustrated in Figure 6.2.

The case study participants were clinicians who were recruited based on their familiarity with TM patients, service delivery modes, and the relevant technologies. Ideally, participants should have previously worked in different TM services. Recruitment details are elaborated in Chapter 6.

The simulation sessions were conducted online using the Microsoft Teams application; each session comprised two TM services to be personalized. The duration assigned for each session was 60 min, during which time each participant simulated two different TM modes. The duration also allowed for an introduction, a review, and feedback. See Chapter 6 for further details (Document A3.c, Appendix 3).

Data collected from the simulation sessions included transcripts of voice-recorded sessions (the participants were asked to think aloud while making the personalization decision), the set of selected options using the SerViU Personalize Tool, and scores produced by the SerViU formula. Data types collected during the simulation sessions are detailed in Chapter 6 and represented in Table 6.3.

The aim was to demonstrate the applicability of the SerViU Personalize Tool for different telehealth modes and levels of complexity. The analysis process included comparisons within and cross-case (i.e., between and across different telehealth modes; Eisenhardt, 1989). The analysis technique is elaborated in Chapter 6.

4.2.4. Scenario Validation

Three different TM scenarios, each representing a TM delivery mode, were validated by key informants. The scenarios were reviewed, modified based on the key informants' comments, and approved (Document A3e., Appendix 3). The scenario validation process is elaborated below.

The key informants were experts with experience and knowledge needed by the researchers to better understand TM events and situations (i.e., TM scenarios).

Each scenario portrayed a different telehealth service delivery mode. The key informants were asked to review the scenarios and provide comments regarding their correctness and completeness. The validation process was performed through document exchanges via email and verbal interactions via Microsoft Teams when deemed appropriate by key informants.

The TM scenarios were developed based on existing literature. Each key informant reviewed, commented on, and approved all three scenarios. Before the validation process, a general consent letter was sent to the key informants. Once consent was granted, TM scenarios were sent via email to the key informants, based on the scenario validation protocol (Document A3.b, Appendix 3).

The TM scenario document included three scenarios and was sent to each key informant via email. The TM scenario document contained text describing a situation where a hypothetical patient was utilizing the telehealth service. This included patient equipment use, service navigation, challenges faced, and decisions made. The document also described the way the clinician adjusted (personalized) the TM service to accommodate these situations. The scenario document included a visual representation of the scenario timeline. The key informants had two to three weeks to review the TM scenario document and comment. Questions about the scenarios' correctness and completeness were provided as guidance, but the key informants had free rein to comment, request revisions, and provide feedback as they pleased.

After receiving key informant feedback, follow-up communications took place, especially when the researcher needed further explanations or a revised scenario was requested by a key informant (permission to "contact again" was obtained on a form completed at the beginning of the interview session).

4.2.5. Evaluating the Design Method

In the evaluation step, case study participants were asked to provide their feedback regarding three criteria: relevance, usefulness, and sufficiency of the information provided by the artifact (SerViU Personalize Tool) utilized to personalize TM services.

To this end, a questionnaire form was developed where each criterion was represented with a statement, and the participant was asked to provide their level of agreement with the statement using a 3-point Likert scale. The value 3 is equivalent to the highest agreement. The value 2 has a neutral level of agreement, and the value 1 represents a disagreement of the participant with the criterion statement. The form also provides a space for free text for the participant to express (using their own words) their concerns and suggest improvements. The questionnaire forms were provided to the participants prior to the simulation sessions, and they were given time to fill them in during the simulation timeframe (see Documents A3.d, Appendix 3 for further details).

Relevance refers to the personalization decision as distinct from regular adjustments that participants used to make in similar situations. This also includes the contextual information available in the artifact: the technology components of TM systems (hardware and software), operation methods and business-related information (e.g., brand and cost), and healthcare network constraints.

Usefulness refers to evaluating the decision-making criteria and process whether the tool is helpful to personalize telehealth services based on the participants' contextual experience; the clinicians proposed whether the tool required further adjustment and how these should be adjusted.

Sufficiency of information refers to whether further detailed information was needed to enable the clinician to make the personalization decision. Participants helped to identify if information was sufficient for this purpose.

4.2.6. Communicating the Design Method

The systematic literature review results presented in Chapter 3 (Oday Aswad & Lysanne Lessard, 2021) and the description of the SerViU method (Oday Aswad & Lysanne Lessard, 2021) were presented at the American Conference on Information Systems. The former publication helped clarify the way ICT-Personalization supported the long-term adherence factors. The latter helped clarify the research contribution, especially regarding the Personal service encounter level as a new service context level where SerViU personalization takes place. Preliminary results from the case study have also been submitted as a book chapter (Aswad et al., 2022). This publication helped articulate the patient' role in personalizing their telehealth services and suggested improvement towards further empowerment to the patients to personalize their telehealth services .

4.3. Data Collection

The recruitment criteria (elaborated in Appendix 3) conditioned the case study participants to be clinicians who were recruited based on their familiarity with TM patients, service delivery modes, and the relevant technologies. Clinicians can include nurses, phycisians, physiotherapist, pharmacists, psychitists who, ideally, have previously worked in different TM services and dealt with patients who received telehealth treatment.

Data were collected from twelve personalized TM services (as described in Section 6.2.4). Table 6.3 shows the different data types that were collected during the simulation sessions. Participants were asked to personalize TM services and then provide feedback about the tool and the personalization process. During the TM service personalization decision-making, the following data were collected: the selections made by the participants on the interactive spreadsheet (SerViU Personalize Tool) to personalize the current TM services; a score for each personalized TM service, based on the SerViU formula embedded in the SerViU Personalize Tool; and, finally, transcripts of the voice-recorded sessions (the participants were asked to think aloud while making their personalization decisions).

Table 4.2

Data Collection Methods

DSRM step	Data Collection	Description
Demonstration	Selected personalization options	Selected personalization options using the SerViU Personalize Tool were recorded on the interactive spreadsheet regarding the decision taken by the participant in each simulation session.
Demonstration	SerViU formula scores	The SerViU Personalize Tool calculates the selected personalization options and produces scores that help to prioritize the personalization options for the clinician.
Demonstration	Transcripts of voice recordings	The simulation sessions were conducted online via Microsoft Teams, and voice-recording transcripts were produced for these sessions and temporarily stored in the Canadian hospital’s cloud.

Evaluation	Likert scale	The participants responded to questionnaire statements using a 3-point Likert scale to indicate their level of agreement.
Evaluation	Transcripts of written feedback	The participants responded to questionnaire statements by providing written feedback identifying challenges and suggesting improvements.
Evaluation	Correspondence	Follow-up communication was conducted with the case study participants, including emails, phone calls, or virtual meetings. According to the participant's clarifications, changes to the written questionnaire were made and then analyzed.

At the end of the TM service personalization, the participants were asked to provide their evaluation feedback. There were two types of data collected for that purpose: written feedback and a questionnaire. An evaluation questionnaire form was provided to the participants that included statements about the three evaluation criteria. The participants were asked to provide their agreement level with each statement using a 3-point Likert scale and to point out in a written format challenges or suggest improvements regarding each statement. One set of feedback evaluation data was provided for each simulation session.

In total, there were twelve sets of data for the TM personalized services and six sets of data for the evaluation feedback. The collected data were transcripts of the voice-recorded simulation sessions, the selected SerViU options (saved in logs), scores, evaluation data, and follow-up correspondence. The protocols of the simulation sessions, evaluation feedback, and information exchanged with the participants are detailed in Appendix 3, and the simulation session events are summarized in Section 6.2.2.

4.4. Data Analysis

Within and cross-case comparisons were conducted to analyze the case study data. Comparisons were made between the TM personalized services that belonged to the same TM mode (called within-case—i.e., different participants personalizing the same TM mode) and between the different modes of TM services (Eisenhardt, 1989).

Comparisons included personalization options at the higher level as well as the detailed selection of TM features. The selected options were saved as a log on separate copies of the interactive spreadsheets for each personalized TM service. Using a tabular format, the selected options were compared between different logs. Cross-case comparison tables are displayed in the results chapter (Chapter 7), and within-case comparisons are presented in Appendixes 4 and 5. The second comparison criterion was the scores produced by the SerViU Personalized Tool formula. The overall scores represent the priority of a personalized TM service in terms of applicability of the ICT component, the level of patients' willingness to accept personalized services (as perceived by the case study participant), and the accessibility of healthcare resources (including clinician work hours; see Table 7.1). The third comparison criterion was the rationale behind the personalization decision. Rationale themes were identified from the voice-recorded sessions' transcripts by the means of the thematic analysis technique. Theme analysis results are available in Appendix 8.

4.4.1. Within-Case and Cross-Case Comparison: DSRM Demonstration Step

Within-case analysis was conducted within each TM mode. The comparison included high-level and detailed personalization options selected over four units. For example, TM components and communication methods were selected (detailed selections) to provide patients with further education (high-level personalization decision). Scores included the overall scores of the personalized TM service, the level of ICT applicability, and the accessibility of resources provided by the selected healthcare network; the rationale behind such decisions helped with the interpretation of the choices. For example, the need for visual interaction between the patient and her nurse was the reason behind selecting video calls (communication methods) and videoconferencing features (TM components). These choices also helped identify that SerViU facilitated different means to implement similar personalization options. For example, to provide further education, SerViU provides alternative educational materials, including paper manuals which were preferred over digital content by some participants. Further elaboration is available in Appendices 4 and 5 and this is discussed thoroughly in the results chapter (Chapter 7).

In the cross-case analysis, personalization decisions were compared between different TM modes (e.g., similarities and differences between remote patient monitoring and remote medication management modes). The comparisons included high-level and detailed personalization decisions, and whether there was a focus on using or avoiding certain selections. Comparisons also included scores of and rationales behind the personalization decisions. This helped demonstrate and is expected to improve the SerViU Personalize Tool's applicability to personalizing all TM delivery modes (three modes in this case study). For example, the SerViU Personalize Tool allowed the use of touchscreens to improve the usability of TM services across the TM modes. The improvement, however, was to provide further education, further assistance, and some technology improvement (types of personalization options). The cross-case analysis also showed that the SerViU Personalize Tool was mainly utilized to address the patient's mental interaction abilities, including cognitive.

Both types of analysis (i.e., within and cross-case) were expected to result in an overall understanding of how TM services could be personalized using the SerViU Personalize Tool, including associated challenges, preferences, and provider priorities. For example, if the SerViU Personalize Tool can facilitate different decision-making tendencies across different modes (e.g., technology-driven versus price-driven personalization decisions), people with different decision-making tendencies can help the same patient interact with the telehealth service. Further results are presented in the results chapter (Chapter 7) and discussed in the discussions chapter (Chapter 8).

4.4.2. Evaluation Feedback: DSRM Evaluation Step

The purpose of the feedback that the case study participants provided was to help create an understanding of how context-relevant the SerViU Personalize Tool could be and how useful it is for making personalization decisions, addressing different complexity levels of TM delivery modes, and providing information about providers' priorities. In this sense, the simulation sessions and clinician feedback generated possible improvements to the SerViU Personalize Tool (see Chapter 7).

Evaluation criteria depends on the design goals (Hevner et. al, 2004). Common literature included different criteria, such as security, usability, efficiency, correctness, reliability, maintainability, testable, flexible, comprehensible, reusable, portable, or interoperability (Venable et al., 2016). In this thesis, the Evaluation of the SerViU Personalize Tool was based on three criteria: relevance to the telehealth context, usefulness of the tool to make personalization decisions, and sufficiency of information that the tool provides to make personalization decisions. Data were collected in two formats: questionnaires and a three-point Likert scale. The participants were provided with an evaluation form that allowed for the provision of written feedback regarding the three criteria; participants also indicated their level of agreement with the questionnaire statements regarding each evaluation criterion (Likert scale). The evaluation feedback addressed the three criteria (relevance, usefulness, and sufficiency of information); for simplicity reasons, a 3-point scale was chosen which was supported with written feedback.

The relevance criterion refers to comparing the personalization decision with regular adjustments participants would have made in similar situations. The sufficiency of the contextual information detailed in the interactive spreadsheet also needed to be evaluated. The LPO provided information about the technology components of the TM systems (hardware and software), methods of operation, business-related information (e.g., brand and cost), and healthcare network constraints. Regarding usefulness, the case study participants evaluated the decision-making criteria and process, and they determined whether further adjustments were required and what those adjustments should be. The case study participants were asked whether more information was needed to make the personalization decision and in which direction.

Feedback from case study participants enabled interpretation of their numerical evaluation of SerViU. This revealed further understanding of the providers' perceptions of personalization, especially with regard to common personalization strategies for TM services across different modes (including technological improvements, brand selection, operational changes, or solutions resulting from constraints in the healthcare network). However, this evaluation was not expected to represent all care providers; instead, this helped pose questions for future research about how personalization affects providers' value propositions regarding telehealth services.

4.5. Threats to Validity

In DSRM, validation is a knowledge task by which the proposed design method is verified to determine whether it can bring stakeholders closer to their goals (Wieringa, 2009). To that end, the following threats were identified:

A threat to construct validity is the relevance of the case study results to the proposed artifact (i.e., the degree to which resultant information from the case study about patient experience with TM leads appropriately to improving the artifact). I attempted to address this threat by having key informants review and validate the case study documents (Yin, 1994, pp. 32-33).

However, there are other telemonitoring services, and developing more relevant scenarios could have improved the construct validity because different modes have different levels of complexity and patient involvement.

A threat to external validity concerns the limited ability to generalize this study to all TM modes and not just the conceptual framework developed in this study. Involving only one institution in the research is a limitation. On the one hand, this could have diversified the telemonitoring delivery mode further. On the other hand, this could have allowed recruiting a bigger sample of clinicians with more specialties. For example, involving three more hospitals and twelve more participants could have mitigated the external validity threats. This could have provided a broader view of the providers' priorities, specialties, and procurement preferences. What was attempted is limited to using a multiple case study approach that involved more than one TM delivery mode which shared the same context: TM services.

In terms of threat to internal validity, there was a potential bias of some participants regarding familiarity with specific TM modes and technologies. Addressing such a threat in this thesis was limited to having four participants simulate decision-making for each TM mode. A better solution could have been by diversifying the specialties, the hospital the work at, years of experience - and of course, the bigger the sample, the better. In addition to the three types of clinicians involved in this thesis, family doctors, community nurses, and trained family members could have also been included.

4.6. Ethical Considerations

The data collection of this research study complies with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2). Application requests were approved by the Research Ethics Board, the Office of Research Ethics at the Canadian hospital, and the Office of Research Ethics Integrity at the University of Ottawa (see Document A3.f, Appendix 3). The main risk for case study participants was that the study could become too time-consuming. This potential risk was mitigated by offering to divide 60 min sessions into shorter timeslots: for example, two sessions of 30 min each. Another potential risk was related to information security. Participant information was voice-recorded if the participants consented to this. To ensure that the recorded information was secure, the researcher transferred recorded audio files to RedCap, the secure online research platform provided by the Canadian hospital. Files on the digital recorder were destroyed as soon as a copy was placed on RedCap. A master list containing participant names and their corresponding participant number was also stored on RedCap. Anonymity was ensured so that any simulation session transcript or other electronic or printed document referring to participants was coded before being used; specifically, transcripts or other documents only referred to participants by number (e.g., Participant 1, 2, etc.).

The validated SerViU Personalize Tool could be beneficial to study participants or other knowledge users at the Canadian hospital to prioritize telehealth personalization options. Moreover, a short report outlining the case study results was offered to participants who expressed interest. The report provided a complete picture of the SerViU Personalize Tool's decision-making process and presented managerial insights related to healthcare resource planning and procurement management.

Chapter 5: SerViU Service Design Method

5.1. Introduction

This chapter presents SerViU, a tool-supported method for personalizing existing telehealth services. This method was developed to address long-term adherence factors better than existing service design methods while also drawing from two of the identified methods in the literature review chapter (Chapter 3): namely, Multilevel Service Design (MSD; (Patrício, Fisk, Falcão e Cunha, et al., 2011) and URN (Weiss & Amyot, 2005). MSD was chosen to address the complexity of the telehealth context. The complexity of the telehealth context is presented as multiple service systems where different stakeholders (service actors) and healthcare organizations interact by integrating resources, capabilities, and information to cocreate services (Tien & Goldschmidt-Clermont, 2009). MSD was adapted to an additional service level because personalizing the telehealth service implies involving patients' use of the service to develop unique experiences, assessing patients' experiences, and personalizing the service accordingly. Tools were developed to support SerViU at the different phases by using a goal-oriented requirement language (GRL) which is part of URN. The GRL modeling support provided the means for a granular understanding of the patient experience, needs, and expectations, and hence a better opportunity to personalize the telehealth service.

Conceptually, SerViU also draws from the value-in-use (Stephen L Vargo & Robert F Lusch, 2004) and ICT personalization (Fan & Poole, 2006) frameworks. The ViU framework allows SerViU to operate on the personal encounter service level by assessing the unique experiences of individual patients after they use the service. The ICT personalization framework allows SerViU to provide three types of personalization—architectural, relational, and functional ICT personalization—that address long-term adherence factors.

The remainder of this chapter is organized as follows: A conceptual understanding is presented in Section 5.2. Operational definitions are presented in Section 5.3 to provide the reader with an operational legend and explanations for some technical terms. In Section 5.4, SerViU, its phases, and tools are detailed. In the last section, Section 5.5, an illustrative application of SerViU is presented using a hypothetical scenario.

5.2. Conceptual Understanding

The perspective of service-dominant (S-D) logic enables the patient to participate in service creation by contributing with their knowledge, skills, and information; the S-D logic perspective considers information to be an operand resource and knowledge and skills to be operant resources (Stephen L. Vargo & Robert F. Lusch, 2004). The patient, therefore, becomes part of the telehealth service system where their resources are integrated with other resources to cocreate the service value.

The patient's information, knowledge, and skills need to be utilized and assessed. Thus, the concept of ViU was considered for the proposed method. ViU is a core concept of S-D logic which provides a means to account for individual patients' unique experiences while using telehealth services; the value results when a patient applies their operant resources (i.e., skills and knowledge), develops new operand resources (i.e., information about their abilities), and evaluates the service (Stephen L. Vargo & Robert F. Lusch, 2004). The patient could perceive the service as complicated, time-consuming, or not useful. Such an evaluation should be relayed to the provider to adjust the service accordingly (Dinesen et al., 2016). Moreover, the concept of ViU emphasizes that value is determined by the patient—the service beneficiary (Stephen L. Vargo & Robert F. Lusch, 2004).

Once a patient starts using the telehealth service, SerViU assesses information related to the patient's developed experience to personalize their telehealth services. Through an iterative process of Use–Assess–Personalize, SerViU supports an ongoing personalization of telehealth services for the duration of treatment. SerViU addresses the complexity of telehealth service contexts through a multilevel service system understanding. Configurations of people, information, technologies, and resources that exist at different service levels interact to cocreate value. SerViU utilizes MSD to articulate the contextual differences between standardized and personalized services (Patrício, Fisk, Falcão e Cunha, et al., 2011).

Figure 5.1

The Telemonitoring Service Context, Adapted from (Patrício, Fisk, Cunha, et al., 2011))

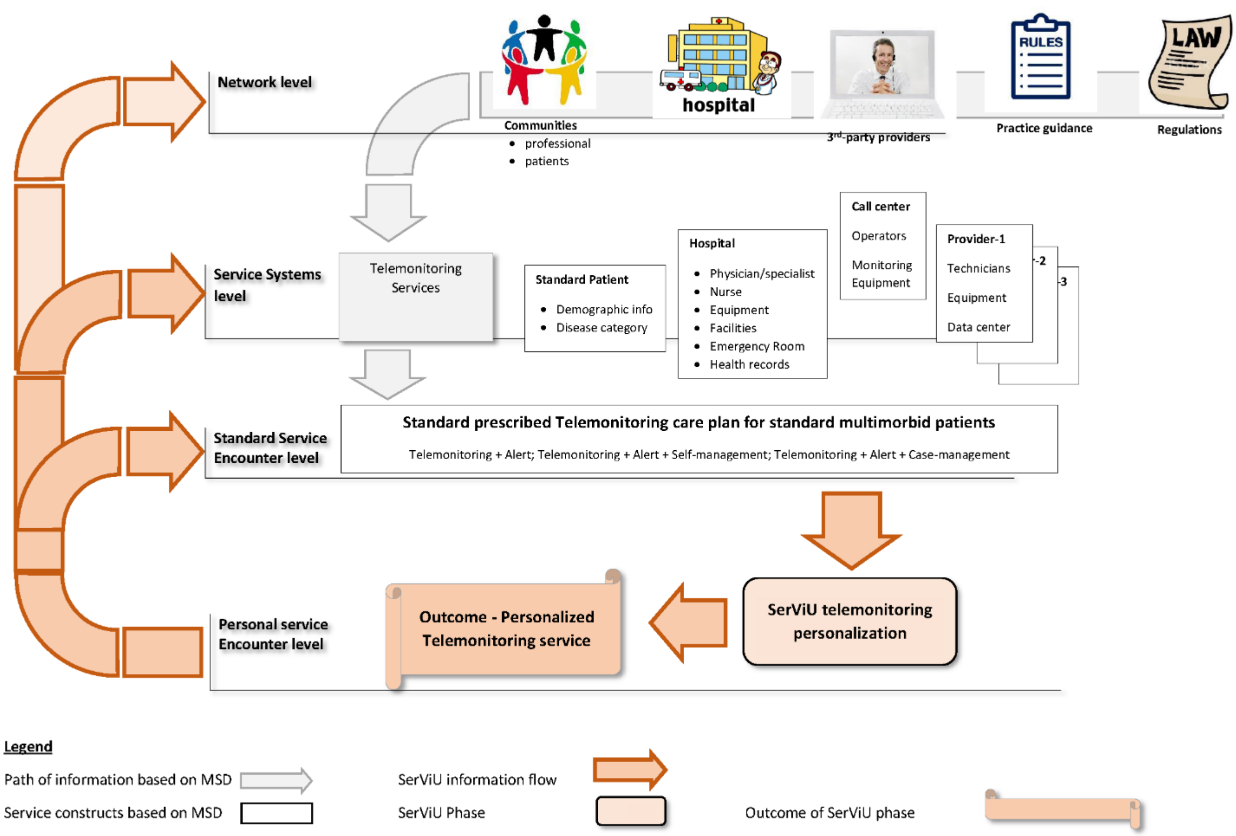


Figure 5.1 shows the telemonitoring (TM) service context from an MSD perspective. It also shows the new additional level where SerViU operates: the personal service encounter level. MSD helps to categorize the levels of service context: "network" includes institutions, third parties, and jurisdictions; "service systems" represents different TM services provided by an institution, such as home TM and telecare; and "encounter" represents standard TM services prescribed for a category of patients. SerViU introduces an additional new service level, the "personal service encounter level," thus differentiating from the "standard service encounter level." At the personal service encounter level, SerViU operates where individual patients use their telehealth service, apply their skills and abilities to implement their prescriptions, and develop personal experiences: the personal service encounter level is where telehealth services are personalized. The type of telehealth that is the focus of this thesis is TM services (see Figure 5.2).

Telehealth is an ICT-enabled service that facilitates collaborative value creation among service actors (Tuunanen et al., 2010) and focuses on interactions between technical, human, and organizational components (Bryl et al., 2009). Thus, this research adapts a personalization framework for ICT-enabled services (Fan & Poole, 2006). This framework helps articulate personalization in three dimensions: architectural, relational, and functional. As elaborated in Appendix 1, architectural personalization is about fulfilling a "human being's needs for expressing himself/herself through the design and build of an immersive, functional, and delightful environment that is compatible with a sense of personal style" (Fan & Poole, 2006). SerViU supports architectural ICT personalization through the ability to (re)allocate and (re)connect entities, goals, and resources with tasks and functions in a way that improves their experience with the telehealth service. For example, patients might need direct instructions from clinicians while taking medication. A videoconferencing feature supports this need, especially if patients experience symptoms that could influence their cognitive abilities.

Relational personalization is about fulfilling “a human being’s needs for socialization and a sense of belonging [by mediating between the service] social context and relational aspects of the user” (Fan & Poole, 2006). SerViU supports relational ICT personalization through the ability to mediate between the service context (i.e., care plan components, healthcare resources, etc.) and the patients’ needs, abilities, and preferences. For example, high severity levels of Chronic Obstructive Pulmonary Disease (COPD) limit patient mobility and their physical interactions. Relational ICT personalization for such a situation could consider the patient’s mental and physical limitations and suggest home-based treatment and in-person interaction with a nurse to supervise their medication taking. Assigning the needed resources would be an architectural support, such as nurse hours and home-based monitoring equipment.

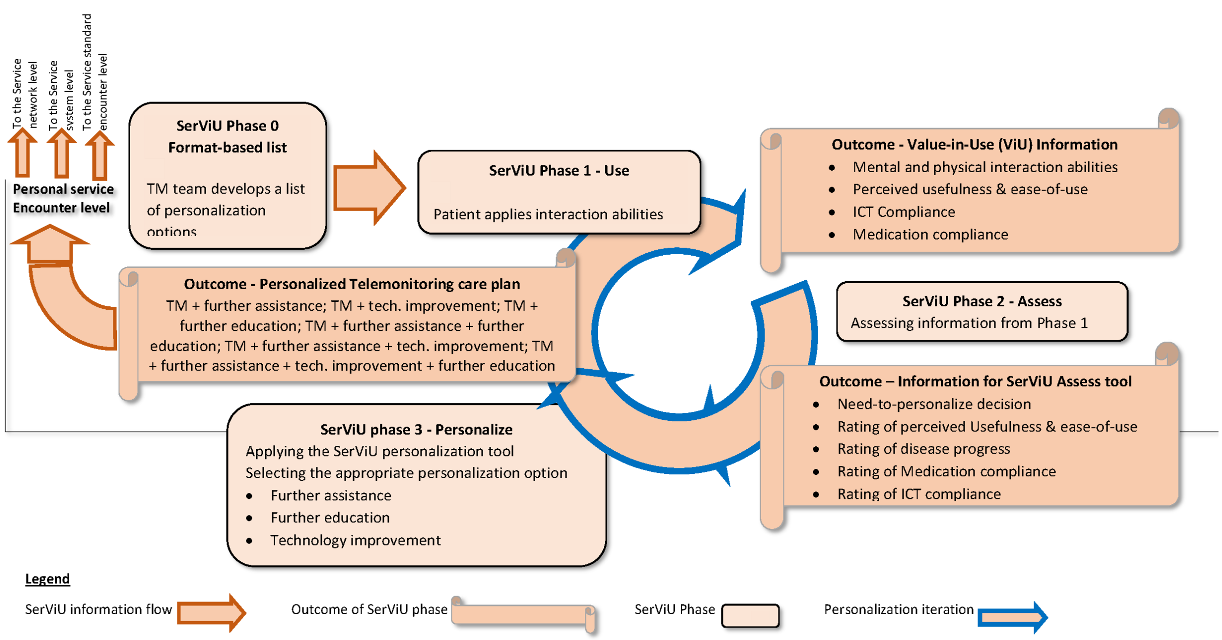
Functional personalization is about fulfilling the need to “to increase [the patient’s] efficiency and productivity of using the system” (Fan & Poole, 2006). SerViU supports functional ICT personalization through the ability to enhance patient interaction outcomes, such as decision support systems that help patients in their daily activities which improve the quality of patient answers (for further details, see Appendix 1).

TM services are a subset of telehealth services that enable healthcare systems (e.g., hospitals and clinicians) to remotely provide ICT-enabled health services, including chronic patient care, medication management, wound care, counseling, post-discharge follow-up, and mental health care; TM services are used to test SerViU in this thesis. TM services could also include video interactions for health education, physical activity, diet monitoring, and medication adherence (Hanlon et al., 2017; Tuckson et al., 2017).

As shown in Figure 5.1, an initially prescribed care plan (TM service) is personalized by SerViU through the offering of further assistance, education, and technology improvement (i.e., personalization options). The personalized service is the outcome of SerViU and can have the same formats (i.e., telemonitoring + alert, telemonitoring + alert + self-management, etc.; (NICE, 2016); however, it is tailored to individual patients in particular situations (at a particular treatment stage with specific patient abilities and preferences). Patients use the TM service and, in so doing, provide the information needed to personalize it. Personalization using SerViU is an ongoing process, and Phases 1, 2, and 3 are iterative throughout the treatment duration; Phase 0 is an initial prerequisite phase that the health care provider conducts only once prior to the patient’s engagement with the TM service.

Figure 5.2

SerViU Operating at the Personal Service Encounter Level



5.3. Operational Definitions

- Telemonitoring (TM). TM is a remote patient monitoring system involving the use of electronic devices and telecommunication technologies, such as monitoring devices, hand-held or wearable technologies, and intelligent sensors. TM is used for the digital transmission of disease-related data (informational resource) from the patient's home to healthcare centers or data stores (Stowe & Harding, 2010).
- The TM service system. "TM service system" as a term is only needed to explain SerViU's service system meta model; hence, it is used with terms such as actors and activities relevant to this definition and the proposed SerViU method. The TM service systems generic model is derived from (Lessard et al., 2020).
- TM services. TM services comprise the care plan components (e.g., medication prescription), technological components (e.g., tablets), and other healthcare resources (e.g., clinician hours). Classic TM services are standard formats that are initially prescribed by physicians. According to (NICE, 2016), TM formats vary in terms of operation, delivery, and the level of delegation to the patient, and are also called "encounter" formats: i.e., 1) telemonitoring + alert; 2) telemonitoring + alert + self-management; and 3) telemonitoring + alert + case management. These formats are used, in this thesis, as TM scenarios that need to be personalized based on the patient's situation.
- Personalized TM service. This term refers to the outcome of SerViU and has the same encounter formats; however, it is personalized for individual patients. Personalization of TM services is achieved by offering further assistance or further education to patients in their interactions with the TM, in addition to technological improvement. These are

called “personalization options,” and an appropriate one is selected based on SerViU guidance.

- Personalization options. Personalization options are different TM services, i.e., a collection of components, activities, and resources that are offered by the SerViU Personalize Tool to the clinician to choose from. SerViU provides three types of personalization options—further assistance, further education, and technology improvement—according to which the clinician makes a detailed decision about the technologies and operational methods.
- Provider. The provider is a healthcare organization, such as a hospital or a clinic, that provides TM services. The provider could also provide relevant resources, such as equipment and personnel (i.e., technology specialists, operators, physicians, nurses, and other clinicians).
- List of Personalization Options (LPO). The LPO is a catalog-like set of information prepared by the provider, prior to the involvement of patients. The LPO includes technological, clinical, brand, and jurisdictional information for each TM component. The LPO becomes the part of the SerViU Personalize Tool that provides options to the clinician to choose from. SerViU provides a form-like tool to be filled in by providers which includes different information categories available to the TM nurse.
- TM nurse: A TM nurse is a nurse practitioner who is trained to use the TM technology and orchestrate relevant TM service activities for many patients.
- TM team. This term refers to the healthcare provider’s personnel and comprises clinicians, operators, maintenance staff, and administrators. The TM team prepares the LPO and assists the TM nurse in different tasks, such as operating TM equipment.

SerViU suggests including a service design specialist on the TM team to participate in the development of the personalized service.

- TM scenario. This term refers to the description of a sequence of events that takes place while applying TM services, such as a patient's compliance and interaction with the TM system and clinicians. TM scenarios occur during SerViU phases where individual patients use the system, are assessed by the TM nurse, and receive a personalized service.

5.4. SerViU: Phases and Tools

SerViU is composed of four phases: Phase 0 to Phase 3. The first phase, Phase 0, is conducted only once; however, other phases of SerViU are iterative for the duration of the service in a Use–Assess–Personalize process. SerViU is a tool-based method: Phases 0, 2, and 3 are equipped with tools that facilitate their purposes.

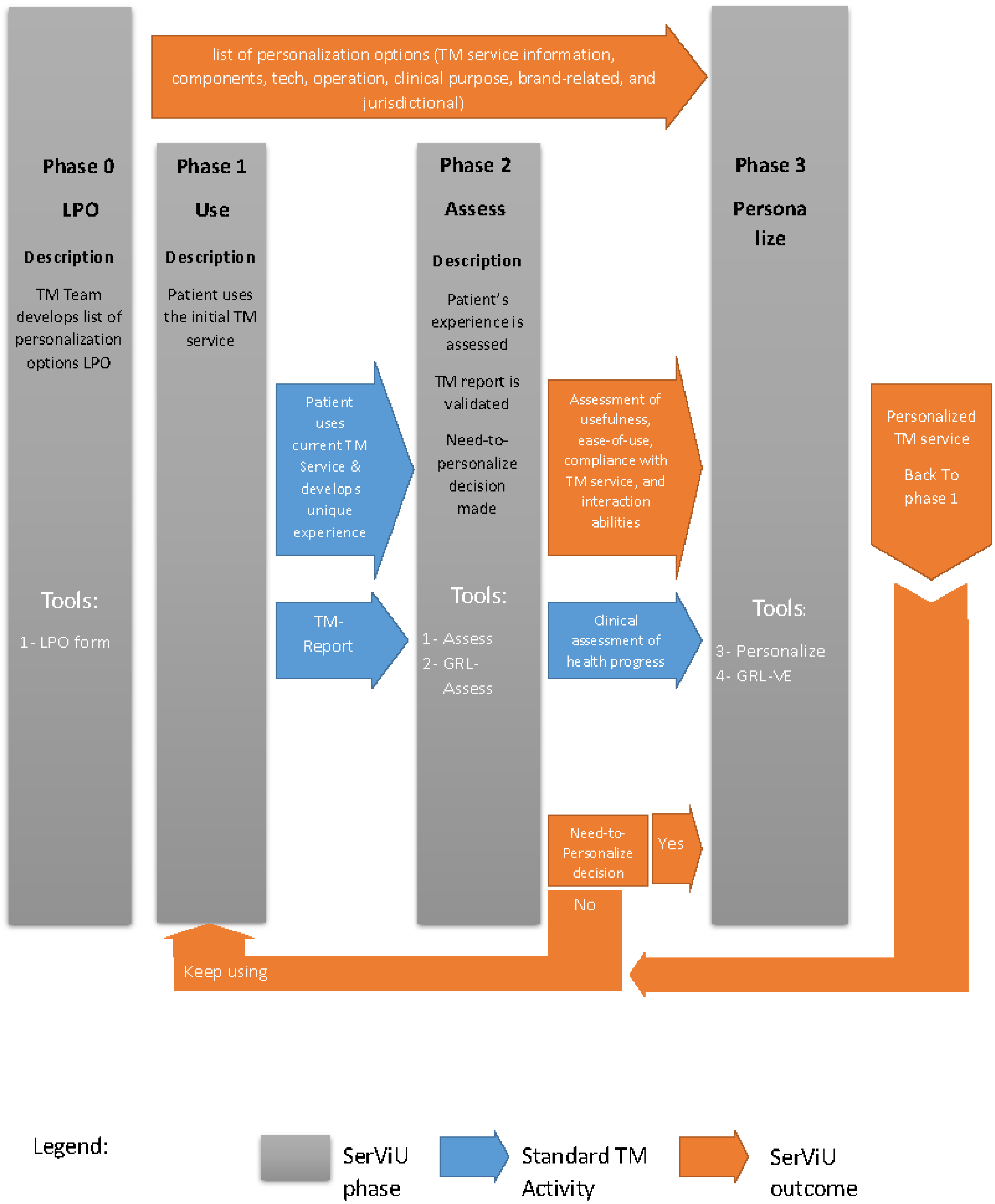
Figure 5.3 shows that SerViU's activities can take place concurrently with standard TM services and make use of information from the SerViU phases. Information needed throughout the SerViU phases is generated from 1) the standard TM service which is initially prescribed by a specialized physician and 2) SerViU phase outcomes. An overview of each phase and its supporting tools is presented here and explained in more detail in Sections 5.4.1 to 5.4.5.

- Phase 0: Creation of the LPO tool. In this phase, an LPO tool is created by the TM team, guided by SerViU. The LPO tool should include details about the technology components, operating methods, brands-related information, and specific legal/jurisdictional constraints. See the LPO Form in Appendix 8.

Phase 1: Use. Phase 1 refers to the process of using the TM service by patients. During this phase, patients utilize measurement equipment and communicate via the TM system with their TM nurse while taking their prescribed medication. During this phase, patients develop their unique experiences of the service, learn more about their ability to understand, and become familiar with the instructions and technical terms. By the end of this phase, the patients should have developed an evaluation about the usefulness and ease-of-use of the TM service.

Figure 5.3

Information Flow between the Standard TM Activities and SerViU Method Phases



- Phase 2: Assess. Phase 2 refers to the process of evaluating patients' experiences with their TM services. In this phase, a decision is made whether to personalize the patient's TM service or to return them back to Phase 1 (Use) where they would keep using the TM service as it is until the next assessment. The need-to-personalize decision is clinical. SerViU provides tools to record and calculate the assessment which supports the decision and directs the TM nurse to potential areas of focus. To this end, two tools are introduced in this phase: the SerViU Assess Tool and the SerViU GRL Tool. The assessment frequency is up to providers based on their specialties and policies.
- Phase 3: Personalize. Phase 3 refers to the decision-making process of selecting a personalization option tailored to each patient to address a particular situation (i.e., disease condition severity, interaction abilities, and preferences).

In Phase 1, patients use the TM service (e.g., they use equipment to take measurements, report results, ask for explanations, or answer a daily wellbeing questionnaire), and they develop a perception about their experiences using the TM service. In Phase 2, the patient's experience is assessed in terms of the TM service's perceived ease-of-use and usefulness. The assessment in Phase 2 also includes health progress, compliance with the TM service instruction, and the patient's ability to interact with the TM service, both mentally and physically. Using tools specifically designed for this evaluation, a need-for-personalization decision can be made. Alternatively, the patient will be returned to Phase 1 to keep using the current version of the TM service (see Figure 5.3).

5.4.1. Phase 0: LPO

In SerViU, TM personalization requires information about individual patients, including their unique experiences interacting with the technology and how they use these services within the telehealth context (Glushko & Nomorosa, 2012; Ranjan & Read, 2016). SerViU helps collect such information iteratively, in multiple phases. However, a prerequisite set of information needs to be prepared prior to engaging with patients in order to identify the telehealth technologies available to TM teams for personalization purposes. This phase is not iterative because it only needs to be prepared once, unless the provider chooses to update it. SerViU provides a form tool by which the TM team is guided in the creation of the LPO (see Figure 5.5; an empty sample form can be found in Appendix 8).

The TM nurse uses the LPO during Phase 3 to choose the most appropriate personalization option for particular patients in a particular situation. The LPO should contain sufficient information for the TM nurse to have alternatives available for minor and major adjustments to the service. This list supports the TM nurse's decision-making by providing information about clinical purpose, availability of a component in a certain healthcare network, and potential legal constraints (Brown & Bussell, 2011). Moreover, the LPO should be developed in a manner that makes it easy to use by the TM nurse, such as using an interface and terminology familiar to the user. The LPO should contain technical, operational (e.g., patient, clinician, or technician users), business (e.g., brand and cost), and jurisdictional (e.g., legal constraints of local privacy regulations) information that helps decision-makers differentiate between list items based on situational priorities. Guidelines with an example are provided in Appendix 8.

Figure 5.4

Screenshot of the List of Personalization Options (LPO)

Telemonitoring system			Clinical			Operational						Business				Jurisdictions	
Brand	Model	Component	disease	severity	test	Setup	Communication method	Data transfer	connectivity	Power	Personnel	supplier	Price	Insuror	3rd party	Health Network	specific regulation
Honywell	Genesis DM	Touchscreen and breathometer	CHF	level 1,2	Breath Rate	Home-based	scheduled phone calles	Real-time	wireless	Power cord for the main component and chargeable battry for the breathometer	Trained Nurse with TM certification					Ontario	PIPTA - Act, 2004, S.O. 2004, c. 3, Sched. A
		hard and soft copy educational materials					email messages										
							Video confernence				Nurse visits		monthly payments		communi ty nurse	local	contractual relationship & privacy-related issues

The upper part of Figure 5.4 (left side of LPO) shows technical, clinical, and operational information, while the lower part of Figure 5.4 (right side of LPO) shows business- and healthcare-related information. The LPO form becomes part of the SerViU Personalize Tool where each personalization option is evaluated to support the TM nurse's decision.

5.4.2. Phase 1: Use

In SerViU, individual patients start to utilize the TM service in their care plans and develop knowledge about it as a means of assessment. The Use phase aims to record patients' use-related data, including their interactions with the TM service. This comprises operating TM technologies (e.g., performing physical tests while wearing a blood pressure monitor and then transferring results to the hospital data center) and answering a daily questionnaire about their wellbeing, sleep condition, cough severity, and technical concerns. The TM service records this information in addition to other types of patient data, such as compliance with medication and operation-related information (e.g., logins, entry, and connection errors). This set of information is transferred to data centers and then automatically arranged as a daily report available to the TM nurse as a TM report (Dinesen et al., 2016; Haynes et al., 2002).

In the Use phase, patients use the initially prescribed TM care plans (e.g., performing a physical exercise while being monitored by a pulse meter or measuring their breath rate before and after exercise using a breathometer). The outcome of this phase includes a daily report generated by the TM system (TM report) and knowledge that is developed by the patient about using the TM service. Based on this knowledge, patients become more able to discuss their experience and expectations with their TM nurse in the following phase (Assess).

5.4.3. Phase 2: Assess

This phase aims to assess patients' experiences with the TM service and enables a decision to be made about whether there is a need to personalize the current TM service. The SerViU Assess phase is intended to support the TM nurse's clinical decision rather than replace it. During this phase, patients inform their TM nurse about their perceptions of the service; the TM nurse verifies information received through the TM report with the patient, conducts an interaction abilities assessment, and records results using the SerViU Assess Tool. The SerViU Assess Tool helps to assess the Use phase's outcomes and triggers a Need-to-Personalize decision. The Need-to-Personalize decision is calculated using the SerViU Assess Tool, as detailed in Section 5.4.4.

This phase is supported by a second tool, the SerViU GRL Tool. The SerViU GRL Tool helps to determine the influence on each other of assessment components which contribute to the need-to-personalize decision, and the extent of their influence. The SerViU GRL Tool has the capability to measure the goal achievement of each of the service actors. The GRL Tool is optional, depending on whether the healthcare provider has a modelling specialist among their IT or TM team.

Patients provide the needed information regarding usefulness and ease-of-use through face-to-face assessment sessions (whether virtual or in-person) with the TM nurse.

5.4.4. SerViU Assess Tool

The SerViU Assess Tool supports the TM nurse in assessing the adequacy of a patient's current TM service. This is achieved through use of a set of input information based on existing telehealth literature, such as (Dinesen et al., 2016; Hommel et al., 2015; Jensen et al., 2012), although the existing literature does not provide a basis for proportionate or quantifiable relationships between the sections of this set of information.

The set of information in the SerViU Assess Tool consists of five subsections, each with measurement criteria and a score: perceived usefulness, ease-of-use, patient's compliance, wellbeing (disease progress), and interaction ability evaluation. There is no unified method to measure each item.

Perceived usefulness and perceived ease-of-use could be addressed via a Likert five-point scale (shown next section), and the remaining sections have different measurement approaches. The disease condition can be measured by severity level, such as A to D or very severe, severe, and moderate (Ambrosino et al., 2016; Bailey, 2004; Mohktar et al., 2015). Regarding interaction abilities, no telehealth-specific assessment method was found in existing literature for patients' mental and physical interaction abilities. There were, however, standard assessment methods that are deemed superset to telehealth, such as the mini-mental state examination and the Rey Auditory Verbal Learning Test for mental abilities, and the ten step test and short physical performance battery for physical interaction abilities (Won et al., 2014). Such assessment methods are generic (i.e., superset to the telehealth context) and valued using scores that indicate the level of the patient's abilities. Patient's compliance is measured by standard methods, such as the Medical Adherence Rating Scale (MARS; (Thompson et al., 2000) and the Morisky Medication Adherence Score (Cross et al., 2012).

Because the SerViU Assess Tool is not used for statistical purposes or population representation, its measurement scales were unified into a five-point scale (i.e., a Likert scale). This decision helped to simplify the tool for the clinicians and resulted in the same value being entered into the SerViU GRL Tool as key performance indicators (KPIs). In the existing literature, both five- and ten-point scales have been previously used in the healthcare sector, with a preference for five-point scales for simplicity (Norman, 2010; Viitanen et al., 2011).

The scores are recorded in the SerViU Assess Tool in integer format (i.e., no fractions). Moreover, each information section (e.g., interaction abilities), should have a threshold at which the need-to-personalize decision is triggered. The value of 2 out of 5 was chosen for this purpose. Therefore, any information section that scores a value equal to or less than 2 out of 5 will trigger the need-to-personalize decision. SerViU assumes equal importance of information sections (i.e., perceived usefulness, perceived ease-of-use, compliance, wellbeing, and interaction abilities each comprise 20% of the total) because no quantifiable relationships were identified in the reviewed literature or local practices.

The final score in the SerViU Assess Tool should not be less than a threshold of 50%; each information section contributes to this score based on its weight (i.e., 20% * 5 = 100%). The thresholds at the section and total levels trigger the need-to-personalize decision. The subsections contribute equally to the total section score and help to trigger the need-to-personalize decision if the main section does not pass the threshold (e.g., scoring equal or less to 2/5 on the Likert scale).

The set of information in the SerViU Assess Tool consists of five sections which are considered to be equally important:

- Perceived Usefulness. The usefulness subsection consists of safety, privacy, accessibility of clinicians, and self-dependance (Dinesen et al., 2016).
- Perceived Ease-of-Use. The ease-of-use subsection consists of technology literacy, vision (character recognition), language familiarity, and complexity of instruction (Dinesen et al., 2016).
- Health Progress. This is clinical information related to the current severity level of the patients' disease condition, but represented with a high–mid–low rating—a general evaluation that applies to different morbidity conditions which use 1 to 4 and A to D levels (Ambrosino et al., 2016; Bailey, 2004; Mohktar et al., 2015). The purpose of this subsection is to follow up on the progress of the patient's health, such as to record changes in the severity level of a chronic condition. The lower the score, the better the disease condition. A Level 2 disease severity differs from Level 4 in terms of the patient's abilities to interact with the TM service and self-dependence; clinicians may decide that the patient is now allowed to become mobile and go outdoors.

- Compliance with TM service. This section consists of two subsections: ICT compliance, and medication compliance. Both are measured using a 5-point Likert scale.
    - ICT Compliance: This subsection comprises information about patients' behavior with ICT technology (e.g., logins and entry errors) which is obtained from the TM report and validated by the patient during the assessment session with the TM nurse. ICT-related compliance includes communication and operation activities through the TM service. Telehealth technologies store behavioral information, such as times of recorded logins, incorrect answers to TM-generated daily questionnaires, and entry errors (Dinesen et al., 2016; Haynes et al., 2002). Patients might find it difficult to access information or comply with daily requirements, and they may prefer face-to-face communication over virtual. For example, the TM nurse verifies repetitive entry errors and less-than-instructed logins with the patient to assess their situation. The TM nurse can use other sections in the SerViU Assess Tool to determine the cause of lack of compliance in order to address it. In such cases, the SerViU GRL Tool can help to trace back the relationships between different information sections and determine how each section contributes to goal achievement.
    - Medication Compliance: This subsection refers to the patient's compliance with prescribed medications and tests using the TM service. Clinical information is captured by the TM nurse and measured in different ways, depending on TM suppliers, such as the MARS (Thompson et al., 2000) or the percentage of doses taken by patients compared with their prescriptions (Hommel et al., 2013).

- Interaction Abilities: This subsection is about assessing patients' mental and physical abilities to interact with the TM service. SerViU differentiates between mental (cognitive) abilities and physical abilities. In the literature, mental and physical abilities implicitly affect each other, especially in the case of elderly people (Won et al., 2014).
    - Mental abilities consist of technology literacy (the ability to perform test activities, such as measuring breath rates and blood pressure), communication (language familiarity, complexity of instruction, and service), and visual ability (recognizing characters and buttons; (Dinesen et al., 2016).
    - Physical abilities consist of the ability to move, reach, lift, and mobilize the TM device; the ability to attach devices to the body, press buttons, and connect parts; and the ability to perform physical exercises (Dinesen et al., 2016).

The Need-to-Personalize decision is the main outcome of the Assess phase and determines whether the current TM service needs to be personalized. This decision causes Phase 3 to be initiated. Alternatively, patients are redirected to Phase 1 to use the same TM service. This decision is triggered by a low score in any information section (e.g., perceived ease-of-use < 10%) or in the final result (i.e., final score < 50%).

Subsections have equal shares within their sections, such as ICT and medical compliance; each makes up 50% of the Compliance to TM service section, and each has 12.5% of the total score. The SerViU Assess Tool provides a means to address specific or general causes of lack of adherence at different levels, such as its safety subsection and perceived usefulness section. Moreover, this tool provides a means to identify multiple causes, such as safety, visibility limitations, and ICT compliance (each belongs to a different information section). Each of these subsections has a threshold value that helps to alert that attention is needed and that, hence, there is a need to personalize (see Table 5.1). Moreover, the tool allows the providers to determine the weights of each section based on their context (i.e., disease combinations, practice, and jurisdictional constraints).

Table 5.1

SerViU Assess Tool

Information Section	Information Subsection	Measurement	Score	Threshold of Need-to-Personalize Decision	Importance to the Main Section	Importance of Sections to the Need-to-Personalize Decision
Perceived Usefulness				10%		20%
		Safety	5-point Likert scale	2 out of 5	25%	
		Privacy	5-point Likert scale	2 out of 5	25%	
		Self-dependence	5-point Likert scale	2 out of 5	25%	
		Accessibility to clinicians	5-point Likert scale	2 out of 5	25%	
Perceived Ease-of-Use				10%		20%
		Technology literacy	5-point Likert scale	2 out of 5	25%	
		Vision and recognition	5-point Likert scale	2 out of 5	25%	
		Language familiarity	5-point Likert scale	2 out of 5	25%	
		Complexity of instructions	5-point Likert scale	2 out of 5	25%	
Health Progress		Severity level of the disease condition	1–3 (Low–mid–high)	Change of score	Importance to the Need-to-personalize decision →	20%
Adherence to TM service				10%		20%
	Medication Compliance		5-point Likert scale		50%	
	ICT Compliance		5-point Likert scale		50%	

Information Section	Information Subsection	Measurement	Score	Threshold of Need-to-Personalize Decision	Importance to the Main Section	Importance of Sections to the Need-to-Personalize Decision
Interaction Abilities				10%		20%
	Mental Interaction Abilities		5-point Likert scale	2 out of 5	50%	
		Technology literacy	5-point Likert scale	2 out of 5	12.5%	
		Vision and recognition	5-point Likert scale	2 out of 5	12.5%	
		Language familiarity	5-point Likert scale	2 out of 5	12.5%	
		Complexity of instructions	5-point Likert scale	2 out of 5	12.5%	
	Physical Interaction Abilities				50%	
		Move, reach, lift, and mobilize	5-point Likert scale	2 out of 5	16.7%	
		Attach devices, press buttons, and connect parts	5-point Likert scale	2 out of 5	16.7%	
		Perform physical exercises	5-point Likert scale	2 out of 5	16.7%	
Need-to-Personalize Decision				50%		100%

5.4.5. SerViU GRL Assess Tool

This is a GRL-based tool that helps obtain a granular understanding of the factors impacting the need-to-personalize decision. The five information sections that constitute the SerViU Assess Tool (i.e., perceived usefulness, perceived ease-of-use, interaction abilities, health progress, and compliance with the TM service) are represented as goals and soft goals. The relationships between the goals and soft goals with service actors are derived from a generic TM service system lightweight GRL model, as described below.

The lightweight GRL model for TM services is based on the view of the service context as service systems that cocreate service by integrating resources belonging to different stakeholders (actors), including the patient. To implement concepts that belong to S-D logic, such as value proposition (VP) and value expectation (VE), the TM service system is represented as a lightweight GRL profile based on (Lessard et al., 2020). The GRL profile is supported by jUCMNav, a specialized tool that helps to develop and analyze goal models (Amyot et al., 2012). GRL provides intentional elements (goals, soft goals, tasks, resources, and indicators), propagates the contribution of intentional elements to each other, and allows qualitative and quantitative measurement of goal achievement (International_Telecommunication_Union, 2012). The SerViU GRL Assess Tool is a specialized tool that requires conceptual modeling expertise not typically found in a TM team, but that may be available in a health care provider's information technology department (Akhigbe et al., 2021). This model will become the basis for developing more GRL models as tools to progress personalizing TM services. Representing the value expectations of service actors will guide goal achievement and its measurement via KPIs.

A generic representation of existing standard TM service systems is modeled using GRL in Figure 5.5 and shows the service actors and their intentional elements (a goal, soft goals, and tasks). Each intentional element is linked to other intentional elements that belong to other actors. Service systems entities that are represented in the lightweight GRL model are the hospital, TM nurse, patient, as well as the TM service. Each service system has its own configuration of goals, tasks, and resources that interact and contribute to cocreate TM services.

Figure 5.5

Generic GRL Model of a Service System, Adapted from (Lessard et al., 2019)

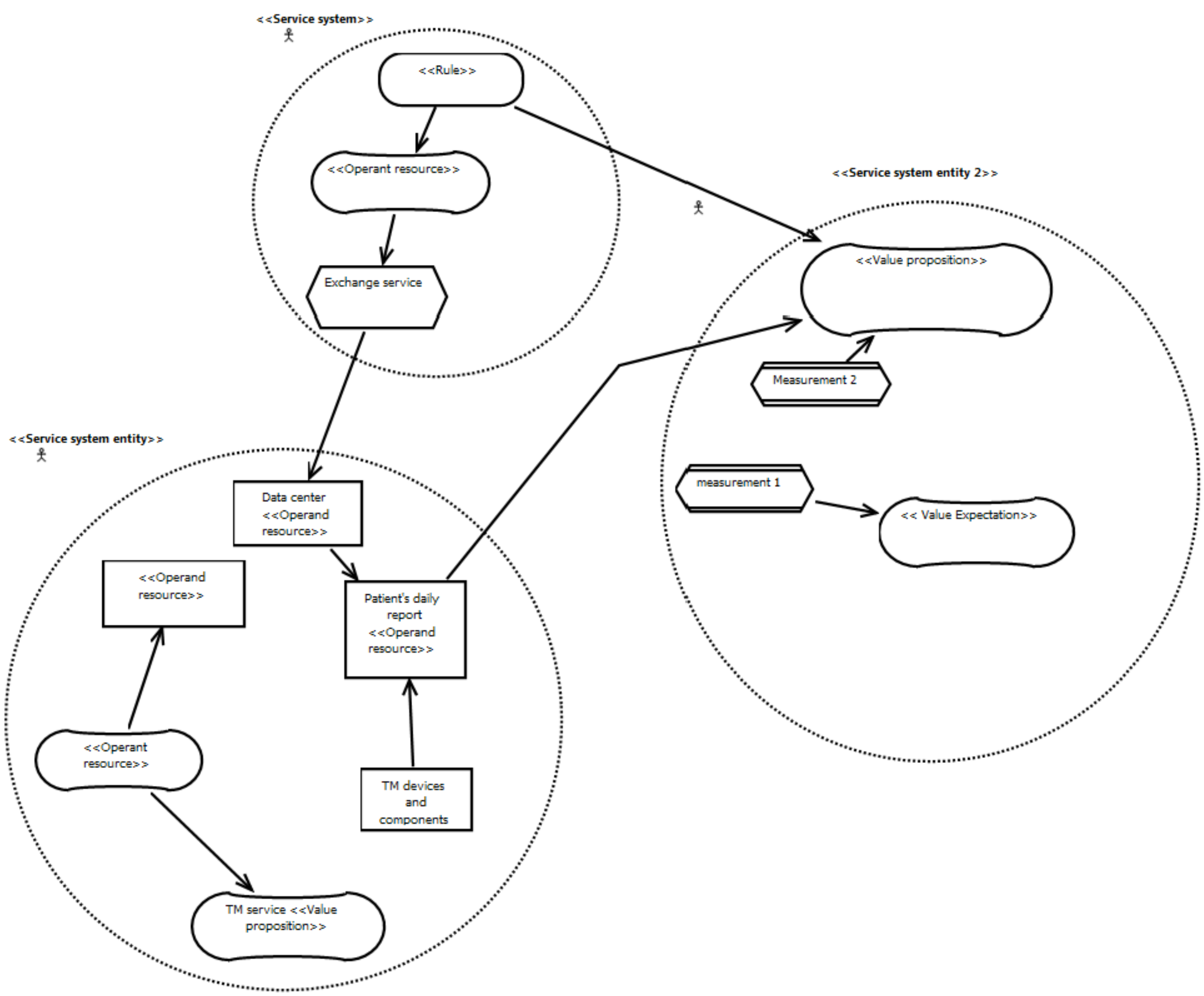


Figure 5.5 shows the way VEs and VPs are represented and connected within the service systems context: as GRL soft goals. GRL tasks are services that are exchanged between different

service system entities. Operand resources are represented as GRL resources; operant resources, such as skills, are represented as GRL soft goals. For example, the assessment process depends on the patient's use, interaction, and evaluation (tasks) of the TM service, though such tasks depend on mental and physical interaction abilities (operant resources). The personalization of the TM service depends on the patient's optimal use of the TM service. Both operant resources are deemed to be value propositions that belong to different actors: the hospital and the patient.

In SerViU, the TM nurse is a central service system entity—a GRL actor who aims to apply the service by utilizing clinical skills as a means to 1) assess the patients' situation, 2) decide whether personalization is needed in the TM service, and 3) select the appropriate TM personalization option. The hospital service system entity aims to provide personalized services as a value proposition. For this purpose, it provides the needed resources, both operant and operand.

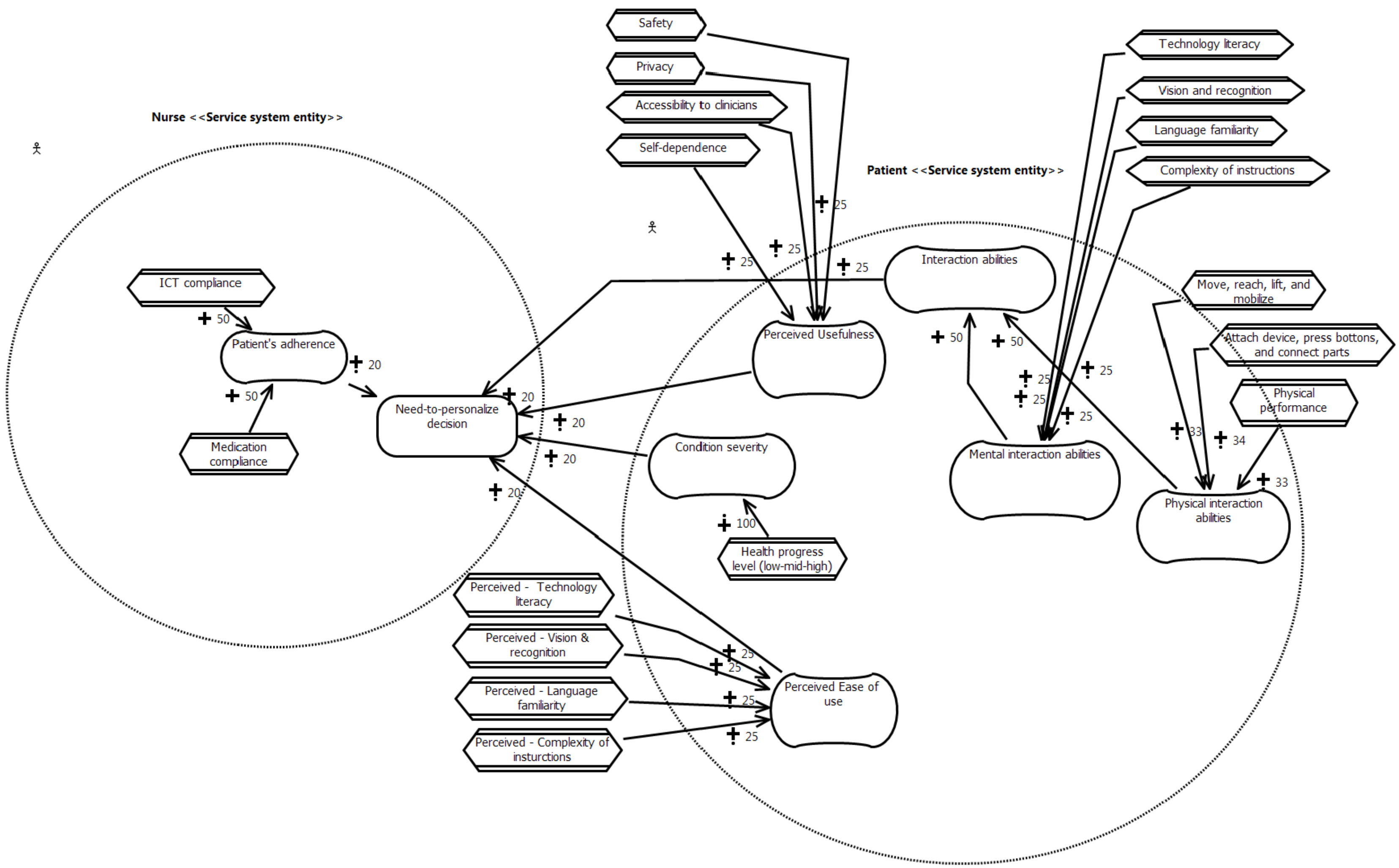
The patient service system entity also provides resources, has VEs, and exchanges services with other entities as a means to participate in the cocreation of the personalized TM service. The patient's task is to use the TM service (i.e., take medication, measure vital signs, answer a daily wellbeing questionnaire, perform physical activities, or attend virtual sessions).

The patient's VP is an interaction with the TM service. The patient's VEs comprise 1) the usefulness of the service in terms of how helpful it is as a replacement of the same healthcare service provided in-person and 2) the ease of using the TM service, including the ease of use of technologies and ease of access to healthcare resources. The VP of the TM nurse is the monitoring and assessment of the patient's health progress. The TM nurse's VE is the patient's adherence and the hospital's VP is a TM service.

In the SerViU GRL Assess Tool, the achievement of each goal (i.e., information section) is measured by means of a GRL KPI that represents a subsection of the SerViU Assess Tool. The jUCMNav tool facilitates the development of evaluation strategies by which the KPIs are given values. Accordingly, each KPI has a value between 1 and 5 with a threshold value of 2 (similar to the Likert scale values belonging to the SerViU Assess Tool). This is a manual and iterative process that should be performed after every assessment session. Figure 5.6 shows two actors represented in this GRL model: the patient and the TM nurse. The KPI values contribute to their relevant goals and soft goals which contribute to the need-to-personalize decision. This propagation helps the TM team to identify subsections that have no risks per se, but collaboratively could represent a considerable influence on the Need-to-Personalize decision. In Figure 5.10, the SerViU GRL Assess Tool presents a hypothetical case where the patient had a severe disease condition and the medication affected interaction abilities and their perception of the service value. The TM service was personalized to accommodate her specific situation.

Figure 5.6

SerViU GRL Assess Tool



5.4.6. *Phase 3: Personalize*

The Personalize phase is the process of adjusting TM services to fit a particular patient at a certain situation (i.e., level of disease severity, interaction abilities, and personal preferences). The Personalize phase is conducted by the TM nurse who will select TM service components, activities, and operation methods that could better meet the patient's VE (i.e., perceived usefulness and perceived ease of use) than the initial TM service.

The starting point of the Personalize phase is the need-to-personalize decision made in the previous phase (Phase 2: Assess). The areas of attention that were identified in the Assess phase (Phase 2) will be the focus of the Personalize phase (Phase 3), including sections such as mental interaction abilities and subsections such as safety issues.

SerViU guides the user through three types of personalization options: 1) further assistance for patients who cannot perform the service tasks or need more resources to perform the service task; 2) further education for patients who need coaching, training, or educational materials, and 3) technology improvements for patients who need a simple modification to their TM systems, such as software or hardware setups. The TM nurse can choose one or a combination of these types. Based on the selected types of personalization options, the TM nurse can move forward to a detailed selection of TM components, including operation methods, communication methods, and connectivity technologies.

The result is a TM service that represents the best fit for a particular patient experiencing a particular situation. The personalization process is iterative; options and components could change depending on new results from the Assess phase.

To guide the TM nurse throughout the Personalize phase, SerViU provides specialized tools. The SerViU Personalize Tool is the main tool in this phase; it encapsulates the LPO created in Phase 0 and provides a user-friendly interface that connects the personalization option types to the relevant TM components. Moreover, this tool calculates scores for different personalization options, prioritizing them from the best to the worst fit (higher to lower scores). Choosing the most appropriate personalization option, however, is the nurse's choice because the choice could entail clinical reasons and professional responsibility, but the SerViU Personalize Tool assists the TM nurse in making such a decision. SerViU provides another tool, the SerViU GRL VE; this is a GRL model by which the TM team can understand how close the personalization decision is to the patient's VE. This tool justifies the selection of a personalization option that scores less than another if it can be deemed to be closer to the patient's VE.

5.4.7. Types of Personalization

A personalization option is a modification that the TM nurse chooses to make to an existing TM service and can include TM components, device size and setup, connectivity, operation methods, and healthcare network. There are three types of personalization options: i.e., further assistance, further education, and technology improvement. These personalization types are based on the telehealth encounter formats for multimorbid patients designated by the National Institution for Health and Care Excellence (NICE, 2016) and patient-centered interventions for adults with multimorbidity (Boyd et al., 2012)

Selecting the type(s) of personalization options is the first step—a high-level decision that is followed by a detailed decision to determine the resources and setup necessary to implement that type of personalization, such as touchscreens and videoconferencing features, whether operation will be by patients or their clinicians, and whether the devices are mobile or home-based. All TM components listed in the LPO will become part of the personalization main tool, the SerViU Personalize Tool.

The further education personalization option is a modification to the TM service that aims to provide methods and activities for the patient to learn. The education could be technical (i.e., related to using the technology) or it could also pertain the medication process or its side effects. In severe cases, the patient could need to be reminded by the nurse when to take their medication. Further education to coach the patient could be provided as face-to-face hours with the TM nurse (virtual or in-person), or the patient could access online educational materials or paperback manuals (Cross et al., 2012).

The further assistance personalization option is a modification to the TM service that aims to provide the patient with additional resources (replacement of existing resources or add-on features) that enable better interaction with the TM service and better compliance with instructions, or provide convenience and familiarity for the patient to adhere to the TM service. For example, some patients prefer visual interactions and others have privacy issues and avoid visual contact. Moreover, the TM nurse may discover a clinical or physical reason why a patient is unable to interact with the TM service (e.g., dizziness). Clinician hours (also called tele-assistance) with the patient could help improve the patient's compliance, satisfaction, and interaction with the TM service (Bertini et al., 2015). Resource availability and feasibility, such as connectivity options, could affect the clinician's decision. In this case, the clinician could choose different options from various means of staying in touch with the patient, such as home visits, video counseling, online live medication monitoring, SMS, emails, or phone calls. (Cusack et al., 2008; Hirani et al., 2017). To this end, SerViU provides many options for the clinician to choose from in order to facilitate an option that the clinician finds appropriate for the situation.

The technology improvement personalization option involves upgrading, resetting, or integrating software or hardware features that can help improve the patient's interaction abilities, such as a videoconferencing software application and SmartWare that automatically generates daily questionnaires based on the patient's feedback. It can also include features that capture and transfer the patient's biodata while they are asleep or increase the speed of biodata capture to reduce the time spent by the patient using the TM service. Technology improvement examples available in the LPO can include, but are not limited to, the following:

- personal health and wellbeing sensors (e.g., bed/chair occupancy sensors, enuresis sensor, epilepsy sensor, fall detector, medication dispenser);
- sensory impairment aids (e.g., big button telephone, wearable vibrating alert), safety and security aids (e.g., bogus caller button, key safe), and environmental monitoring sensors (e.g., carbon monoxide detector, heat sensor, flood detector; (Bower et al., 2011);
- a color-coded light-altering system, such as one that uses red, amber, or green light, based on relevant NICE guidelines or as specified by clinicians (Bower et al., 2011); and
- automation, such as clinical decision support systems and data capture (Boyd et al., 2012).

5.4.8. SerViU Personalize Tool

This is an interactive spreadsheet tool that aims to facilitate the personalization decision-making of existing TM services. The LPO is embedded within this tool and displayed for users on a user-friendly interface. The typical user of this tool is the TM nurse who will choose TM service components from the LPO using the decision-making criteria provided by this tool; the

TM nurse could choose more than one personalized TM service (see Figure 5.7). After the TM nurse has made their choices based on the results of Phase 2, a prioritized LPO is displayed (see Table 5.4 for an example of a populated instance of the tool). A usable open-source version of the tool is available at https://doi.org/10.5281/zenodo.5808024.

The SerViU Personalize Tool displays three types of personalization options; the TM nurse starts by choosing one or more types. The tool allows the user to select from a variety of TM components and provides their relevant information as per the LPO, including operational, clinical, and technical information. The tool also allows the selection of resources from different healthcare networks, though it also informs the user about jurisdictional constraints, if any. The SerViU Personalize Tool calculates the scores of the selected options and produces a score for each TM personalized plan based on a formula specially developed for this purpose (SerViU formula). The produced score will help to prioritize different personalized TM services in terms of how close they are to fitting the needs of that particular patient in a certain situation (interaction abilities, disease severity, and personal preferences).

Figure 5.7 displays the suggested interface design: the light gray area represents the LPO that is embedded into the tool's environment. The dark gray area represents the SerViU Personalize Tool components: the leftmost column displays the types of personalization options. The rightmost column represents the scores produced by the SerViU formula by which the personalized TM services are prioritized.

To use the SerViU Personalize Tool, the TM nurse makes the personalization decision using the following steps:

1. Selecting the personalization option types(s) (i.e., further education, further assistance, technology improvement, or a combination of more than one), and

2. Selecting the relevant TM service details from the LPO which is assumed to be developed during Phase 0. Each personalization option can be implemented by choosing relevant LPO elements. Further education, for example, could be implemented by providing coaching, paperback manuals, or website links. The choice of educational resources and methods depends on the nurse's assessment during the Assess phase (Phase 2) where the patient might have a limited ability to learn, read, or apply instructions. Patients might have personal preferences, such as using paperback manuals instead of internet sources. LPO components are detailed earlier in Phase 0 (see Section 5.4.1).

Figure 5.7

The SerViU Personalize Tool Interface with Embedded LPO

SerViU Personalize Tool																			
Personalization Options	List of Personalization Pptions LPO																		Priority score
	TM system			Clinical			Operational						Business				Jurisdictions		
	Brand	Model	Component specs	disease	severity	test	Setup	Communication method	Data transfer	connectivity	Power	Personnel	Vendor	Price	Insuror	3rd party	Health Network	specific regulation	
Further Assisstance		Genesis DM	Touchscreen and breathometer	CHF	level 1,2	Breath Rate	Home-based	scheduled phone calls	real-time	wireless	Power cord for the main component and chargeable battry for the breathometer	Trained Nurse with TM certification					Ontario	PIPTA - Act, 2004, S.O. 2004, c. 3, Sched. A	30%
Further Education			hard and soft copy educational materials					email messages											50%
Technology improvement								Video conference				Nurse visits		monthly payments		community nurse	local	contractual relationship & privacy-related issues	22%
								Video confernence				Nurse visits		monthly payments		community nurse	local	contractual relationship & privacy-related issues	12%
			Touchscreen and breathometer			Breath Rate	Home-based	scheduled phone calles	Bluetooth	wireless	Power cord for the main component and chargeable battry for the breathometer	Trained Nurse with TM certification					Ontario	PIPTA - Act, 2004, S.O. 2004, c. 3, Sched. A	45%
								Video confernence				Nurse visits		monthly payments		community nurse	local	contractual relationship & privacy-related issues	80%

Legend:		LPO elements		SerViU Personalize Tool Environment		Scores

5.4.9. *SerViU Personalization Formula*

The equation provided in the SerViU Personalization Formula (1) consists of three variables that address the long-term adherence factors asserted by Dinesen et al. (2016) to personalize telehealth services. The score is determined by multiplying the three variables: applicability of ICT personalization, patient's willingness to adhere, and resource accessibility. Due to the importance of each variable in the equation, all must be greater than zero. Otherwise, the chosen TM personalized service would score zero and not be prioritized.

$$Score\ \% = (Applicability * Willingness * Accessibility) \qquad (1)$$

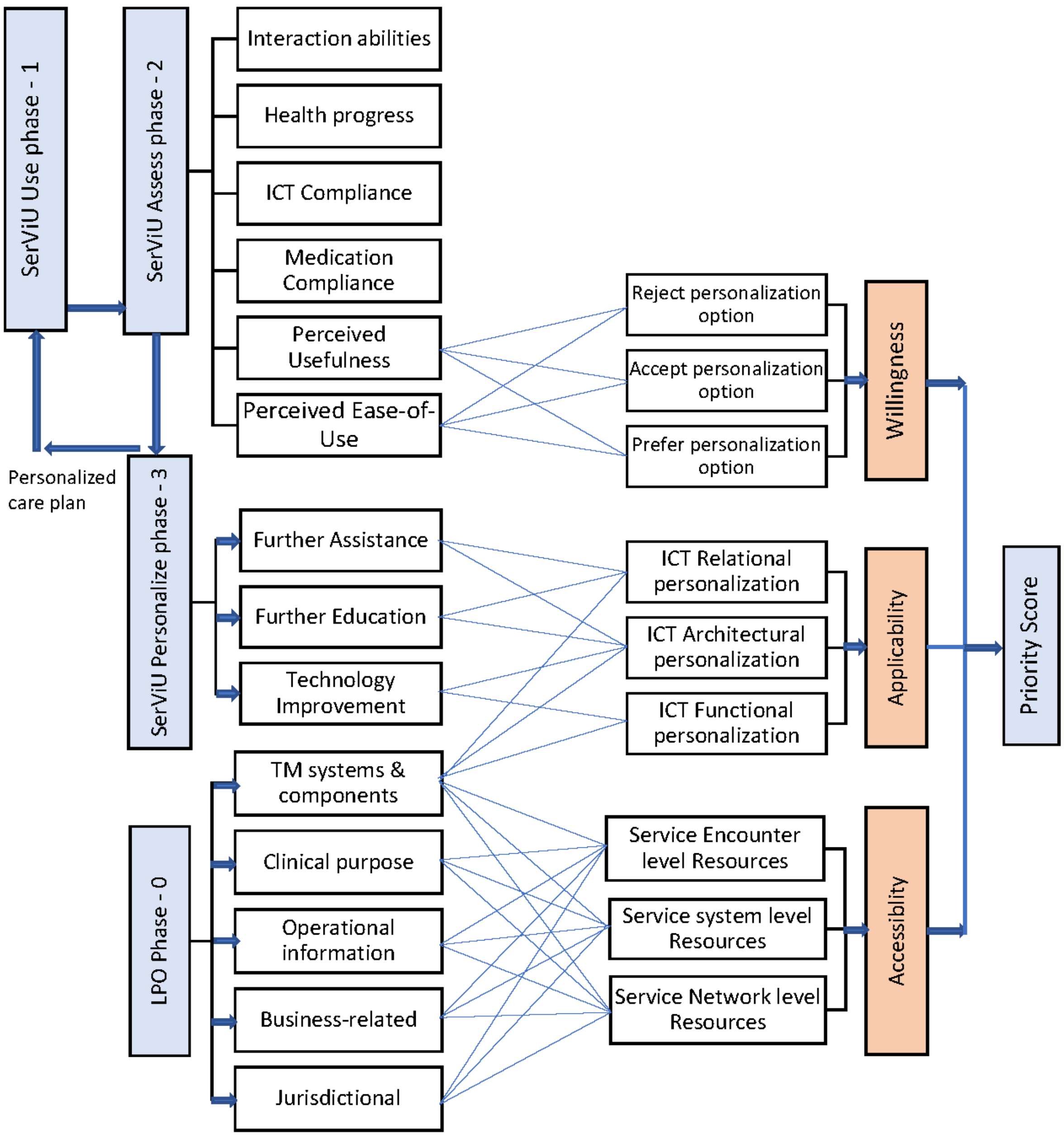
The applicability variable refers to the ICT personalization that best fits the patient's current situation. The willingness variable refers to the patient's decision to use and/or continue to use the TM. The patient is informed about the personalization options of their TM service by the TM nurse prior to making a final decision. The accessibility variable represents the accessibility and availability of contextual resources (human and nonhuman) needed for particular personalization options. This variable is based on the difficulty of accessing desired resources, including human healthcare skills.

Figure 5.8 and Appendix 7 show the way each variable is calculated. The applicability variable is calculated using ICT personalization (architectural, relational, and functional); the more ICT personalization types, the higher the applicability value. For example, using real-time biodata collection technologies to develop knowledge about the patient is deemed a relational ICT personalization. Adding videoconferencing features to improve a patient's performance is deemed an architectural ICT personalization. The same applies to installing software for voice recognition which is deemed to be a functional ICT personalization. The maximum value of applicability is 3. Each type of ICT personalization has a value of 1. Therefore, the three types combined gives the value of Applicability = 3.

Applicability = architectural personalization (AP) + relational personalization (RP) + functional personalization (FP).

Figure 5.8

Mapping SerViU Phases' Outcomes to Equation Variables



At least one ICT personalization type should be supported; otherwise, applicability is equal to zero, and the personalization option has a zero-priority percentage because it is multiplied by the other variables in the personalization equation.

Moreover, rules are added to the tool by the TM team to calculate ICT personalization based on the provider's policy and diseases conditions. In this research, the following rules were implemented: ICT architectural personalization is equal to one (AP = 1) if the further assistance option is selected because this includes resource allocation. Relational personalization is equal to one (RP = 1) if the further education option is selected, in the sense that it would improve integration with telehealth actors and resources. Functional personalization is equal to one (FP = 1) if the technological improvement option is selected. FP will also have the value of FP = 1 if particular components (e.g., SmartWare) are preferred, in the sense that using specific components, such as voice recognition software and automatic data capture and transfer would improve the patient's outcomes. Finally, for each TM component selected, a small percentage is added to the applicability value (0.01*Applicability). In other words, the more components and resources assigned to the service, the better the accommodation of the patients' situation and abilities. This is in line with the definitions of ICT personalization types (Appendix 1).

The willingness variable represents the patient's agreement to continue using the TM service. This variable is assessed during Phase 2 (Assess) and is based on the perceived usefulness and ease-of-use of the TM service. In the Personalize phase, patients must inform the TM nurse about which personalization options are more acceptable for them. They are given a choice to reject, accept, or prefer options—equivalent to 0, 1, and 2, respectively. The patient's decision represents the willingness variable in the personalization equation. Therefore, a value of 0 for willingness nullifies that personalization option.

The accessibility variable represents the accessibility and availability of contextual resources needed for personalization. Information about this variable is collected by the TM team and represented in the LPO. The healthcare context is complicated (Tien & Goldschmidt-Clermont, 2009) and is viewed in SerViU as a multilevel context. It includes multilevel stakeholders, their interests and restrictions, and ownership of resources. It is easier for TM nurses to modify (personalize) services at the encounter service level, where the initial care plan is located in the service context. However, it has become increasingly difficult to access resources that need to be obtained from higher levels. For example, suppose a personalization requires resources available from the same provider (the hospital), but which were not prescribed in the TM service. In that case, this would require an approval from certain service network level stakeholders. It becomes harder to access resources that belong to or are patented by a third party; third parties are external to the hospital and deemed to be at the network level. The same applies to privacy-regulated solutions and cost-related decisions. In order to differentiate between the hardship of resource accessibility, SerViU utilizes the centrality equation, a social network theory (Scott, 2013; Vargo et al., 2012). Each SerViU service level represents a network level in the centrality equation; a resource that belongs to that same service level in SerViU represents nodes of networks in the centrality equation (see **Table 5.**2).

The centrality closeness of a node is calculated as the sum of the length of the shortest paths between the node and all other nodes in a closed graph (2). The more central a node is, the closer it is to all other nodes. In other words, if the sum of the distances is large, then the closeness is small and the less reachable a network node (i.e., resource) becomes, and vice versa.

$$C(x) = \frac{N-1}{\sum_y d(y,x)} \qquad (2)$$

*w*here d (y, x) is the distance between nodes x and y, and N is the number of nodes.

In the TM and healthcare context, the number of resources differs between providers (e.g., hospitals). The provider is assumed to be at the center and can select resources within the same service level or from another level. Determining the exact number of resources at each service level is beyond the scope of this study, and further refinement would require case-by-case research, such as conducting contextual surveys of local healthcare institutions and care programs. Thus, SerViU assumes each level is represented by a simple star network with six nodes (a central node and five peripheral nodes), to which the centrality equation (2) is applied, resulting in the following: Scenario Level factor = 1, the Service System Level factor = 0.526, and the Network Level factor = 0.345. This equation should be normalized, then used in the SerViU Personalize Tool. **Table 5.**3 shows the value produced at each service level.

Table 5.2

Mapping SerViU Entities to the Centrality Equation

SerViU Service Context	**Centrality Equation Variables**
Service level	Network
Number of resources at a service level	Number of nodes in a network

Table 5.3

Normalizing the Centrality Equation Using MS Excel Spreadsheet

N1	N2	N3	Network =	Service level	
6	11	16	Number of nodes =	the number of resourses at a level	
C1	C2	C3	Centrality value =	the hardship to access resources	
1	0.526316	0.348837		the closer the resource the higher value	

Note. Where N = the number of nodes within a network and C = the closeness centrality level

Moreover, in SerViU, a personalization option can include resources that belong to the network level, but which are supported by another level (i.e., the Service System Level).

Consider an example of a personalization option of daily further assistance: The hospital does not provide the needed nurse hours, but it outsources the task to an external nurse (network level) and supports with videoconferencing equipment (Service System Level). SerViU sums the values as represented in the below equation (3)

$$Accessibility = [1 * (Encounter\ Level\ (0\ or\ 1)] + [0.526 * (Service\ System\ Level\ (0\ or\ 1)] + [0.348 * (Network\ Level\ (0\ or\ 1)] \quad (3)$$

Finally, the centrality theory offers many more complex solutions than closeness centrality that could fit a sophisticated healthcare context. The number of nodes within a network enables service providers to better represent resources (number of types or categories) available at a certain institution. The number of levels could be increased to represent a more hierarchical structure of healthcare contexts where the provider operates. Centrality theory also enables service providers to represent resources with more value or influence than others at the same level, using the concept of betweenness centrality (Scott, 2013). Therefore, the centrality concept in this study could be a means to differentiate service offerings from different providers.

5.4.10. SerViU Personalize GRL VE Tool

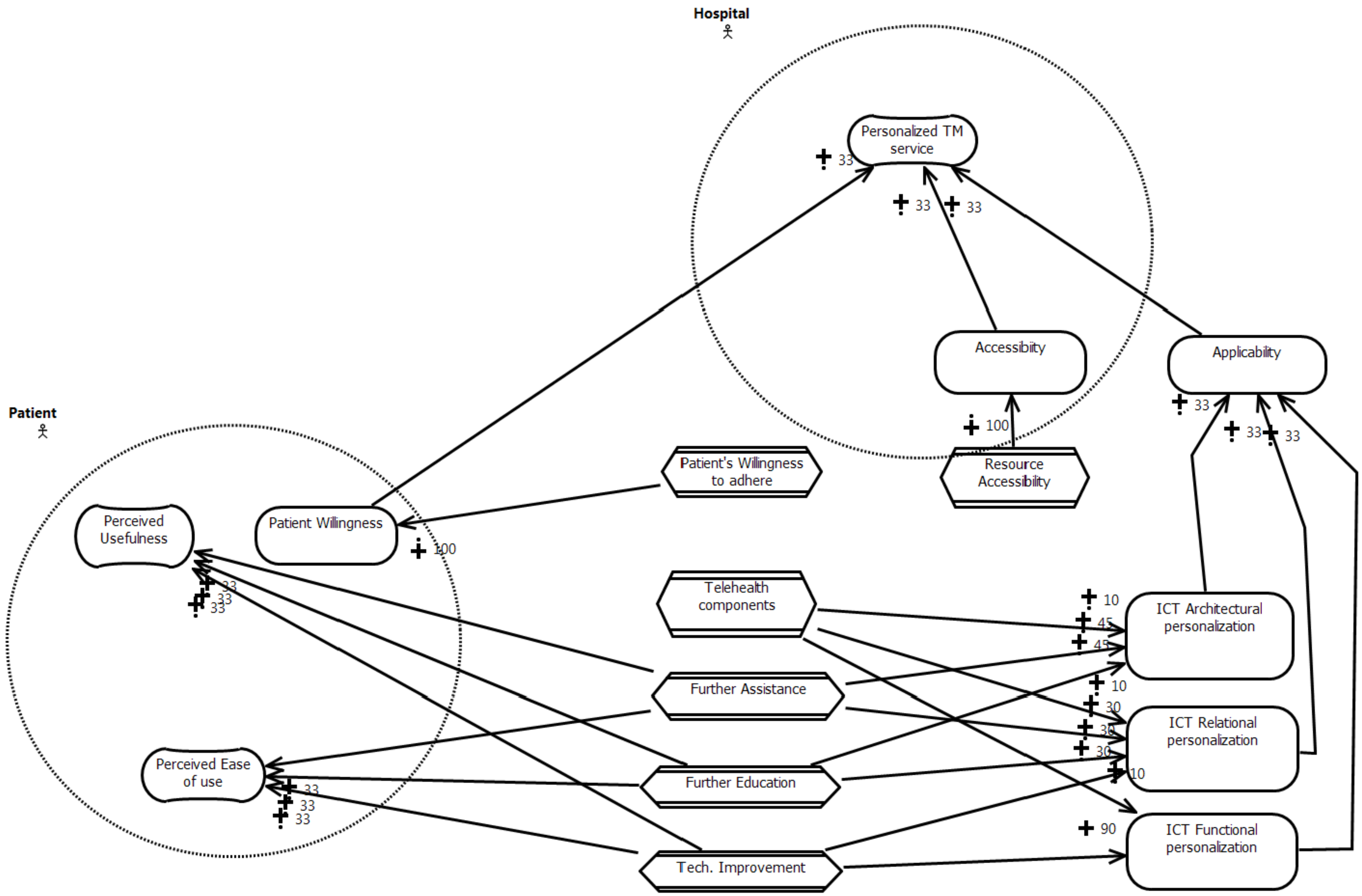
This tool aims to evaluate the extent to which the personalized TM service has met the patient's VE. The tool is based on a GRL model that can be used by the TM team to obtain a more granular understanding of how and why varied personalization options would achieve varied goals and to analyze trade-offs among options (see Figure 5.12).

This model is also derived from the lightweight GRL elaborated in the GRL Assess Tool section. The personalization options (further assistance, further education, and technology improvement) affect the patient's VE (represented by usefulness and ease-of-use goals) and are measured through KPIs with the values 1–5. For simplicity, the value scale (minimum, maximum, and threshold) chosen is similar to that used in the SerViU GRL Assess Tool. To calculate the patient's goal achievement, the GRL model propagates the contribution of the personalization options to the patient's VEs (usefulness and ease-of-use). To calculate the provider's goal achievement, the GRL model propagates the contribution of the personalization options to the provider's VP (a personalized TM service). To this end, the variables of the SerViU Personalization Formula are represented (i.e., applicability, willingness, and accessibility). Finally, the TM nurse's VE, patient's adherence, is achieved if the TM service was perceived as useful and easy to use by the patient.

For further elaboration, the SerViU GRL VE Tool was populated with information based on four personalized TM services (Units 1.1–1.3) that belong to same TM mode (remote patient monitoring). Appendix 8 shows how the chosen personalization options contributed to the patient's and provider's goals and that this contribution could be uneven. Unit 1.3, for example, shows that the personalized service achieved the patient's goals better than the provider's goals because resources needed to be imported from another healthcare network which could imply jurisdictional constraints (e.g., a different privacy policy).

Figure 5.9

SerViU GRL VE Tool



5.5. Illustrative Application of SerViU

This section presents an illustrative application of SerViU in which a hypothetical patient uses a TM service and discovers that it needs to be tailored to her situation. The activities, problems, and solutions are described based on the SerViU phases, tools, and results. The case narrative is based on a scenario from the website of the Ontario Telemedicine Network (ONT, 2020). Further details needed to be added from the literature to complete the hypothetical scenario for a multimorbid patient engaged in a TM service as described below.

The added details are 1) disease-related information related to chronic Congestive Heart Failure (CHF), including severity levels and types of medication (Moertl et al., 2017) and 2) information related to TM equipment, including brands, technologies, and operation methods from the Medical Expo online catalog (Virtual_Expo_Group, 2020). The added information is needed to better illustrate how SerViU could be applied to personalize the TM service of the hypothetical patient and to support an understanding of the assessment made by a TM nurse in this context. The scenario is as follows:

> "Carole, 83, is a multimorbid patient. Her daughter lives hours away, and Carole experiences loneliness, hopelessness, and anxiety about her condition. She had a few serious episodes that resulted in hospital admissions" (ONT, 2020). Upon discharge from the provider (the hospital) Carole's physician recommended a remote monitoring program: an initial TM care plan, requiring Carole to record her daily vitals. Her multimorbidity included CHF at stage C (a severity level for patients with known systolic heart failure and current or prior symptoms, including shortness of breath, fatigue, and reduced ability to exercise). In addition, Carole had high blood pressure and diabetes.

5.5.1. The Initial TM Services

In this phase, the hospital had a standard TM service for use by patients with disease conditions similar to Carole's. Carole's TM equipment included a TytoCare brand product with store-and-forward technology; the patient operated this product to measure and record vitals and send the information to the hospital's data center at certain times during the day.

According to the initially prescribed TM service, Carole was required to manage different medications at different times, such as before/after meals and before/after going to the bathroom. She was equipped with devices and had to keep them charged, connected, and usable (i.e., wearables, blood pressure measuring device, one-lead electrocardiogram recorder, pulse oximeter, and weighing scales). These devices were supposed to store Carole's vitals (biodata) locally and then transfer this information to the hospital data center at certain times during the day. Some tests required the patient to perform physical exercises before and after tests. Each time, Carole had to authorize the data transfer via a secure data connection (Scalvini et al., 2017). To enable exacerbation detection, Carole also had to answer daily questionnaires regarding symptoms, general wellbeing, cough and sputum production (quantity and color), and breathlessness.

5.5.2. LPO Phase (Phase 0)

Prior to discharging the patient, the hospital provided Carole with educational and training sessions to help Carole self-manage her TM service. The SerViU LPO form guided the hospital TM team in developing an LPO which detailed available and accessible resources.

5.5.3. The Use Phase (Phase 1)

Carole used the TM service which logged her daily activities and compliance; she was supposed to be contacted by the nurse. However, Carole faced a number of issues in the first days of use that caused her to be incompliant (i.e., incompliant with both the medication and technology), including

- feeling isolated,
- missing medication,
- considering the technology to be too complicated,
- forgetting to recharge the device batteries, and
- providing wrong answers to the daily wellbeing questionnaire.

Because Carole used a ventricular assist device (an artificial pump with a controller and batteries located outside the body; (Moertl et al., 2017), her mobility was reduced and she was confined to home. This exacerbated Carole’s social isolation and affected her willingness to continue with the service. Carole could not measure her vital signs because she frequently forgot to charge the devices, was too dizzy to recognize the characters and device buttons, and found the device to be too complicated to connect (wireless settings).

Carole stopped being compliant with her daily medication instructions because she started to find the instructions complicated and the medication disturbed her sleep. When Carole started to take the medication (applying the care plan), the medication’s diuretic side effects started to affect her. This included increased urination, dizziness, dehydration, changes in kidney function, ringing and buzzing in her ears, skin rashes and hives, itching, increased blood sugar levels, painful inflammation of the joints, dizziness, and the urge to go to the washroom at night. This influenced Carole’s mental and physical ability to adhere to the plan, as well as her willingness to continue. Moreover, Carole started to miss completing her daily wellbeing questionnaire about her sleep activity, and mental and cough conditions.

The TM systems recorded information about Carole's daily login activities, measurements relevant to her disease condition, and her compliance. The TM systems then generated a report (TM report) at the data center which was at the disposal of the TM nurse and included immediate alerts via email and paging devices. The TM report presents data in colorful graphs and charts that enable clinicians (and families, if needed) to view and discuss key patterns with their providers (Welkin, 2020).

5.5.4. The Assess Phase (Phase 2)

The TM nurse reviewed the TM report, which showed a lack of compliance with the prescribed TM service, including Carole not answering some daily wellbeing questions and operation-related errors (e.g., double pressing of buttons, connectivity and login issues). During this phase, a face-to-face follow-up session was conducted to validate the contents of the TM-generated report and to assess Carole's disease condition, interaction abilities, and willingness to continue using the SerViU Assess Tool:

- Interaction abilities: Carole was unable to answer the daily questionnaire. The TM report recorded that Carole had missed days of her questionnaire schedule and selected wrong answers. This was due to the medication's side effects. Mentally, it became harder for Carole to remember and/or understand instructions generated by the TM system.
- Ease-of-use: It was hard for Carole to hold and control the device, read the screen characters, and press the buttons (touchscreen buttons). The TM report recorded entry errors, double clicking, and late responses (i.e., the session expired without sending Carole's entry). During the face-to-face session with the TM nurse,

Carole advised that she thought she was doing the right thing and expected that the information had been sent.

- Usefulness: During the face-to-face session, Carole informed the TM nurse that using the TM system was too complicated and she would prefer a standard in-person service over a TM-enabled one. Carole also asked for direct, real-time guidance throughout the process from an actual clinician. She explained to the TM nurse that direct supervision would ensure that she was performing exercises appropriately and taking vital measurements correctly.
- Health progress assessment: the clinical information received from the TM report showed that Carole was still at the high severity level.

The SerViU Assess Tool helped the TM nurse to notice that the perceived usefulness and ease-of-use of the TM service needed to be addressed, specifically for issues related to self-dependence, accessibility to clinicians, technology literacy, and complexity. The main information sections that indicated a need to personalize were perceived usefulness, perceived ease of use, compliance, and health progress; any of these sections could indicate the need for a need-to-personalize decision. The TM nurse did not find issues with the patient's interaction abilities because the patient was assessed without taking the dizziness-causing medication into account. Each of the three first sections indicated the need to personalize. The overall score also indicated a need to personalize because it did not reach the threshold of 50% (see Table 5.4).

The SerViU Assess Tool was helpful to the TM nurse, not only for deciding that there was a need to personalize, but to direct the nurse to the exact area of focus that needed to be addressed to personalize the TM service (e.g., self-dependence issues; see Table 5.4).

Table 5.4

Carole's Assessment Using SerViU Assess Tool

Information Section	Information Subsection	Measurement	Score / 5	Importance to Need-to-Personalize Decision	Section Results	Overall Results
Perceived Usefulness					**45%**	**9.00%**
		Safety	4	25%	20%	
		Privacy	3	25%	15%	
		Self-dependence	1	25%	5%	
		Accessibility to clinicians	1	25%	5%	
Perceived Ease-of-Use					**45%**	**9.00%**
		Technology literacy	1	25%	5%	
		Vision and recognition	3	25%	15%	
		Language familiarity	4	25%	20%	
		Complexity of instructions	1	25%	5%	
Health Progress		Severity of disease condition	High		**7%**	**1.33%**
Adherence to TM Service					**40%**	**8.00%**
	Medication Compliance		2	50%	20%	
	ICT Compliance		2	50%	20%	
Interaction Abilities					20%	**14.17%**
	Mental Interaction Abilities			**50%**	**38%**	
		Technology literacy	4	12.5%	10%	
		Vision and recognition	4	12.5%	10%	

		Language familiarity	4	12.5%	10%	
		Complexity of instructions	3	12.5%	8%	
	Physical Interaction Abilities			**50%**	**33%**	
		Move, reach, lift, and mobilize	3	16.7%	10%	
		Attach devices, press buttons, and connect parts	3	16.7%	10%	
		Perform physical exercises	4	16.7%	13%	
Need-to-Personalize Decision				**100%**		**41.50%**

To develop a better granular understanding of the root causes of and relationships interconnecting information sections, the TM utilized another assessment tool: the SerViU GRL Assess Tool.

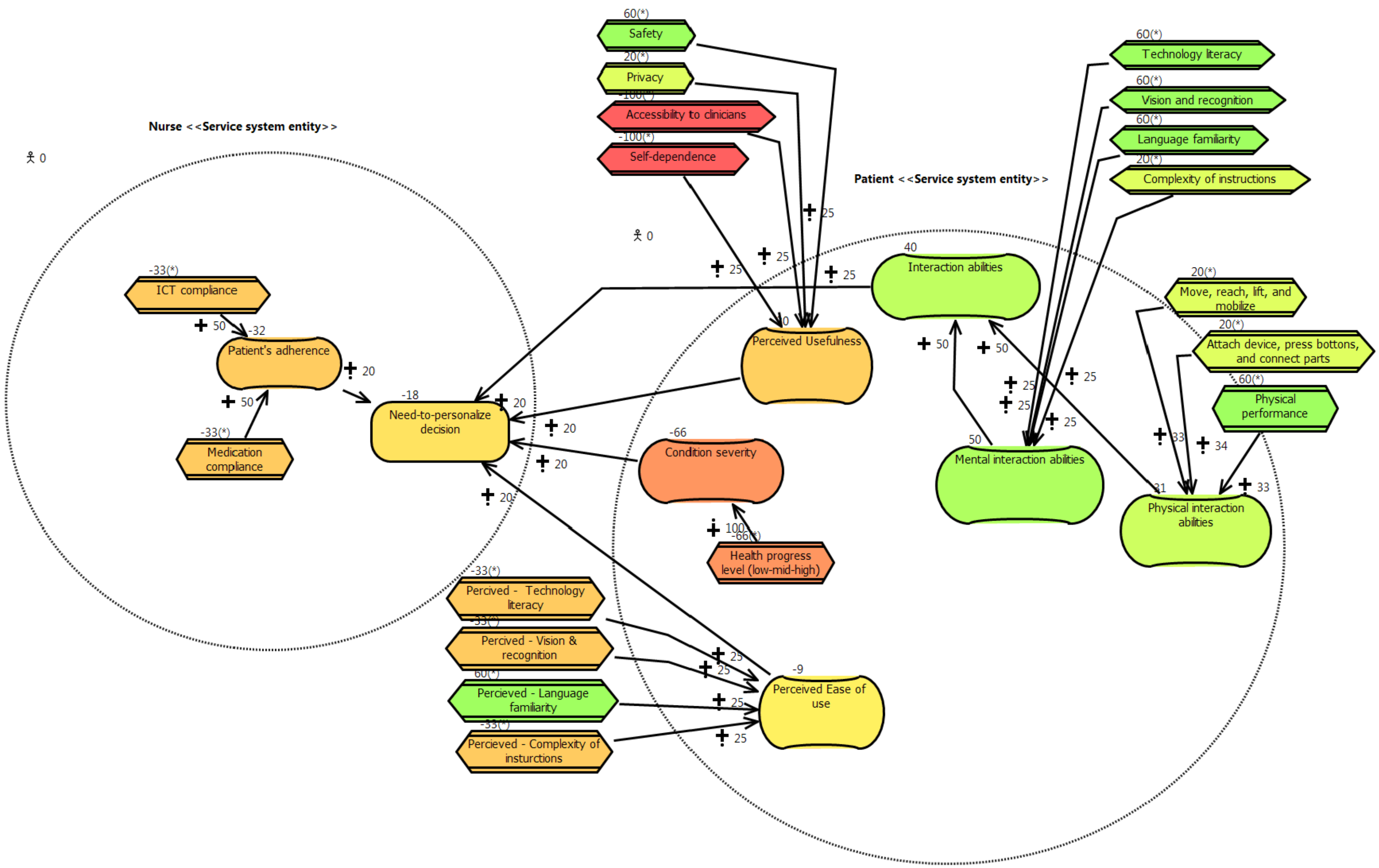
Although the assessment of Carole's interaction abilities was good, it was undermined by her perceived usefulness and perceived ease of use of the TM service. The populated model in Figure 5.9 guided the TM nurse to further details about what could indirectly affect the need-to-personalize decision. The GRL model is color-coded from green to red (i.e., low to high value). For example, a value of 1/5 in the self-dependence subsection results in a red-colored KPI.

Carole's issues with self-dependence and ability to access a clinician contributed to the need-to-personalize decision. Carole was unable to access the nurse outside of work hours and could not apply the instructions. She believed that she should not be left alone; hence, someone should be there to help her use the equipment.

The tool also guides the TM nurse to consider the implications of the high severity level of Carole's disease condition (i.e., the dizziness-causing drug). Testing Carole's interaction abilities without the drug during the in-person meeting with the TM nurse resulted in positive results. However, when Carole was taking the medication at home by herself, she perceived a lack of ability and knowledge about how to use the TM service. This situation could cause the TM nurse to decide to keep Carole monitored in her home and not allow her to go outdoors, and to increase the automation and speed of the data recording and transfer.

Figure 5.10

Carole's Assessment Using SerViU GRL Assess Tool



5.5.5. *The Personalize Phase (Phase 3)*

Information from the SerViU Assess Tool was essential for informing the personalization decision. For example, further education was not considered to be a personalization option because Carole's mental abilities were affected by the level C CHF medication's side effects. At this severity level, using a lightweight monitoring device was also inappropriate, and Carole could not leave home; personal visits by a clinician could address her social isolation and avoid further depression. Using the results of the Assessment Tool and the GRL Tool, the TM nurse now needed to decide how to adapt Carole's TM service to better meet her needs. Using the SerViU Personalize Tool, the TM nurse first selected the personalization option "further assistance." Carole could not make use of the further education option given her current cognitive situation; hence, a nurse was needed to help her perform the required tasks and take the medication. The LPO showed two options: in-person nurse hours and virtual nurse hours. The LPO also showed the option to hire a community nurse instead of the provider's nurse. The SerViU Personalize Tool weighed each resource based on its accessibility hardship.

The option of assistance via nurse hours from the same hospital was limited because all the nurses were busy for both virtual and personal consultations. The TM nurse selected the second-best option, which was a community nurse—a third party who could coordinate with the hospital. This option had a lower accessibility score because it did not belong the initial plan nor to the hospital. Additionally, the number of nurse hours required to assist Carole was higher than the capacity of the third party provider. The TM nurse selected videoconferencing features from the LPO, which belonged to the provider, to support the nurse hour resource to be provided to Carole. The format of this technology resource selected should by easy to use for Carole (e.g., a tablet for visual communications where the text and voice were aligned with Carole's interaction abilities). Moreover, during the times of the day where no direct supervision by a nurse was available, Carole was advised to use some wearables that had the ability to automatically record and transfer her biodata to the data center. Figure 5.11 shows how to numerically trace the TM nurse's decision-making using SerViU Personalize Tool, and how alternative choices made a difference. In the personalization of Carole's TM service, two personalization options were selected: further assistance and technology improvement. The ICT selected were reallocated from the hospital and readjusted to fit Carole's interaction abilities: i.e., ICT architectural and ICT relational personalization support. Automated data capture, an ICT functional personalization, was acceptable because the LPO information section showed that, under certain approvals, passive data collection (while asleep) is legally compliant with the local privacy regulation.

Using the SerViU Personalize Tool helped to personalize the TM service to fit the patient's current situation, on the one hand, by providing all types of ICT personalization support. On the other hand, it helped to overcome the resource limitation and the scarcity of nurse hours. LPO flexibility is key to helping the TM nurse select alternative technology and operation means. To represent how the personalized TM service met the patient's VE, another GRL tool that belongs to the Personalize phase (Phase 3) was used: the SerViU GRL VE Tool (see Figure 5.6). This figure shows that VE (i.e., perceived usefulness and perceived ease of use) of the patients were met, and at the same time the provider was successful in providing a personalized TM service approved by the patient (VP: personalized TM service). This figure also shows the influence on the ICT personalization support of eliminating further education as a personalization option; both architectural and relational support types scored lower. ICT resources, related to the patient's education, would have improved the patient's interaction abilities and relationship with the service context. If the patient's disease severity improves in the future, the patient is expected to become able to receive education; hence, in the next Assess phase (phases 1–3 are iterative), the TM nurse could decide to include educational support that fits with the newly assessed interaction abilities.

The SerViU GRL-VE tool could be further improved to consider actor-based importance levels (0-100). Such improvement could help improving satisfaction levels for both patients and providers, especially by considering social (e.g., the family's involvement) and economic goals that are beyond SerViU's scope.

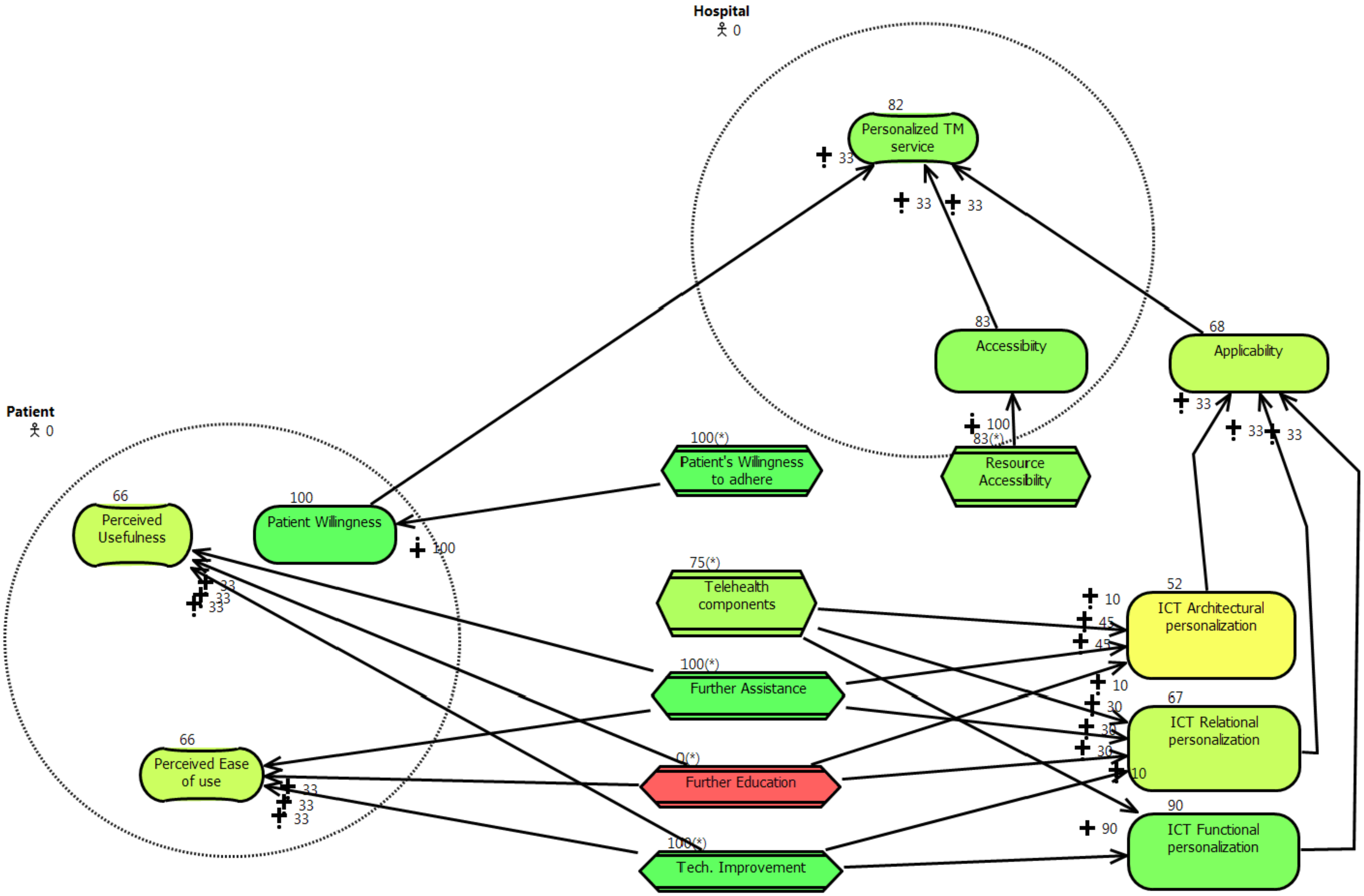
Figure 5.11

Calculating the Priority Percentage

Technology-related personalization (ICT-enabled service personalization support types)	Applicability			Willingness	Accessibility			Priority percentage	Hardships and preferences
	ICT Relational personalizaiton	ICT Architectural personalization	ICT Functional personalization		Scenario level	Service system level	Network level		
Personalizaiton options	RP	AP	FP	W	SC	SS	NT	**%**	Notes
Further education									
Providing educational courses - in-person	0	1	1	1	0	1	0	35%	
Providing educational courses - virtual	0	0	1	1	1	0	0	33%	
Further assistance									
Daily assistance by the nurse to walk Carole through the process.									
1 - Actual meetings	1	1	1	1	0	1	0	53%	
2 - Virtual meetings	1	1	1	0	0	1	0	0%	
3 - involving a family caregiver to take over and be responsible for reporting the daily status as well as the medication compliance	1	1	1	1	0	0	0	0%	Not available
4 - hiring a community nurse who works within a local community and can cooperate with the practitioner nurse at the hospital. This includes two options									
4.i - Actual visits of a community nurse	1	1	1	1	0	0	1	35%	
4.ii - Virtual visits of a community nurse	1	0	1	1	0	1	1	58%	
Technological improvement									
1 - Automatic data capturing.	1	1	1	1			1	35%	Provincial permission extra fees of third party provider
2 - Changing medication dosage from remote.	0	1	1	1			1	23%	
iii. Integrating a video conference feature	1	1	1	1	0	1	0	53%	
iv. Software settings	1	0	0	1	1	0	0	33%	
v. Using lightweight or mobile devices	0	1	1	1	0	0	1	23%	

Figure 5.12

Implementing the SerViU GRL VE Tool



Chapter 6: Case Study

6.1. Introduction

This chapter presents a multiple case study conducted to demonstrate and evaluate the steps of the design science research methodology (DSRM; (Peffers et al., 2007). The demonstration of SerViU was conducted by simulating the use of the SerViU Personalize Tool to support personalization decision-making for hypothetical telemonitoring (TM) patients within a multiple case study design. The six participants recruited for the study were clinicians with telehealth experience. For the purposes of the study, the SerViU Personalize Tool was implemented as an interactive spreadsheet with integrated guidelines for its use and scenarios for which personalization decisions had to be made. The evaluation of SerViU was conducted through case study participants' responses to a questionnaire following their use of the SerViU Personalize Tool. Participants were asked about their perception of the tool concerning three evaluation criteria: relevance to the telehealth context, usefulness for making personalization decisions, and sufficiency of the information provided by the tool to make such decisions. The context was a Canadian hospital that provided TM services in three delivery modes (TM modes: remote patients monitoring, remote medication management, and monitoring by TM nurse).

The remainder of this chapter is organized as outlined: Section 6.2 describes the case study design, including the SerViU Personalize Tool (6.2.1), the simulation sessions (6.2.2), the TM service delivery modes (6.2.3), and the case study participants (6.2.4).

6.2. Case Study Design

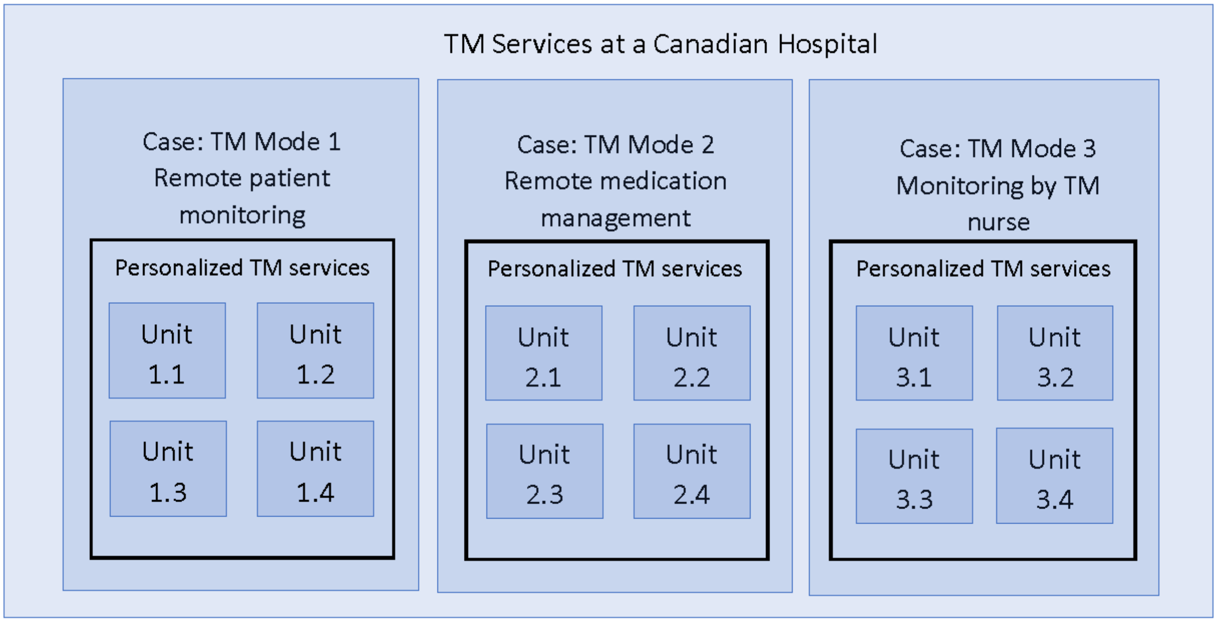
A multiple case study research design with embedded units of analysis was adopted for this study (Yin, 2017). In this case study, different TM delivery modes are deemed to be multiple case studies with embedded units of analysis. Such as setup could improve understanding of the nature of telehealth services in the sense of 1) filling gaps in understanding of context and results; and 2) reducing the potential uniqueness of artifactual conditions, such as special access to key information, resources, or skills that are available in one TM mode but not in another (Yin, 2017). This case study context represents an opportunity for a deeper understanding because the delivery modes differ in terms of technological complexity, testing procedures, patient authorization, and the extent of patient–provider interaction, resulting in more compelling findings regarding the rationales for personalization.

Figure 6.1 shows the three TM modes provided at the Canadian hospital; each was deemed to be a case and each comprises four units of analysis.

Each case (TM mode) was represented by a validated TM scenario that narrated the events of a patient who utilized the TM service and faced challenges based on personalization decisions (see TM scenario document: Documents A3.e, Appendix 3).

Figure 6.1

Multiple Case Study Units of Analysis



The SerViU Personalize Tool was represented as an interactive spreadsheet and introduced to the participants to simulate the decision-making process. The SerViU Personalize Tool provided two levels of decision-making: a high-level personalization decision (further assistance, further education, technology improvement, or a combination of more than one) and, subsequently, a detail-level personalization decision regarding TM components, operating methods, communication methods, connectivity technologies, and choice of healthcare network as a resource provider. This allowed participants to create a personalized TM service using the SerViU Personalize Tool.

The tool provides the means to prioritize personalized TM services by producing a score for each personalized TM service. The score is based on a formula (SerViU Formula) explicitly created for this purpose (see Section 5.4.9). The participant could save or revise their selections before ending the simulation session.

The participants were asked to use the SerViU Personalize Tool to select personalization options, think aloud while making the selections, and then provide their feedback regarding the tool and the personalization process. Thinking aloud is a technique that helps to trace decision-making processes (Boren & Ramey, 2000). At the end of the simulation sessions, the case study participants were asked to provide their evaluation of the tool based on three criteria: usefulness, relevance, and sufficiency of information provided to make the personalization decision. Further details are provided in the decision-making simulation protocol (Document A3.c, Appendix 3).

The data collected during the simulation sessions included the selections made using the SerViU Personalize Tool, transcripts of the voice-recorded think aloud sessions, and the scores produced by the SerViU formula embedded in the SerViU Personalize Tool. The feedback collected from the participants included written improvement suggestions as well as a 3-point scale evaluation. The evaluation was based on three criteria: usefulness, relevance, and information sufficiency. Further details are provided in the evaluation questionnaire form in Document A3.d (Appendix 3).

This data gives an understanding of the personalization decisions made using the SerViU Tool and specifically how the SerViU Personalize Tool was used to implement high-level decisions using detailed technical and operational choices. It also helps to explain the rationale behind the personalization decisions, in addition to highlighting needed improvements.

Decision-making using the SerViU Personalize Tool was simulated four times for each case (TM mode). This approach enabled the comparison of results within and across cases: i.e., within personalized TM services that belonged to the same TM modes and across different TM modes (Eisenhardt, 1989); see the case study documents in Appendix 3, including the case study protocol, consent forms, and scenarios documents).

6.2.1. The SerViU Personalize Tool

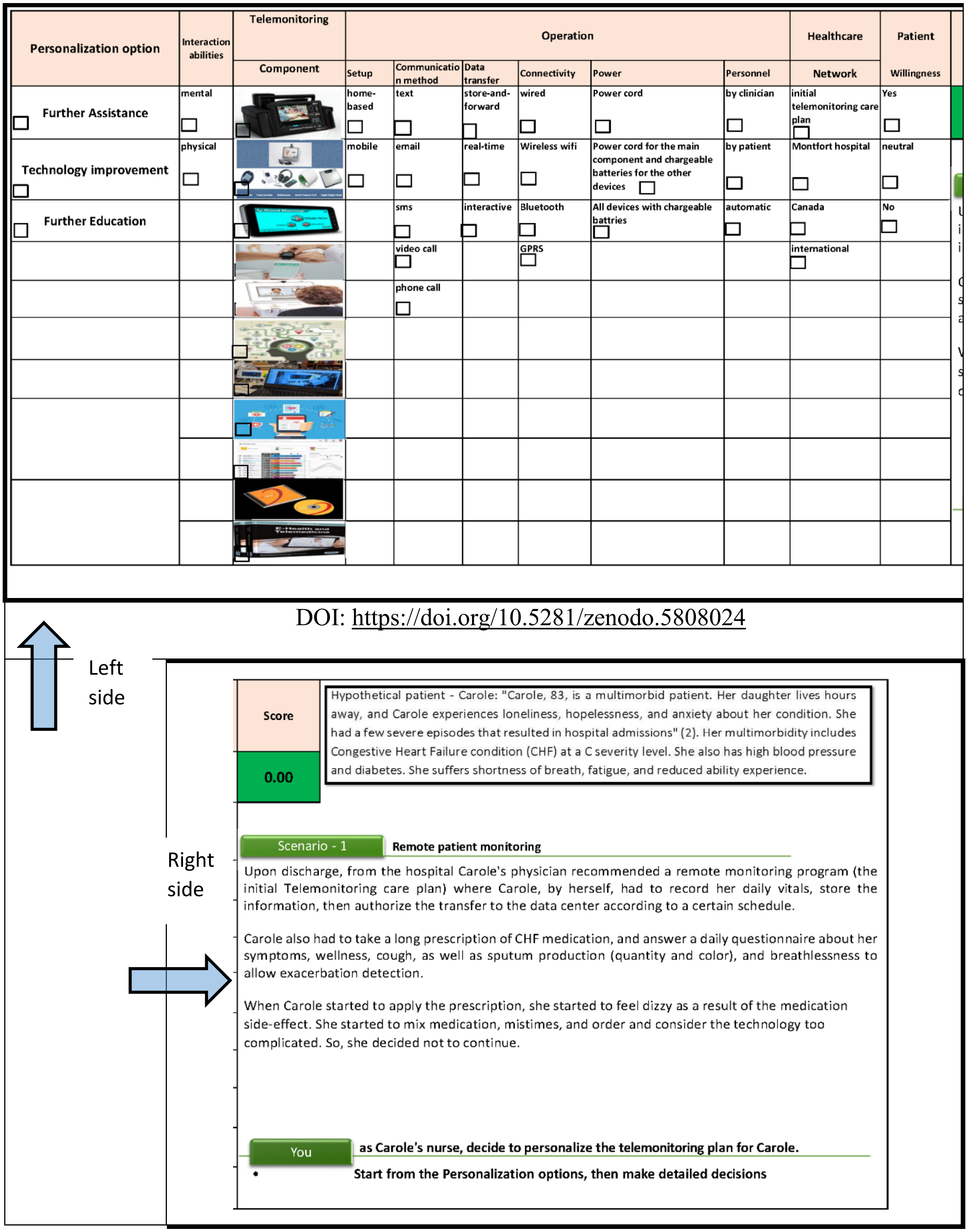
For simplicity for the case study participants, the SerViU Personalize Tool was represented as a Microsoft Excel interactive spreadsheet. The Microsoft Excel application facilitated Visual Basic for Applications (VBA) coding which enabled customizing the interface and facilitated calculation of the priority score. An external VBA coder, approved by the thesis supervisor, was hired for this purpose and supervised by the Ph.D. student. The SerViU Personalize Tool interface reflects the order of the decision-making process. The high-level personalization options are on the left side, and the detailed contextual selections are on the right. Instructions were provided in the same spreadsheet file, including a flowchart of the process, definition page, and pop-up hints that appeared whenever an option was selected to ensure that the participant had made their intended selection.

SerViU provides flexibility in terms of selecting one or more high-level choices (see the case study protocol in Document A3.a, Appendix 3). The high-level options to select from are: 1) further education, 2) further assistance, or 3) technology improvement. In the detailed personalization decision-making process, SerViU provides technical, operational, and contextual options based on the list of personalization options (LPO) developed in Phase 0 by the TM team. The LPO included technical descriptions of the available devices, relevant components/accessories, and their purpose of use (e.g., a touchscreen tablet to enable visual or real-time communication with the patient). The LPO also provided information about healthcare networks from which the personalization resources could be acquired, such as jurisdictional constraints of using a particular device or component.

The tool's interface shows the score of the personalized TM service on the left side. Finally, the TM scenario is displayed in the interface to help the user review the patient's situation to make the personalization decision (see Figure 6.2).

Figure 6.2

Simulation Software Tool Interface



6.2.2. *Decision-Making Simulation Sessions*

The simulation session meeting protocol contained an introduction about the case study and instructions about using the SerViU Personalize Tool that the case study participants reviewed prior to their simulation sessions. These instructions were introduced to them at the beginning of the simulation sessions. Each case study participant simulated personalization decision-making using the SerViU Personalize Tool on two different TM modes. As described in the case study protocol (Document A3.a, Appendix 3), the personalized TM services were anonymously numbered based on the TM mode. For example, the personalized TM services belonging to TM Mode 2 (remote medication management) are numbered Unit 2.1 to Unit 2.4. There were twelve personalized TM services (2 TM modes per participant * 6 case study participants = 12 personalized TM services; see Table 6.2)

In the last part of the simulation session, the participants provided feedback about the SerViU Personalize Tool via an evaluation questionnaire form (Document A3.d, Appendix 3). This form also contained space for feedback where the participants could input any comments to improve the SerViU Personalize Tool (e.g., comments on the decision-making process or contextual information about the TM service).

The decision-making simulation sessions were conducted online and took approximately 60 min each, during which time the case study participant simulated two scenarios. The order of events (which are elaborated in the decision-making simulation protocol, Document A3.c, Appendix 3) was as follows:

- Five minutes to finalize signing the general consent letter and obtain permission to contact again,

- Fifteen minutes to introduce the SerViU Personalize Tool (represented in an MS Excel sheet) and the decision-making process,
- Ten minutes for the first decision-making simulation,
- Ten minutes for the second decision-making simulation, and
- Fifteen minutes for evaluation and review—written feedback and a short questionnaire.

The introduction guided the participant through the decision-making process and the SerViU Personalize Tool.

6.2.3. Telemonitoring Service Delivery Modes (TM Modes)

The selected TM modes that are offered at the Canadian hospital are as follows:

Telemonitoring Mode 1 (TM Mode 1) refers to a remote patient monitoring service that comprises an infrastructure supplied by the Ontario Telemedicine Network (OTN infrastructure). In this unit, tele-homecare equipment was used by patients to measure their vital signs at certain times of the day, according to their TM services. In this TM mode, the TM system captured patient data and sent these to a central data center at the Canadian hospital. The patients' data were analyzed daily at the data center, and a report was generated (TM report) which was accessible to the TM nurse. The TM nurse was also notified in case of emergencies. In the case of emergencies or erroneous entries, mainly regarding patients' vital signs, the TM nurse would call the patients, their caregivers, or the related physician if necessary.

Telemonitoring Mode 2 (TM Mode 2) refers to remote medication management, a TM service that comprises a Medispenser infrastructure where patients are responsible for taking their medication (in this case, pills) according to this service. The system automatically sent medication adherence data to the data center at the Canadian hospital. Daily follow-ups were conducted with patients: the TM nurse received daily notifications and called the patient and caregiver if necessary.

Telemonitoring Mode 3 (TM Mode 3) refers to monitoring by a TM nurse. The TM activities are performed in the presence of the TM nurse at the Canadian hospital during work hours. These were consulting activities that were performed virtually with doctors at different locations. The TM services used an OTN infrastructure called eVisit for these consultations. These meetings are similar to a regular doctor's appointment; the only difference is that patients use videoconferencing equipment to meet and speak with their doctors.

6.2.4. Case Study Participants

The case study participants were experienced clinicians recruited at a Canadian hospital where these three TM modes are routinely used to monitor multimorbid patients (i.e., remote patient monitoring, remote medication management, and monitoring by a nurse). Six participants with various roles, experiences with TM services, and patients took part in this case study. The participants' range of experience helped to demonstrate that the SerViU Personalize Tool can be used in different clinical positions, as stated in Table 6.1.

Table 6.1

List of Case Study Participants Recruited for the Simulation Sessions Phase

Participant #	Positions	Experience
1	Registered Nurse	Registered since 2012. Experience includes community and the Canadian hospital. She was part of two telehealth pilot projects for three months.
2	Social Worker	Social worker for the last five years. Experience includes TM services at the Canadian hospital for three months.

3	Physician	Physician for more than ten years. Experience includes ten months with telehealth services.
4	Registered Nurse	Registered nurse for 37 years. Experience includes more than ten months with telehealth services.
5	Registered Nurse	Registered nurse for three years. Experience includes more than three months with telehealth services.
6	Physiotherapist Physician	Telerehabilitation physician for more than five years. Experience includes more than ten months with telehealth services.

Table 6.2

Distribution of Participant Assignments for Simulation Sessions

		Participant Code					
#	**Telemonitoring Mode**	**1**	**2**	**3**	**4**	**5**	**6**
1	Remote patient monitoring	1.1	1.2		1.3	1.4	
2	Remote medication management	2.1		2.2	2.3		2.4
3	Monitoring by nurse		3.1	3.2		3.3	3.4

Table 6.2 shows the six participants and the TM services assigned to them to simulate the personalization decision-making utilizing the SerViU Personalize Tool.

Chapter 7: Results

7.1. Introduction

This chapter presents the results of the case study in which the SerViU Personalize Tool was applied to three validated scenarios, each representing a telemonitoring (TM) mode. Two types of results are presented: demonstration and evaluation results.

The demonstration results that were obtained from the decision-making simulation sessions include the selections made by the participants, the scores produced via the SerViU formula, and rationale themes identified from the think aloud transcripts where participants were asked to explain the rationale behind their decisions. Six participants simulated the decision-making process using the SerViU Personalize Tool to personalize three TM services. The six participants simulated two personalization decision-makings each, resulting in a total of twelve personalized TM services.

The evaluation results were based on three criteria: relevance to context, usefulness in making the personalization decision, and sufficiency of information. Each criterion was assessed by the case study participants by means of a 3-point Likert scale and free text feedback. The case study participants evaluated the SerViU Personalize Tool positively and provided feedback which included suggestions for its improvement.

7.2. Demonstration

The applicability of SerViU for personalizing telehealth services was demonstrated by simulating the use of the SerViU Personalize Tool—a core decision-making tool in SerViU. Personalization decision-making was analyzed at the mode level (within-case), then compared at the TM higher level (cross-case). The analysis results collected from the twelve personalized TM services were compared in terms of personalization options, technological components, operational factors, and resource-related selections (provided in the SerViU Personalize Tool). Scores presented in each section demonstrate how applicable the selected options are to personalize the service and how accessible the selected resources are (see Table 7.1). Finally, the rationale behind the personalization decisions help to explain differences and similarities between decision-making related to TM modes and units.

Table 7.1

Score Results from Simulated Decision-Making Sessions

Telemonitoring Modes	Analysis Units	SerViU Formula				Average ICT Applicability	Average Accessibility	Score Average
		ICT Applicability (%)	Willingness Prefer=2 Accept=1 Reject=0	Accessibility (%)	Overall Score (%)	86.13%	62.55%	31.38%
Mode 1: Remote patient monitoring	1.1	100.00%	2	27.70%	19.62%	91.68%	41.88%	23.50%
	1.2	100.00%	2	12.10%	8.03%			
	1.3	66.70%	2	100.00%	44.10%			
	1.4	100.00%	2	27.70%	22.24%			
Mode 2: Remote medication management	2.1	100.00%	2	27.70%	19.62%	75.03%	81.93%	42.31%
	2.2	66.70%	2	100.00%	40.95%			
	2.3	66.70%	2	100.00%	70.88%			
	2.4	66.70%	2	100.00%	37.80%			
Mode 3: Monitoring by nurse	3.1	66.70%	2	27.70%	10.46%	83.35%	63.85%	28.32%
	3.2	66.70%	2	100.00%	40.95%			
	3.3	100.00%	2	27.70%	20.93%			
	3.4	100.00%	1	100.00%	40.95%			

7.2.1. Within-Case Analysis

The SerViU Personalize Tool is utilized in a certain order—selection at a high level before selecting detailed options—as described in the SerViU method (Chapter 4). For example, the participants could select the personalization option type “further assistance” before selecting the technological component that facilitated that personalization option (e.g., videoconference). The same method is used to determine which interaction abilities need to be addressed (e.g., mental), the system setup (e.g., home-based), and operational selection. Scores produced via the SerViU formula are expected to support the comparisons between the personalization decisions, especially in how they identify providers’ tendencies, such as being resource driven (Appendix 4). The following describes the rationale of case study participants when making personalization decisions; thematic analysis led to generation of an rationale identification list (see Appendix 5).

Remote Patient Monitoring Mode (Units 1.1–1.4).

> Carole, the hypothetical patient, was discharged from hospital to be monitored at home—a TM scenario. A TM component was part of her initial care plan. Carole was to record her daily vitals, including her weight, store the information, then authorize its transfer to the data center every morning. Carole also had to take many medications for her CHF. Moreover, Carole had to answer a daily questionnaire about how she felt, her symptoms, general wellness, cough, sputum production (quantity and color), and breathlessness to allow exacerbation detection. Carole started to feel dizzy because of a side effect of the medication. She started to mix and mistime medications, change their order, and consider the technology to be too complicated.

The different levels of agreement among case study participants regarding options selected using the SerViU Personalize Tool are shown in the note below Table 7.2. Personalization decision-making was simulated by four participants for each TM mode. The five levels of agreement are: total agreement to use a component; partial agreement to use a component; disagreement; total agreement not to use a component; and partial agreement not to use a component.

Table 7.2

Results of Within-Case: Remote Patient Monitoring Mode

TM Mode 1						
		Agreement	1.1	1.2	1.3	1.4
Personalization Options	Further assistance	A	*	*	*	*
	Technology improvement	P	*	*		*
	Further education	A	*	*	*	*
Interaction Abilities	Mental	A	*	*	*	*
	Physical	D			*	*
Telemonitoring Components	Universal unit	P	*	*	*	
	Multiple devices	Pnot				*
	Touchscreen	D	*			*
	Mobile device	Pnot				*
	Videoconference device/feature	P	*	*		*
	SmartWare	P	*	*		*
	Hardware	Pnot		*		
	Mobile app	D			*	*
	Website	Anot				
	CD ROM	Anot				
	Paperback learning	A	*	*	*	*
Setup	Home-based	D	*		*	
	Mobile	D		*		*
Communication Methods	Text	Pnot				*
	Email	Pnot				*
	SMS	Pnot				*
	Video call	A	*	*	*	*
	Phone call	A	*	*	*	*
Data Transfer	Store-and-forward	Anot				
	Real-time	D	*			*

	Interactive	D		*	*	
Connectivity	Wired	Pnot	*			
	Wireless Wi-Fi	P	*		*	*
	Bluetooth	P	*		*	*
	GPRS	D		*	*	
Power	Cable cord	Pnot		*		
	Cord and chargeable devices	P	*		*	*
	All chargeable devices	Anot				
Personnel	By clinician	A	*	*	*	*
	By patient	A	*	*	*	*
	Automatic	A	*	*	*	*
Healthcare Network	Initial plan	D	*		*	
	Hospital	D	*			*
	Canada	Anot				
	International	Pnot		*		
Willingness	Yes	A	*	*	*	*
	Neutral	Anot				
	No	Anot				

Code	Definition	Range
A	Agree to consider the option/component	4/4
P	Partially agree to consider the option/component	3/4
D	Disagree	2/4
Pnot	Partially agree NOT to consider the option/component	1/4
Anot	Agree NOT to consider the option/component	0/4

Table 7.2 shows that the case study participants (hereafter called "participants") agreed on the appropriateness of the personalization types "further assistance" and "further education." This was a high-level decision, and it scored the highest agreement level (A) among participants: i.e., in this TM mode all participants decided on these two personalization types. Table 7.2 is the only table of within-case results shown in this chapter; the remaining tables are presented in Appendix 4.

There was partial agreement (P) on the "technology improvement" personalization type: more than half of the participants chose to improve the technology and partially agreed to using SmartWare. There was a high agreement level (A) about the interaction abilities that needed to be addressed: i.e., all participants decided to address Carole's lack of cognitive interaction abilities.

To implement these high-level decisions, Table 7.2 shows that different TM components were chosen by participants. The only TM component that was agreed upon by all participants (A) was educational: all participants chose to provide their patient with a paperback manual to help them with medication instructions and equipment use. However, all participants agreed to avoid (Anot) using websites and CD ROMs for further education. There was disagreement about providing a touchscreen and mobile app (D), partial agreement about videoconferencing features, and disagreement about the device setup (i.e., home-based or mobile-based). It is worth mentioning that the SerViU Personalize Tool allows the user to select two types of device setup modes (i.e., home-based and mobile-based); however, no participant chose both setups at the same time in this mode.

For communication methods, there was a high level of agreement (A) about using video and phone calls while participants partially agreed not (Pnot) to use SMS and email to communicate with the patient. There was disagreement about the data transfer method (real-time and interactive). All participants agreed not (Anot) to allow the patient to use store-and-forward as a data transfer method (i.e., where the patient can willingly choose when and what to transfer); there was partial agreement (P) about using Wi-Fi and Bluetooth technologies for connectivity coverage, with less agreement about GPRS and cable connection.

Participants partially agreed (P) to secure a wired power supply via cords to the main unit, supplemented by other chargeable battery-powered devices, while agreeing not (Anot) to let all devices be powered only by chargeable batteries.

In this mode, there was total agreement (A) about permitting joint operation of the TM system by patient and clinician and to automate tasks.

Participants disagreed about access to healthcare resources. Half the participants agreed (D) to use resources from the initial plan; the other half chose to ask for resources from the same hospital (D) and partially agreed not to import resources from international sources (Pnot), while agreeing not (Anot) to ask for nationally available resources (inter-provincial). One participant decided to select both the initial plan and the hospital with a preference for the initial care plan.

All participants agreed that the patient would agree to use the newly personalized care plans.

The overall scores produced by the SerViU formula (Table 7.1) ranged from 8% to 44%. Specifically, there was a tendency toward fulfilling the highest ICT applicability. Three of four analysis units scored 100% for ICT applicability and only one scored 66.6%. Contrarily, only one analysis unit scored 100% for resource accessibility: scoring 100% requires selection of resources from the initial care plan, a selection only made in Unit 1.3 which is the same unit that scored 66.6% for ICT applicability.

The main rationale behind personalization decisions identified in this TM mode was improving the usability of the TM service. This was followed by the accessibility (availability and feasibility) of resources and patient education, respectively. The rationale least considered was trust of technology. As defined in Table A5.1 (Appendix 5), participants desired to simplify the tasks and reduce complexity for the patient.

The main rationale for selecting personalization types at the higher level was to improve the usability of the TM system, followed by patient education. The participants emphasized the need to prepare the patient for her disease management and make necessary adjustments in the current plan to improve her interaction abilities.

The rationale behind addressing Carol's mental interaction abilities was to overcome the medical limitations presented in the case study scenario. To this end, the participants focused on improving usability when selecting telehealth components. Participants made different decisions regarding the setup of the system. For example, a home-based setup was preferred by one participant because this would help Carole develop self-management skills through her medication routine (i.e., improving self-management). Another reason offered for a home-based setup was because her disease condition indicated that she should not be allowed outside by her physician (i.e., medical limitation).

The rationale for choosing communication methods was to improve the usability of the TM system to better support interaction with the patient. Real-time updates about the patient's biodata and disease condition were deemed essential by the participants. They disagreed on how to address this in terms of whether it would be better to select real-time or interactive data transfer.

The selection of connectivity technologies was mainly based on the availability of resources and improving patient mobility. According to a participant, flexibility was needed to allow Carole to spend time at her daughter's home or to move within her residence. Some participants suggested that owning a smartphone would help Carole to connect via GPRS, though this may not be available for all patients.

The rationale behind selecting power supply components mainly concerned having constant power backup; however, the participants selected different options to achieve this. For example, the selected options ranged from cable-connecting the main unit to providing multiple power sources. Another rationale was to simplify the recharging tasks for patients. In other words, improving the usability of the TM system could improve the patient's ability to operate the equipment.

Despite all the participants selecting all the operations personnel options (i.e., further assistance, further education, and technology improvement), these selections were motivated by different rationales. Firstly, the patient may not have been allowed to or been able to make decisions due to medical limitations, such as disease severity or mental limitations (e.g., dizziness) caused by side effects. In this case, a clinician would need to assist the patient in the medication process. The second rationale related to patient education. Based on this rationale, some participants assigned a clinician to educate and interact with the patient. The third rationale was data accuracy: the patient might make a data entry error, necessitating automated entry or entry by the clinician.

The main rationale emphasized in the talk-aloud transcripts was resource availability; much less emphasis was put on the provision of the appropriate resources. While participants selected different options in the SerViU Tool (i.e., initial plan, hospital, national, or international), they mostly selected the initial plan and hospital. One participant opted to select two options—"initial," then "hospital"—as a means to prioritize selecting the health care network of the resources used to implement their personalization decisions. Another participant preferred the initial plan so as to be compliant with the Health Insurance Portability and Accountability Act (HIPAA), a legal privacy constraint which set the standard for sensitive patient data protection. This would affect the providers' ability to select data center locations and automatic recording methods for patient information. It is worth mentioning that the tool does not allow selection of two network-related options; hence, the participant suggested this prioritization.

The patient's assumed willingness in this mode was influenced by various rationale themes compared with the two other TM modes. These included simplicity, knowledge about the personalization process, availability of guidance support, and personal interaction.

Remote Medication Management Mode (Units 2.1–2.4).

> Carole started to use a Medispenser (smart pill dispenser device) that was prefilled by a community pharmacist. This device tracked Carole's adherence to her medication and reported this to the data center at the Canadian hospital. The first problem arose when Carole thought the pharmacist had made a mistake regarding her medication dose. She called the TM nurse outside of working hours but could not contact her; then, she decided to stop taking the medication. The next day, the TM nurse was alerted in the daily report about missed doses. She contacted Carole and discussed the matter.
>
> The second problem Carole encountered was a disruption to her Wi-Fi connection caused by a power outage which took place during a storm. As a result, the device's battery was depleted. Carole replaced the auxiliary battery but could not restore the Wi-Fi connection and device settings. She measured her vitals, but her biodata information was not sent to the data center.

Table A4.2 (Appendix 4) shows that there was full agreement among the participants (A) that further assistance and further education should be provided; however, participants disagreed

(D) about providing a technology improvement. There was a high agreement level (A) about the interaction abilities which needed to be addressed—Carole's lack of mental interaction abilities.

Table A4.2 shows that different TM components were chosen by participants to implement these personalization options. They agreed to use a universal TM unit that included all the needed features and functions in a single unit. Half the participants (D) agreed to provide touchscreens and videoconferencing features, with less agreement (Pnot) about providing a mobile app. The participants agreed (A) to provide the patient with a booklet, which provided medication and equipment operation instructions, for educational purposes.

A home-based setup for the TM system was agreed upon by all participants; a mobile setup was less preferable to the participants.

In terms of communication, there was high agreement on a video call (A) and partial agreement on phone calls (P). There was also high agreement not to use text and email to interact with the patient (Anot and Pnot, respectively). Regarding data transfer, the participants agreed not to allow the patient to use the store-and-forward function, whereby the patient could choose what information to send and when to send it. There was partial agreement (P) to use a real-time data transfer mode and partial agreement (Pnot) not to use the interactive mode. Most agreed (A) that the connectivity technology should be Wi-Fi, with partial agreement on Bluetooth technology (D) and less agreement on GPRS (Pnot). The selection of communication methods and data transfer technologies is consistent with the home-based setup intended to keep the patient in the controlled monitoring environment preferred by participants.

There was disagreement regarding the power supply, though half of the participants chose to provide a mix of wiring and chargeable batteries. Participants preferred for main units to be wired while complementary devices, such as the weighing scales, could be powered with chargeable batteries.

With regard to operational information, there was full agreement (A) to use automatic tasks for functions such as biodata capture and data transfer. This option, however, always necessitated patient, clinician, or both to be operations personnel. There was partial agreement (P) about delegating operation of the equipment to the patient and disagreement (D) about clinician involvement.

In terms of healthcare resource accessibility, there was partial agreement about using resources belonging to the initial care plan. Moreover, there was agreement about avoiding the use of resources from other provinces (national) and international healthcare networks.

All participants agreed that the patient would agree to use the newly personalized care plans.

In this mode, the SerViU formula produced overall scores in a range of 19%–70%. Specifically, opinions were divided with half (two of four) of the participants scoring the applicability of ICT personalization options at 100% and a majority (three of four) scoring the accessibility of healthcare resources at 100%. In terms of ICT applicability, half the participants gave a score of 66.6%—a high–moderate score. Hence, resource-driven decision-making tendency had a high–moderate score.

The main rationale behind the choices made in this TM mode pertained to the patient's education, followed by resource availability, and improving the usability of the TM system, respectively.

At the higher-level decision-making level (personalization options) the dominant theme was patient education. As defined in Table A5.1 (Appendix 5), the clinicians supported improvements in the patient's knowledge and capability to self-manage and operate the technology. This included providing guidance and assistance to the patient in a way that enabled the patient to act in case of power outages by preparing the patient both technically and psychologically.

Participants' decisions were influenced by the trust in technology rationale when addressing the patient's mental interaction abilities. Trust in technology (Table A5.1, Appendix 5) includes privacy issues and the reliability of outcomes. The patient lost confidence in her pill dispenser device, believing that it was providing incorrect medication and timing, causing her to stop using it.

The selection of TM components was mainly based on improving technology by avoiding complexity, resulting in the choice of an all-in-one unit. Using patient education as a rationale, for simplicity the participants preferred booklets over electronic sources of knowledge.

The equipment setup was based on improving the usability and availability of resources. When Carole took a pill, she was also supposed to measure her blood pressure. According to one participant, one way to make this easier for her would be to locate all the equipment at the same place—for example, at home or her daughter's home.

There were three rationales behind the selection of communication methods. The first was improving the technology (i.e., ease-of-use or taking the right pill at the right time). Securing visual interaction with the clinician was the second rationale. As stated by more than one participant, taking a pill requires measuring blood pressure, necessitating accurate readings. In this case, the clinician might prefer to visually supervise the process of the patient taking the pill and measuring her blood pressure. Therefore, it makes sense that the third rationale was selection of appropriate resources. Accordingly, the selection of a data transfer mode was motivated by the need for immediate information (i.e., real-time data transfer). The rationale for the selection of connectivity technology was to improve usability by wiring power to the TM equipment (e.g., home phone line). This, according to a participant, assured the patient that she was always connected to her care provider and eliminated the need for her to think about the Wi-Fi settings.

The rationale for securing the power supply was to support mobility and safety. The participants recognized the importance of securing the power source; however, a patient might trip and fall when using a power cable.

The main rationale behind the operational decision (the personnel decision) was the availability (accessibility) of healthcare resources. This rationale, as defined in Table A5.1 (Appendix 5) included human and nonhuman resources and could be affected by jurisdictional limitations. Other rationales had less influence on decision-making. Trust in technology is a rationale based on which the participants decided that patients preferred to interact with clinicians in person over receiving texted instructions. The rationales of improving usability and educating the patient were behind the decision to provide guidance before and during medication taking: i.e., swallowing the pill, measuring blood pressure, and reporting the readings.

Selection of a healthcare network was mainly influenced by the availability of resources, though there were other less influential rationales. Supporting mobility was the basis for suggesting a system that supports patients who frequently travel abroad. The clinicians suggested this based on their understanding of legal and jurisdictional challenges, such as HIPAA standards. Such challenges could limit patient mobility and, hence, affect the benefits of their TM care plans, such as insurance rates, privacy rights, and technological advancement (i.e., social, economic, and technological constraints).

According to the participants, the patient's willingness to use the personalized care plan is influenced by various themes, such as simplicity, knowledge of the personalization process, education, appropriate resources, trust in the process, personal interaction, and medical limitations.

Monitoring by TM nurse (Units 3.1–3.4)

> Carole started eVisit sessions where she and the nurse, at one location, communicated with a medical group regarding her condition and progress. Although Carole was being medicated and monitored from home, she often commuted to the hospital because of equipment availability required by the medical consortium. Carole considered the eVisit sessions to be a waste of time because the group of doctors on the other end talked among themselves and consumed beverages, and she could hear a dog barking. This made her feel disconnected and disrespected.

Table A4.3 (Appendix 4) shows that there was partial agreement (P) about the further education and technology improvement personalization options and disagreement (D) about offering further assistance (half the participants). It was unanimously agreed (A) that Carole's mental interaction abilities needed to be addressed, especially with regard to feeling disconnected and disrespected.

Table A4.3 (Appendix 4) also shows that providing videoconferencing features was partially agreed (P) upon by the participants. This was the highest level of agreement for TM components: half of the participants (D) disagreed that universal units (all-in-one) and touchscreens were appropriate for this situation, while there was less agreement about using

SmartWare, mobile apps, and websites. A paper knowledge source (e.g., device manuals) was disagreed upon (D) by the participants—half decided to provide it.

Both types of equipment setups were equally but partially agreed upon (P). Moreover, half the participants decided that the TM systems should be flexible enough to accommodate both home- and mobile-based setups.

There was full agreement (A) on the necessity of video calls to communicate with the patient. Half the participants preferred to use phone calls as a support over the video call communication method. There was partial agreement (P) on communicating via electronic written communication, such as email instructions, while SMS was less agreed upon (Pnot)—almost all agreed to avoid these communication methods. The most agreed upon (P) data transfer mode was real-time. Less agreement was found for the store-and-forward mode (Pnot), while there was agreement to avoid interactive data transfer. This could be attributed the patient's preference to avoid online meetings with her medical consortium. The connectivity technology agreed on by all (A) was Wi-Fi. The remaining connectivity technologies (i.e., wired, Bluetooth, and GPRS) recorded Pnot-level agreement, indicating partial agreement to avoid using them.

The participants disagreed on the power supply options. Half of the participants agreed to devices with chargeable batteries (D), while the other half (D) preferred power supplies to include, at a minimum, wiring for the main unit with the remaining equipment to be charged by batteries. Most importantly, all participants agreed to avoid wiring for all devices (Anot).

Delegating operation of the equipment to the patient was highly agreed upon (A). Partial agreement (P) was recorded for involvement of the TM nurse and automating tasks. Moreover, all the participants preferred a combination of operations personnel: for example, half the participants preferred to combine the three options (operation by patient, clinician, and automatic operation).

There was another disagreement regarding the selection of healthcare networks. Bringing resources from the initial care plan scored D-level agreement, and hospital resources were given the same score, while all participants agreed to avoid (Anot) cross-provincial and international healthcare resources.

Interestingly, there was partial agreement on the patient's acceptance (willingness) of the personalized care plan.

The SerViU formula produced overall scores ranging from 10% to 41%. Specifically, there was an equal tendency toward each of these variables. For example, half the participants focused on selecting the most appropriate TM components regardless of their availability (accessibility and feasibility of resources). The other half did the opposite. The lowest score pertaining to ICT applicability was 66%—a moderate–high level score. The highest score was 100%, and the lowest score for resource accessibility was 27%.

The personalization decisions in this mode were mainly influenced by the rationale of improving the usability of the TM technology.

The most important rationale behind choosing personalization option types was the need for further assessment. Participants believed that in such a complicated situation, further knowledge was needed before making a personalization decision. More knowledge was needed about the patient's behavior regarding the treatment and technology, their wellbeing progress (even historical), and social information. Some participants evaluated the awareness level based on eVisit outcomes, others evaluated Carole's interaction abilities and technology literacy, while still others suggested evaluating the TM team in terms of telehealth etiquette. Other rationales had lower influence on decision-making at the higher level. These included trust in technology, patient education, and improving usability. The rationales determining which interaction ability should be addressed were improving self-management, improving usability, trusting the technology, and patient education. All the participants addressed the issue of feeling disconnected though they were motivated by different rationales.

Rationales for the selection of TM components mainly aimed to improve usability and the patient's education. Trust in technology and visual interaction had a lower influence. The goal was to address the disconnectedness that the patient felt; this would be achieved by providing communication and measuring devices for the patient to use at their convenience in addition to training them to use such technologies.

The equipment setup was decided upon using the rationale of improving usability—a theme that includes enhancing access to resources, improving ease-of-use, and providing practical solutions. This complexity was addressed by providing a flexible TM system that accommodated both home- and mobile-based setups which were needed and preferred by the patient.

There were many rationales for selecting communication methods. Further assessment of patients' abilities and disease condition was agreed to be essential, as was use of technology for communication. Improving the usability of the technology for the patient helped to accommodate her needs and preferences. Improving self-management refers to consulting the patient about an agenda and meeting time prior to calls with the TM nurse (e.g., confirmation via text messages). The participants stated that visual interaction—seeing the nurse at the other end—would improve the patient's ability to learn from her.

The immediacy of information transfer influenced decision-making about the data transfer method to the same extent as other rationales such as improving usability, improving self-management, and resource availability. This was the only TM mode where the real-time data transfer rationale did not dominate the decision because the participants emphasized that empowering the patient (in terms of her mental status) by allowing her to select the timing for data transfer would improve self-management.

The main rationale for choice of TM component was to improve usability. This was due to a desire to provide easy-to-use, noise-free, mobile-supported equipment convenient to the patient as needed. At a lower level of influence, resource availability and appropriate resource rationales were behind TM components selection. These rationales included appropriate and available resources to accommodate the patient's situation, such as nurse hours. Easier communication with the patient was deemed most important; the main rationale for this was improving usability.

The power supply decision was also influenced by multiple rationales. Improving the usability of the TM system to provide both types (wired and chargeable batteries) should provide uninterrupted power for the TM equipment, which is in line with the rationale of securing the power supply. The patient's safety and medication limitations influenced the decision in this scenario because some participants preferred to avoid wires to prevent tripping accidents.

The rationales behind personnel selection were the need for further assessment of the patient's situation and improving the usability of the TM. Participants wanted to improve the patient's feeling of connectedness. They expressed a need to observe and learn more about the patient's interaction abilities during eVisits to make sure that the TM system accommodated her preferences.

The selection of a healthcare network was resource driven. Resource availability was the main influencer; all the participants agreed to avoid national and international resources, hence focusing on the initial care plan and the hospital's resources.

Willingness was conditional upon improving the eVisit experience. However, in one unit direct approval from the patient seemed doubtful, even after the care plan was personalized. One participant expressed concern about the learning curve required to improve the patient's participation (interaction with the eVisit). Hence, educating the patient about positive participation could, over time, result in her approval to adhere to eVisits.

7.2.2. Cross-Case Analysis

Table 7.3 shows a comparison of participants' decisions and selections between the three TM modes (Mode 1 is remote patient monitoring, Mode 2 is remote medication management, and Mode 3 is monitoring by a TM nurse). Decisions via the SerViU Personalize Tool were compared across the three modes at high and detailed levels, including types of personalization options, interaction abilities, technology components, setups, operations, jurisdictional limitations, and expected willingness to accept the personalized care plan. Table 7.3 uses the same agreement level coding system as Table 7.1.

Table 7.3

Results from Cross-Case Personalization Options

		1. Remote patient monitoring	2. Remote medication management	3. Monitor by TM nurse
Personalization options	Further assistance	A	A	D
	Technology improvement	P	D	P
	Further education	A	A	P
Interaction abilities	Mental	A	A	A

	Physical	D	Anot	Anot
Telemonitoring components	Universal unit	P	A	D
	Multi-devices	Pnot	Anot	D
	Touchscreen	D	D	D
	Mobile device	Pnot	Anot	Anot
	Videoconference device/feature	P	D	P
	SmartWare	P	Anot	Pnot
	Hardware	Pnot	D	Anot
	Mobile app	D	Pnot	Pnot
	Website	Anot	Anot	Pnot
	CD ROM	Anot	Anot	Anot
	Paperback learning	A	A	D
Setup	Home-based	D	A	P
	Mobile	D	Pnot	P
Communication methods	Text	Pnot	Pnot	P
	Email	Pnot	Anot	Pnot
	SMS	Pnot	Anot	Pnot
	Video call	A	A	A
	Phone call	A	P	D
Data transfer	Store-and-forward	Anot	Anot	Pnot
	Real-time	D	P	P
	Interactive	D	Pnot	Anot
Connectivity	Wired	Pnot	D	P
	Wireless Wi-Fi	P	A	A
	Bluetooth	P	D	Pnot
	GPRS	D	Pnot	Pnot
Power	Cable cord	Pnot	Pnot	Anot
	Cord and chargeable devices	P	D	D
	All chargeable devices	Anot	Pnot	D
Personnel	By clinician	A	D	P
	By patient	A	P	A
	Automatic	A	A	P
Healthcare network	Initial plan	Pnot	P	D
	Hospital	D	Pnot	D
	Canada	Anot	Anot	Anot

	International	Pnot	Anot	Anot
Willingness	Yes	A	P	P
	Neutral	Anot	Anot	Pnot
	No	Anot	Anot	Anot

The most agreed upon personalization types were further assistance and further education, with full agreement (A) in Modes 1 and 2. However, participants disagreed about whether assistance or education was applicable in a Mode 3 scenario, where the patient felt disconnected and disrespected. In this mode, whether the patient trusted the technology had a big influence on the participants' decisions. There was partial agreement across the three modes regarding the benefit of improving the technology. Whenever improving the technology was a choice, the main rationale behind it was to improve the usability of the TM system and its ease-of-use with simpler tasks and better resource accessibility.

Mental interaction ability was addressed via the SerViU Tool for all TM modes—all modes had the highest agreement level (A). However, physical interaction abilities had the least agreement across all the TM modes. For all TM modes, the participants emphasized the patient's cognitive ability to perform tests, such as measuring breath rate and blood pressure, communication via the TM device, and understanding instructions.

There was partial agreement regarding using universal TM units (all-in-one) and videoconferencing features. Less agreement was found for hardware and software improvement and for the use of mobile apps. For all TM modes, the participants agreed to avoid (Anot) digital educational components (i.e., websites and CD ROMs), while all participants agreed to using paper-based educational materials (A for all modes).

Preferences for choosing a home-based device setup varied across modes (Levels D, P, and A). Hence, this was not dismissed as a choice. Less agreement was found for mobile-based device setups. Specifically, in Mode 2 (the pill dispenser) the mobile-based setup had a Pnot agreement level.

In terms of communication methods, participants agreed (A) that video calls would be the best option for all TM modes. There was less agreement about phone calls. For all TM modes, the participants agreed to avoid text communication methods (SMS, text, email). Participants recommended that the store-and-forward data transfer method be avoided for all TM modes. Partial agreement was recorded with regard to using the real-time data transfer method. Participants recommended that interactive data transfer be avoided, especially in TM Mode 3 (monitoring by TM nurse). This can be attributed to personalization of the care plan to address Carole's feelings of being disrespected and disconnectedness experienced during eVisits. The connectivity method of Wi-Fi technology had the biggest agreement across TM modes, with less agreement on wired and Bluetooth technologies, while GPRS had the least agreement (Pnot). This can be attributed to the desire to provide simple settings to the patient that could support her mobility (see Table 7.5).

A mix of cables and chargeable batteries was found to be optimal for all TM units. The participants chose to keep the main TM unit wired while providing the other devices with chargeable batteries (e.g., weighing scales and blood pressure measurement devices). The rationales of patient safety and mobility influenced this decision, particularly to avoid tripping and falling accidents (see Table 7.5).

In terms of operations personnel, all options (by clinician, by patient, automatic operating) were acceptable for all modes, with a preference for mixing personnel. In all TM modes, operation by patient and automated operation (automatic data capture and transfer) were preferred over involving the clinician as the main operator.

In terms of choosing a healthcare network to access resources, there was agreement on avoiding national and international networks for all TM modes. Resources from the initial care plan and the hospital had a higher agreement level across the TM modes.

Across the TM modes there was agreement that the patient would be willing to use the personalized care plan facilitated by the SerViU Personalize Tool. The participants agreed that the patient would not reject any personalized TM mode (see Table 7.3).

As shown in Table 7.1, the average overall score of the three TM modes was 31.3%. The three TM modes had close scores, ranging from 23.5%–42.3%. TM Mode 2 had the highest score at 42.3%. The highest overall score in any analysis unit was 70.8% (Mode 2). Table 7.1 also shows that no unit scored 100% in both ICT applicability and resource accessibility.

There was a tendency toward a high score (75%–100%) for ICT applicability across the TM modes (average of 86.13%). Six out of twelve analysis units gave a score of 100% to ICT applicability. In these units, all personalization options were implemented (i.e., further assistance, further education, and technology improvement) as well as a varied selection of TM components and operation modes. The other scores were 66.67%, which is a moderate score resulting from using at least three personalization options. TM Mode 1 had the highest ICT applicability average score (91.7%; three of four units scored 100%). TM Mode 2 had the lowest ICT applicability score (75.03%), but this is still a high score. Finally, TM Mode 3 had an ICT applicability of 83.3%.

In terms of resource accessibility, the average score was moderate (50%–74%) across TM modes, with an average of 62.5%. Five out of twelve analysis units scored 100% (i.e., preferring the initial care plan's resources over other options). According to the accessibility formula, the initial plan scored 100%, the hospital scored 27%, and remaining options were equivalent to a 12% accessibility score. The highest score was found in Mode 2 (average 81.9%; three out of four units scored 100%, i.e., preferring resources from the initial care plan). TM Mode 1 experienced the lowest score (41.88%) because three out of four units preferred resources from other sources than the initial care plan—two from the hospital and one from an international source.

In this section, themes that represent the rationales behind the personalization decisions are presented to help create a better interpretation of selections made on the SerViU Personalize Tool and their scores; themes are defined in Table A5.1 (Appendix 5). There were three dominant themes: improving the usability of the TM system, patient education, and resource accessibility (see Table 7.4). Other rationales scored lower in terms of influencing personalization decision-making (i.e., visual interaction with the patient, using the appropriate resources, and considering the patient's medical limitations). More rationale themes were found at the cross-case level, including trusting the technology, safety, real-time data transfer, and improving self-management (see Table 7.4). The two latter rationale themes are not necessarily weak influencers; they could have a focused influence on a particular SerViU option, such as selecting TM components, compared with the improving usability rationale that affected decision-making throughout the SerViU Personalize Tool (see Table 7.5).

Table 7.5 displays how rationales influenced the selection of each option when using the SerViU Personalize Tool. For example, improving the usability of the TM system for patients was a main rationale that influenced the decision to select TM components and communication methods. This rationale had a lesser influence on selecting connectivity technology, which was also influenced by resource availability. The selection of power supply setup and operations personnel were also influenced by the rationales of improving usability and the healthcare network. The selection of communication methods is another example of a function influenced by the patient's education, resource availability, trust in technology, and visual interaction; this also applies to other options in the SerViU Personalize Tool.

Table 7.4

Results from Cross-Case Themes

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Mode
	5	12	1	5	1	22	7	12	5	15	2	2	2	0	6	Mode1
	6	4	0	1	0	15	1	18	3	16	0	2	0	3	7	Mode2
	3	3	0	7	4	15	2	2	1	5	1	1	0	5	4	Mode3
Total	**14**	**19**	**1**	**13**	**5**	**52**	**10**	**40**	**9**	**36**	**3**	**5**	**2**	**8**	**17**	

Table 7.4 displays a cross-case thematic analysis regarding reasons behind making the personalization decisions. The SerViU Personalize Tool was utilized to make high-level and detailed personalization options by selecting technology components and operation methods. The numbers are the sum of reasons expressed by the participants throughout four sessions within each TM mode (Units 1.1 – 1.4 belong to TM Mode 1)

Table 7.5

Results from Themes: SerViU Components

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction
Personalization options	3	0	0	6	0	6	0	16	0	2	1	1	0	2	0
Interaction abilities	0	0	0	1	1	1	3	6	0	2	0	0	0	2	0
TM components	5	0	0	0	1	26	2	6	0	5	1	0	0	3	10
Setup	0	0	0	1	1	4	1	0	0	4	0	0	0	0	0
Communication methods	1	0	0	0	1	15	1	4	0	1	0	0	0	3	3
Data transfer	2	0	0	1	1	1	0	0	8	1	0	0	0	0	1
Connectivity	1	0	0	0	0	4	1	1	0	3	0	0	2	0	0
Power supply	0	0	0	0	0	2	0	0	0	1	1	4	1	0	0
Personnel	0	0	1	1	0	2	2	3	0	4	0	0	0	1	0
Healthcare network	2	0	0	0	0	1	0	0	0	13	0	0	1	0	0
Willingness	0	19	0	2	0	0	1	0	0	0	0	0	0	0	0

Table 7.5 shows that, in addition to improving technology, visual interaction between the patient and her clinician was an important rationale for selecting TM components. Although selecting the healthcare network was mainly influenced by the resource availability rationale, the decision was also influenced by themes such as appropriate resources and improving usability. This could explain the tendency of some participants to select national and international healthcare networks over the initial care plan or the care-providing hospital (i.e., thinking that international resources are higher quality than local ones).

In the same way, Table 7.5 shows that determining which interaction ability to address was influenced by a combination of rationales. The participants' decisions were influenced by trust in the technology (i.e., "ensuring a closed virtual environment"), resource availability (i.e., "selecting between real-time or interactive depends on the availability of the healthcare team") and improving usability (i.e., "the equipment should facilitate testing at both home and the nurse's location"), but their decisions were influenced more by the patient's education. Selecting the operations personnel was another complicated decision because it was influenced by six rationales.

Linking the findings displayed in Table 7.5 to those in Table 7.3 helps us better understand the level of agreement for each option in the SerViU Personalize Tool. For example, there was agreement to avoid digital educational TM components (e.g., website and CD ROMs). This agreement can be deemed as mainly influenced by the improving usability rationale (i.e., instruction simplicity and technology ease-of-use). This was confirmed by the "think aloud" transcripts of the case study participants: many of them expressed their desire to avoid complexity and provide the patient with direct access to information.

Further understanding of the influence of rationales can be gleaned by linking findings from Tables 7.4 and 7.5 to those in Table 7.3. For example, the trusting the technology rationale appeared in TM Modes 2 and 3, and influenced the selection of TM components, communication methods, and operations personnel. This can be attributed to the situations narrated in the scenarios (TM Modes 2 and 3) where the technology affected the patient's confidence in the system and their feeling of connectedness, respectively.

Each TM mode was simulated by four different participants with different areas of expertise or experience. Biases may have existed due to potential familiarity with a particular TM mode. I cross-linked findings from Tables 7.6, 7.7, and 7.8 to compare selections, scores, and rationale with the professional backgrounds of participants.

First, I checked whether participants made identical choices for different scenarios when using the SerViU Personalize Tool; each participant simulated decision-making for two different

TM modes. Table 7.6 shows that the participants tended to make similar but not identical personalization decisions for different scenarios. No two participants made identical personalization decisions. Different decisions were made at the high level by four out of six participants (further assistance, further education, and technology improvement). At the detailed level, minor differences existed in selections like device setup, TM components, communication methods, and data transfer technologies.

Table 7.6 also shows that further assistance and further education personalization options were offered by all participants; however, technology improvement was not offered by Participant 3—a physician with more than ten years of experience. Participant 3 participated in the second and third TM modes and scored second highest in TM Mode 2 and highest in TM Mode 3. Table 7.8 shows that the rationale which mainly influenced Participant 3 was the availability of resources, combined with other rationales at a lower level of influence.

In two units, all participants agreed on addressing mental interaction abilities and physical abilities. Both units belonged to TM Mode 1 (remote patient monitoring). By comparison, physical interaction abilities were only addressed by Participants 4 and 5; their rationale was to improve usability. Both were registered nurses, though with different levels of experience—thirty years and three years respectively (see Table 7.8).

In terms of selecting TM components, Table 7.6 shows high agreement among participants to use a universal TM device (all-in-one) and videoconferencing features. There was disagreement about offering touchscreens and software/hardware improvement components. This disagreement was not associated with the participants' specialty or years of experience. The same applied to the choice of texting as a communication method (SMS and email). Participants 3 and 5 were the only ones to make such a decision (different specialties and years of experience) but for different reasons. Participant 5 stated that the patient should be provided with all available communication methods and could select which to use each time. Hence, Participant 5 had no specific preference and decided to provide all the communication methods listed in the SerViU Personalize Tool. Participant 3 (a physician) preferred for the patient to be able to see the instructions and read them, in addition to other communication methods, to feel connected.

Another disagreement was found regarding the selection of the power source. Only Participant 3 (a physician) decided that all devices should be charged using batteries, including the main unit. The participant emphasized that there should be “no power cord.”

In terms of selecting a healthcare network, the only participant who selected the international network was Participant 2, a social worker. In the voice-recording transcript, the participant expressed a preference for providing the best option for the patient (i.e., appropriate over available).

As for the patient’s willingness to adhere to the newly personalized care plan, Participant 6 (a psychotherapist) expressed doubt. The dominant rationale for this participant was improving usability. However, the participant had no other significant differences from the others.

Results of scores and themes across participants (Tables 7.1 and 7.7) show that only two participants had similar scoring tendencies when personalizing different TM mode scenarios (e.g., resource accessibility scores remained high in both TM modes). The other four participants had different scoring tendencies across TM modes.

Moreover, by cross-linking information between Table 7.4 and Table 6.1, it was possible to determine that high and low scores (overall, ICT applicability, or accessibility of resources) were not associated with length of experience, specialties, or TM modes. Participants with many years of experience could score as high as 70% or as low as 8%.

Table 7.6 shows the results of SerViU Personalize Tool selections made by the case study participants.

Table 7.6

SerViU Options Selections Made Across Participants

	Participant #	**1**		**2**		**3**		**4**		**5**		**6**	
	Unit #	**1.1**	**2.1**	**1.2**	**3.1**	**2.2**	**3.2**	**1.3**	**2.3**	**1.4**	**3.3**	**2.4**	**3.4**
Personalization options	Further assistance	*	*	*	*	*	*	*	*	*		*	
	Technology improvement	*	*	*	*				*	*	*		
	Further education	*	*	*	*		*	*	*	*	*	*	*
Interaction abilities	Mental	*	*	*	*	*	*	*	*	*	*	*	*
	Physical							*		*			
Telemonitoring components	Universal unit	*	*	*	*	*	*	*	*			*	
	Multi-devices									*	*		*
	Touchscreen	*	*			*	*			*	*		
	Mobile device									*			
	Videoconference device/feature	*	*	*	*				*	*	*		*
	SmartWare	*		*						*	*		
	Hardware		*	*					*				
	Mobile app							*	*	*	*		
	Website												*
	CD ROM												
	Paperback learning	*	*	*	*	*	*	*	*	*	*	*	
Setup	Home-based	*	*		*	*	*	*	*		*	*	
	Mobile			*		*	*			*	*		*
Communication methods	Text				*	*	*			*	*		
	Email				*					*			
	SMS									*	*		
	Video call	*	*	*	*	*	*	*	*	*	*	*	*
	Phone call	*	*	*				*	*	*	*	*	*
Data transfer	Store-and-forward				*								
	Real-time	*	*				*		*	*	*	*	*
	Interactive			*		*		*					
Connectivity	Wired	*	*									*	*
	Wireless Wi-Fi	*	*		*	*	*	*	*	*	*	*	*
	Bluetooth	*	*					*	*	*	*		

	GPRS			*		*	*	*					
Power	Cable cord			*								*	
	Cord and chargeable devices	*	*					*	*	*	*		*
	All chargeable devices				*	*	*						
Personnel	By clinician	*	*	*	*			*	*	*	*		*
	By patient	*	*	*	*	*	*	*	*	*	*		*
	Automatic	*	*	*	*	*	*	*	*	*	*	*	
healthcare network	Initial plan					*	*	*	*			*	*
	Hospital	*	*		*					*	*		
	Canada												
	International			*									
Willingness	Yes	*	*	*	*	*	*	*	*	*	*	*	
	Neutral												*
	No												

Table 7.7

SerViU Score Across Participants

Distribution of analysis units		Case study participants #					
#	Telemonitoring modes	1	2	3	4	5	6
1	Remote patient monitoring	1.1	1.2		1.3	1.4	
	ICT applicability %	100	100		66.7	100	
	Accessibility %	27.7	12.1		100	27.7	
	Total score %	19.62	8.03		44.10	22.24	
2	Remote medication management	2.1		2.2	2.3		2.4
	ICT applicability %	100		66.7	100		66.7
	Accessibility %	27.7		100	66.7		100
	Total score %	19.62		40.95	70.88		37.80
3	Monitoring by nurse		3.1	3.2		3.3	3.4
	ICT applicability %		66.7	66.7		100	100
	Accessibility %		27.7	100		27.7	100
	Total score %		10.46	40.95		20.93	40.95

Table 7.7 displays detailed scores across participants to demonstrate the differences between participants in terms of resulting scores: total score, ICT applicability, and accessibility.

Table 7.8

Themes Across Participants

Participant	Specialty	Units	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction
1	Registered nurse	1.1, 2.1	4	3	1	0	0	8	0	7	2	7	1	1	1	1	4
2	Social worker	1.2, 3.1	2	2	0	2	2	6	2	5	1	3	0	0	1	0	6
3	Physician	2.2, 3.2	2	1	0	3	1	2	1	3	0	6	1	1	1	0	2
4	Registered nurse	1.3, 2.3	4	5	0	4	0	7	4	7	2	7	0	1	1	2	2
5	Registered nurse	1.4, 3.3	1	0	0	2	2	12	3	5	1	9	1	0	0	2	1
6	Physiotherapist	2.4, 3.4	0	2	0	1	0	18	0	9	2	4	0	2	0	2	3

	physician																

Table 7.8 shows that rationale themes had unequal influence on participants' personalization decisions. Data accuracy, for example, was addressed by one participant—a registered nurse. Rationales such as patient education, further assessment, and visual interaction had similar influences on the participants' personalization decisions. The resource availability rationale also affected all participants' decisions, but it had higher influence. This table also shows that some participants were influenced more by particular rationale themes than others. Participants 5 and 6 (registered nurse and psychotherapist, respectively) were mostly influenced by the improve usability rationale. This rationale was dominant in this case study: it influenced the decisions of all participants, but it had less influence on the four other participants.

7.3. Evaluation

The case study participants were asked to evaluate the SerViU Personalize Tool in terms of relevance to the telehealth context, its usefulness for telehealth care plan personalization, and sufficiency of the information it provided to make personalization decisions. Two measurement methods were provided: a 3-point Likert scale and an open feedback form. The latter was thematically analyzed and discussed in light of the three evaluation criteria. The extracted themes were based on agreement with a statement provided for each evaluation dimension (e.g., "the decisions made using the SerViU Personalize Tool are relevant to the TM context"). Results of the Likert scale are presented in Table 7.9 and definitions and analysis of the themes are presented in Tables A6.1 and A6.2 (Appendix 6).

Table 7.9

Participant's Evaluation Using a 3-Point Likert Scale

Participant	Analysis	Relevance (x/3)	Usefulness (x/3)	Sufficiency (x/3)

	Units			
1	1.1 and 2.1	3	3	3
2	1.2 and 3.1	3	3	3
3	2.2 and 3.2	3	2	2
4	1.3 and 2.3	3	3	2
5	1.4 and 3.3	3	3	2
6	2.4 and 3.4	3	3	3
Average		3	2.83	2.5

Table 7.9 shows the numerical evaluation of each participant who used the SerViU Personalize Tool. Each participant applied the SerViU Personalize Tool in two different TM modes in one simulation session. Hence, the evaluation was cross-case. All scores are between two and three, with no score below two.

The SerViU Personalize Tool's relevance had an average score of 3/3. The SerViU Personalize Tool's usefulness had an average score of 2.83 because one participant gave an evaluation score of 2/3. The sufficiency of SerViU's information (to make a personalization decision) received an average score of 2.5 because half the participants provided an evaluation score of 2/3.

Agreement with the Usefulness Statement. The evaluation feedback confirmed that the participants' agreement with the given statements was mostly influenced by the usability rationale, and participants suggested that the tool be further improved to make it easier to use and to make personalization decisions. The second dominant rationale was clinician education, indicating the need for further training and guidance for clinicians in the use of the SerViU Personalize Tool. There were other rationales given in the evaluation feedback, but these had less influence (e.g., patient-centeredness, real-life applicability, decision-making process; see Table A6.1, Appendix 6).

Agreement with the Relevance Statement. The participants emphasized that the SerViU Personalize Tool is usable, but that a few additions are needed, especially in terms of offering more customization options that are relevant to the TM context. The scenarios and subsequent decisions were found to be relevant to the real-life TM context and patients' situations. The tool was also found to be a source of knowledge, helping clinicians to "think outside the box" and see an "overview of options." Participants emphasized the patient-centeredness of SerViU's functions and features, whether they were at home or in hospital.

Agreement with the Usefulness Statement. The participants advised that the SerViU Personalize Tool is helpful, quick, easy to use, a better communication method, and it helps to provide better accommodation of patients' needs. However, the clinician's knowledge and limitations (relating to TM technology as well as SerViU) was a dominant rationale used to evaluate the usefulness of the SerViU Personalize Tool. Some participants suggested that not all clinicians are knowledgeable about technology and emphasized the need to prepare clinicians to use TM in general and SerViU Personalize Tool specifically. On the one hand, some participants suggested improving SerViU's guidance for clinicians through further training and easy-to-access and easy-to-read instructions. On the other hand, some participants suggested adding more filters to categorize disease conditions and health demographics. Some participants also suggested adding clinical settings to the SerViU Personalize Tool (i.e., amending the setup section to include settings other than "home-based" and "mobile-based"). This should improve usefulness in terms of variety and flexibility of options.

Agreement With Sufficiency of Information Statement. In making the personalization decision, the dominant rationale was to improve usability of the tool. Some participants suggested allowing patients to manually enter information and send free text messages because this would better update the clinician about the patient's situation. Some participants suggested adding detailed information about which resources are available at each healthcare network, such as the hospital, before making the decision. This would help save time in making higher scores and selecting feasible and affordable options. Other participants suggested equipping the tool with additional information regarding patient history, such as surgical pathway, social determinants of health, and educational and financial levels.

7.4. Conclusions

The SerViU Personalize Tool was demonstrated by simulating personalization decisions in three different TM modes (represented by three validated TM scenarios). The case study participants were clinicians with different specialties who participated in the SerViU Personalize Tool simulation. Each had different preferences and tendencies to implement different personalization decisions. Clinical specialties and length of experience had no significant effect on the results.

In TM Mode 1, the participants agreed on providing further assistance and further education as the most appropriate personalization options. Such decisions were mainly motivated by improving usability, resource availability, and patient education, respectively. This combination of priorities was reflected in the selection of technology components, such the partial agreement on whether to select an all-in-one TM device, video call features, or even mobile apps. SerViU achieved the highest ICT applicability scores in this mode because the participants selected all personalization options with the highest number of technological components that SerViU Personalize Tool made available.

In TM Mode 2, the participants fully agreed to provide further assistance and further education as personalization options, with less agreement to provide technology improvement than for TM Mode 1. The three rationales of patient education, improving usability, and resource availability had almost an equal influence on the personalization decision-making, but patient education had the biggest influence. These priorities for decision-making were reflected in selections at the detailed level. For example, all participants agreed that the patient should be given less complicated devices that combine all functions, i.e., all-in-one and home-based, for simplicity and familiarity with the technology setup. SerViU achieved the highest resource accessibility scores and a lower ICT applicability rate than for TM Mode 1. This result reflects the participants' priority for using the initially prescribed care plan resources.

In TM Mode 3, there was disagreement at the higher level regarding the personalization options, which is a main difference from the two previous TM modes (TM Mode 1 and TM Mode 2). This disagreement was also reflected in the scores: e.g., there was an equal priority tendency between ICT applicability and resources accessibility. Moreover, this mode was the only one where the participants were uncertain about whether the patient would be willing to accept the new personalized TM services. The rationales of improving usability and further assessment influenced decision-making in this TM mode. The rationale of further assessment reflected the participant's hesitance in making personalization decisions prior to further observation and assessment of the patient's responses and interaction abilities. This could also be explained by having a low need for visual interaction with the patient, while trusting the technology had the biggest influence on decision-making for the other TM modes.

The cross-case analysis showed that the participants could make similar decisions at the high level (e.g., further assistance), but SerViU allowed for different ways to implement these decisions. In the first two TM modes, all participants agreed to provide further assistance and further education, selected different combinations of components, and made decisions based on different rationales.

This analysis also revealed that improving the usability of the TM services was the main priority, followed by patient education and resource availability. It also revealed the importance of visual interaction through videoconferencing features and scheduled video calls as part of the service to provide guidance, maintain connectedness, and assist with medication.

It is worth mentioning that the scores produced by the SerViU formula were not associated with participants' specialties or length of experience. However, there was a minor influence on some personalization decisions at the detailed level. The diversity of participants' expertise and experience reflects the diversity in the telehealth context; hence, detailed decisions could be prioritized differently. SerViU, in other words, could be utilized across specialties and experiences; however, additional education and training are still necessary.

In terms of the SerViU evaluation, there was agreement among the participants that the tool is useful for personalizing TM services, relevant to the TM context, and equipped with sufficient information to make the personalization decision. However, the latter criterion was less agreed upon by the participants. Further detailed information was suggested, including TM clinical setup, disease-related categories, and patient demographics.

The main theme that emerged from the SerViU Personalize Tool evaluation was its usability. The participants' feedback suggested detailed improvements to make it more usable for clinicians: "It would be great to have the option for the client to manually enter their vitals or note that they took an extra medication. This will help the clinician better manage the care plan and give them a record of the event should anything change in the patient's condition."

Feedback also suggested that it could be more relevant to the context and more sufficiently informative. "The SerViU Personalize Tool needs to be adaptable."

The participants agreed that the tool and scenarios represent real-life TM contexts and patient situations. However, the participants emphasized the need to educate clinicians about technical information and train them to use the SerViU Personalize Tool.

Using SerViU revealed that some decisions have different values from different clinicians' perspectives. For example, familiarity with the patient situation could influence selecting the same medical team (i.e., a resource from the initial plan). Patient-centeredness was behind such a selection rather than the availability and affordability of the resource. Future improvements to the SerViU Personalize Tool should consider the influence of patient-centeredness on the formula.

SerViU provided the flexibility to select a combination of digital and analog personalization options, such as actual meetings and paper handouts. SerViU facilitated the simultaneous addressing of multiple issues relevant to the patient situation and delivery mode. For example, in the second TM mode, the patient lost trust in the technology; multiple combinations of personalization options were available (in the SerViU Personalize Tool) to clinicians to resolve the patient's issues.

Overall, SerViU facilitated the achievement of the goals of both the patient and clinician, providing the patient with convenient operating options and assurance to the clinician that their patient was in a controlled monitoring environment. Moreover, SerViU provided the opportunity to diversify and simplify personalization options (e.g., mixing communication, connectivity, and power supply methods tailored to the patient's needs).

Chapter 8: Discussion

8.1. Introduction

This chapter reflects on how the research objectives (ROs) were addressed, what was achieved, and what limitations could have affected the study results. The RO was to develop a service design method in a manner that accounts for patient-related, context-related, and technology-related factors. SerViU was suggested as a service design method that could achieve that objective. RO1 was to assess the existing service design methods and determine whether they can guide telehealth personalization in a manner that accounts for long-term adherence. This objective was achieved via a systematic literature review which showed limited capabilities of existing service design methods to guide telehealth personalization.

Thus, RO2 was to develop a method that leveraged existing methods and relevant frameworks. This objective was achieved by utilizing an ICT personalization framework that could articulate the support provided by SerViU in addressing patient-related, context-related, and technology-related factors (Fan & Poole, 2006).

RO3 was to evaluate the applicability and relevance of SerViU for personalizing telehealth services to achieve RO1 and RO2. RO3 was achieved by means of the design science research (DSR) paradigm (Hevner et al., 2004), wherein the research activities were guided by the design science research methodology (DSRM; (Peffers et al., 2007). The remainder of this chapter is organized as follows:

In Section 8.2, relevant work is compared to the SerViU method with regard to personalizing telehealth services and addressing long-term adherence. To this end, design method examples are discussed in terms of objectives, functionalities, and supporting tools. In Section 8.3, the research methodology is discussed, including alternative analysis techniques. In

Section 8.4, the research contributions are discussed: telehealth personalization research, service design research, and telehealth service delivery practice. In Section 8.5, the research limitations are elaborated, and future improvements and expansions are suggested.

8.2. Related Work

As elaborated in Chapter 3, telehealth personalization attempts were found in the literature which aimed to improve long-term adherence; such attempts focused on one of the factors recommended by the recent research agenda (Dinesen et al., 2016): e.g., to provide solutions to identify patients' preferences through enhancing data collection technologies (van den Berg et al., 2012) or designing devices and systems in a way that can respond to the needs of patient groups instead of individuals (Lunde et al., 2018; Ramallo-Fariña et al., 2015). Other attempts focused on enhancing the educational support provided to patients and their caregivers through face-to-face or informational web pages concerning awareness of and behavior related to treatment and disease (Bal et al., 2016; Wens et al., 2008). Improving adherence measurement methods was another means of addressing patients' needs. For example, the Medical Adherence Rating Scale (MARS) improved the previous measurement method by integrating psychometric questionnaires to interpret patients' responses (Thompson et al., 2000).

In the literature review (Chapter 3), two long-term adherence factors received a minor focus with regard to ICT personalization support: patient-related and technology innovation. Since these recommendations by Dinesen et al. (2016), recent telehealth personalization research has addressed the patient-related factor. For example, in (Thirunavukkarasu et al., 2021) the patient is seen as the primary source of information to determine whether the service was adequately delivered and whether their expectations were met. The research recommended that the concerned authorities develop action plans to circumvent telemedicine patients' disadvantages and investigate patients' perceptions, preferences, and contributions to the telehealth service. To this end, enhancing the patient's engagement with the service improved the personalization process (Shetty et al., 2018). One way to improve patients' interaction abilities with the service context is by providing new and innovative technologies, including online platforms and personalized messages, supported by enhanced data collection technologies (Saaei & Klappa, 2021).

In terms of features needed to be available to design a service that can personalize telehealth services, the existing service design literature partially addressed long-term adherence factors as recommended (Dinesen et al., 2016). Examples include Multilevel Service Design (MSD), User Requirements Notation (URN; (Amyot, Becha, Braek, & Rossebø, 2008), and user experience (UX; (O'Flaherty et al., 2013; Yoo et al., 2015)).

The MSD method helps to interconnect resources and stakeholders at different service levels. The method utilizes different graphical modeling for each level; an affinity diagram for the network and the service systems level—a second service level where services are cocreated by integrating resources belonging to different actors). The blueprinting diagrams represent the lowest level, which is the service. MSD lacks functional ICT personalization support because there is no mechanism to measure goal achievement. MSD also lacks ICT personalization architectural and relational support for user-related information, i.e., individual users. Service architecture used for MSD lacks the personal level where individual users (patients) use the telehealth service, exchange information (resources) with their provider, and accordingly receive a personalized service.

URN could provide the three ICT personalization types if both diagramming tools were used: Goal-Oriented Requirement Language (GRL) and Use Case Map notation (UCM). The latter facilitates the modeling of different scenarios where the decision made contributes to the goal achievement of different services stakeholders. Using open-source tools such as jUCMNav could help develop strategies or goal satisfaction levels and then propagate the values to other elements in the GRL diagram: i.e., goals (Amyot, Becha, Braek, & Rossebo, 2008). URN's capabilities could be complemented by integrating functions that facilitate capturing users' information and actions in real time.

Such a function is available in the user interface method (UX). This function is deemed to be a relational ICT personalization support because it expands the contextual understanding of the service to include individual users. This method, however, is limited to that service level (personal level) and would require architectural ICT support functions to link with the other service levels.

Combining the features and capabilities of these three methods could theoretically support the personalization of telehealth services to address long-term adherence factors. Nevertheless, it would require customization, coding, and interlinking with interfacing tools familiar to clinicians.

SerViU facilitates an ongoing recording and assessment of individual users' real-time experiences and facilitates personalizing their services accordingly. SerViU is anchored in the ViU concept where the patient's use of the service contributes to developing unique experiences and determining the value of the service. Both are considered to be essential for making the need-to-personalize decision, and an appropriate amount of focus on each aspect of the experience is needed. SerViU utilizes GRL diagrams to develop a granular understanding of the influence of different aspects on need-to-personalize decisions. GRL diagrams also help verify whether patients' value expectations were met. SerViU, however, utilizes other tools to achieve personalization goals. In combination, these tools facilitate all types of ICT personalization support needed at the personal service encounter level: familiar interfaces, multiple personalization options, and a special formula to prioritize the personalization options which assists the clinician in selecting the most appropriate option.

Tool-based telehealth personalization methods were found in the literature; two examples are presented in this section. The first example is a tool-supported telehealth service research study (de Jong et al., 2017) that enables tailoring (personalizing) the service based on the patient's feedback. This is a telehealth service supported by a self-management tool developed to study the difference in outpatient visits and hospital admission compared with non-telehealth-supported services. The study was conducted on patients with inflammatory bowel disease. Results showed that outpatient visits were lower when the patients used the telehealth option.

In this telehealth service, patients perform tests and measurements using telehealth devices and then report results using a web-based tool. The service relies on the patient's self-reporting skills and provides weblinks to access educational materials. Patients reported information by answering daily questionnaires. The daily questionnaire included disease activity, medication use, treatment adherence, treatment satisfaction, and side effects, including infections. There were also questions on factors affecting the disease condition (including nutritional status, smoking, stress, life events, anxiety and depression, social support, physical exercise, and self-management skills), and patient-reported outcome measures on quality of life and work productivity. Medication adherence was measured by the Morisky Medication Adherence Scale (Cross et al., 2012; de Jong et al., 2017).

The personalization decision-making criterion is score-based, and the mechanism is based on a ten-item questionnaire covering four domains; each domain has a score. The tool calculates the need for intervention by meeting score thresholds which flag a "clinical flare" if symptoms suggest disease activity. If an alert is received, a healthcare provider on the local team contacts the patient for further assessment within two working days. Deciding if visits to the outpatient clinic are needed is based on the nature and severity of the clinical complaints (de Jong et al., 2017).

Similarities with SerViU include having multiple phases where patients use the equipment to report results, a score-based assessment, and the provider deciding how to move forward. Patients are empowered by providing their daily feedback via answering a questionnaire. A second similarity is having a tool that calculates the need to take action and determines the direction of that action. The ongoing assessment process is another similarity. The patient is scheduled to use the service for three months and is monitored daily. However, the monitoring sequence is reduced when the patient scores better results, representing an aspect not considered in SerViU.

The researchers sought not only patient empowerment, but also to promote a telehealth service with a communication function (answering daily questionnaires) and a wide range of web-based learning methods (educational materials). The tool-supported telehealth service by de Jong et al. (2017) addresses the need to personalize generic telehealth services and considers adherence to be the decision-making criteria. However, the personalization process relies on the patients' ability and commitment to answering their daily questionnaire. The former could be less applicable to patients who lack cognitive interaction abilities, and the latter could be a cause of nonadherence.

Score-based decision-making represents another similarity to the SerViU Assess Tool; in addition to the questionnaire feedback, where multiple aspects (domains) are evaluated with scores, each has a threshold value: in this case, clinical flair. Clinical flairs belonging to different domains alert the nurse to take action to address a particular domain. No overall scores were considered to have a threshold: i.e., the domains are independent of each other.

The action (i.e., the personalization process) in this example did not consider the availability and appropriateness of healthcare resources. The only suggested actions were to guide the patient to the nearest clinic, exchange emails with the provider, or have the telemonitoring (TM) or assessment sequences reduced (e.g., monthly instead of daily).

In another example, among other criteria, healthcare resources were considered to personalize telehealth services (Zanaboni et al., 2016) offered to chronic obstructive pulmonary disease (COPD) patients. The service consists of home training exercises, TM, and self-management. Depending on the patient's condition, training sessions are programmed. Training intensity is based on an intensity-based scale (Borg, 1998). Program modification (i.e., personalization) can be made by the physiotherapist or the patients themselves.

The patient uses a website tool to access training programs for individual patients; fills in a daily questionnaire regarding wellbeing and a training diary; checks historical data, electronic exchange messages, schedule videoconferencing sessions; and assesses individual goal settings and goal attainment. Every evening, patients are asked to use their pulse oximeter at rest and to fill in the daily electronic diary on the website.

In videoconferencing sessions, patients are encouraged to set goals for their ongoing training program and daily activities. The patients are also provided with self-management education and training to address their adherence to their telehealth service.

The tool detects and reports worrisome events and guides the personalization process based on changes in health status, quality of life, anxiety, depression, self-efficacy, subjective impression of change, physical performance, level of physical activity, and personal experiences of telerehabilitation. The tool conducts a cost-effectivity analysis which considers hospital resources, delivery mode of the telerehabilitation intervention, and equipment. The unit cost for each resource is based on specific public tariffs from the national diagnosis-related group, diagnoses, procedures, and associated costs (Zanaboni et al., 2016).

This method is similar to SerViU in that it is a tool-supported telehealth service that considers the patient's experience, personalization preferences (goals setting), and healthcare resources (represented in the cost-effectiveness of provided equipment). No real-time data transfer was discussed; the patients input data into the website tool at prescribed frequencies.

Both examples of tool-supported telehealth services considered individual patients' experiences and technological advancement as a means to personalize telehealth services. In the example of (de Jong et al., 2017), patients contributed to personalizing their training programs, and in the example of Zanaboni et al. (2016) patients were encouraged to and educated on how to set goals in telehealth services. (Zanaboni et al., 2016) considered the service context to be represented in the cost-effectiveness of the prescribed healthcare resources.

SerViU, as a tool-supported telehealth service, addresses all long-term adherence factors: patient-related, service context-related, and technology advancement–related. Moreover, in SerViU patient information is collected at different phases using different tools. During the Use phase (Phase 1), a TM report is generated daily at the data center which includes logins, biodata, a data entry log, and a daily questionnaire. In the Assess phase (Phase 2), the nurse conducts a physical assessment, interaction abilities assessment, and asks the patient, in a face-to-face meeting, about the perceived usefulness and the ease of use of the telehealth services. During the Personalize phase (Phase 3), the patient can indicate preference for and acceptance or rejection of personalized options; hence, the patient is more empowered and their needs are better understood.

Healthcare resource selection and utilization are addressed in SerViU, from developing a list of personalization options (LPO) in Phase 0 to assessing the accessibility level and articulating how healthcare resources could support ICT personalization toward long-term adherence.

8.3. Research Design

This thesis adopted the DSR paradigm to ensure a rigorous methodology for designing an artifact to solve the observed problems (Hevner et al., 2004). The DSR paradigm provided the means to study personalization decision-making, both as a process and behavior. The former is represented in the analysis of personalization options selected using the SerViU Personalize Tool. The latter is represented in the identification and analysis of the rationale behind making the personalization decision via a thematic analysis of the voice-recorded decision-making simulation sessions.

The DSRM was used to guide research activities within the DSR paradigm and provided useful support for demonstrating SerViU's applicability and evaluating its ability to reach the research objectives (Peffers et al., 2007). Within the DSRM, a number of methods are recommended to demonstrate an artifact, including simulation, conditional prediction, case study, and experiment observation.

For this research, a decision-making simulation was conducted which utilized a case study. Applying both techniques helped to involve telehealth clinicians in the simulation process without using a case study design; experienced telehealth field professionals simulated the personalization decisions. Moreover, the multiple case study context provided by the Canadian hospital facilitated access to clinicians who worked and currently work with different TM delivery modes.

The analyzed data included personalization selections made by the participants, the scores produced via the SerViU formula, and rationale themes identified from the transcripts of voice-recorded (think aloud) decision-making simulation sessions. This triangulation helped generate a better interpretation and allowed the tracing back of participants' personalization decisions and rationales that dominated the decision-making process.

8.4. Contributions

This research contributes to telehealth personalization research by providing a method that guides the transformation of generic telehealth services into personalized services. This research contributes to service design by introducing a new service level - personal service encounter levels, which is paramount for better supporting the personalization of ICT-enabled services.

SerViU goes beyond existing telehealth personalization research that focuses solely on technical or educational dimensions (Bal et al., 2016; van den Berg et al., 2012). Indeed, by drawing on the Fan and Poole (2006) ICT personalization framework and the core service-dominant logic concept of Value-in-Use (Stephen L Vargo & Robert F Lusch, 2004), SerViU provides guidance both at the level of technologies and human experience—hence, in a truly sociotechnical, patient-centered manner.

SerViU is situated as a new level of intervention for service design, separate from but interrelated with the level of generic service encounter design and higher-level contextual levels of service design (Patrício, Fisk, Falcão e Cunha, et al., 2011). SerViU guides the integration of capabilities and resources that belong to individual patients into the complex multilevel telehealth context.

Practically, the suggested service design method enables ongoing personalization of telehealth services throughout the treatment period via the Use–Assess–Personalize process as a means to meet the patients' expectations, hence addressing long-term adherence factors (Dinesen et al., 2016; Hommel et al., 2015). SerViU involves individual patients in decision-making and adjusting their telehealth services based on their evolving expectations and abilities—an implementation of the ViU concept (Stephen L Vargo & Robert F Lusch, 2004). The provider's interests and service offers are also addressed in this research by 1) guiding the development of the LPO in Phase 0 by which the TM team can research and update a catalog of options; and 2) supporting the resource procurement decisions by calculating the hardship of access to healthcare resources needed for the personalization process but available in different jurisdictions. To this end, the SerViU formula, embedded in the SerViU Personalize Tool, calculates resource accessibility based on the centrality theory, where service resources that belong to different jurisdictions are represented in networks of resources belonging to different levels.

8.5. Limitations and Future Work

SerViU's applicability to personalizing telehealth services is limited to existing services; i.e., it does not support designing new telehealth services that could fit each individual patient. Further research could explore potential opportunities, such as integrating decision support systems and patients' electronic health records with algorithms to facilitate the development of an initial "personalized" telehealth service. Further research could also increase the generalizability of SerViU because it is focused only on three delivery modes of TM services. Increasing generalizability could be achieved through testing SerViU on more TM delivery modes, considering telehealth services other than TM (such as telerehabilitation), and approaching more than one provider. The latter could improve SerViU's adaptability to different health care providers in terms of their services, resource priorities, and policies.

SerViU's scope is limited to chronic disease context with long-term treatment. Future research could consider short- and mid-term treatment using telehealth services.

SerViU's effectiveness over time has not been evaluated. A longitudinal study on the perceived health impact of personalization on individual patients as well as on providers' offerings would be needed for such an evaluation.

Due to the scope limitation of this thesis, a core SerViU personalization tool was chosen for demonstration and evaluated by simulating clinicians using its decision-making function—the SerViU Personalize Tool. Further validation is needed for the remaining SerViU tools, such as the tools belonging to the Assess phase (Phase 2). The SerViU Assess Tool and SerViU GRL Assess Tool facilitate granular evaluation and assessment criteria. Validating such tools would help providers adjust the influence percentages of each of the five sections (which currently have equal influence) to the need-to-personalize decision. Such an adjustment could be provider-based, service-based (e.g., telerehabilitation), disease-based (e.g., congestive heart failure or chronic respiratory obstructive pulmonary), or age category–based.

The SerViU Personalize Tool provided only three levels of patient approval for the personalized services (i.e., willingness = prefer, neutrally accept, or reject). The tool did not facilitate an explicit preference, such as operation method or equipment. The case study results show that patients might have conditional approval. Future research could consider different modes or levels of approval, such as using a combination of questionnaires, a Likert scale, and special preferences to facilitate patient's conditional approval. Such an arrangement could improve the patient-provider interaction in terms of understanding the patients' expectations; hence, the provider could reprioritize the personalized telehealth services to meet the patient's expectations.

The overall average scores from the simulated decision-making in the demonstration phase were low; this is attributed to the influence of the accessibility variable. SerViU utilizes the centrality equation, a social network theory (Scott, 2013; Vargo et al., 2012) to differentiate between the hardship of resource accessibility across different healthcare networks (service levels). Some participants chose to bring in telehealth resources from healthcare networks other than the initially prescribed service, which reduced the final score. To this end, it is recommended that the formula be optimized to balance the influence of the accessibility variable.

Moreover, it was noticed that some participants perceived international resources to be of a higher quality (i.e., a better option despite differences in price and availability concerns) for providing care to the patient. Future research could investigate providers' different priorities regarding procurement management and clinical practices, which could influence their personalization decision-making.

The interface of the SerViU Personalize Tool did not show detailed scores to the participants (i.e., the applicability and accessibility scores); these were revealed in the case study results for discussion purposes. The results showed high applicability scores when the clinician made detailed and focused decisions. It is recommended that future research investigate the possibility of including this information within the tool's interface to inform the clinician about how applicable and accessible their ICT personalization option is, hence improving the personalization decision-making and procurement process over time.

The LPO embedded in the SerViU Personalize Tool is expected to vary based on the providers' needs and priorities, though the general categories (Appendix 8) in the SerViU LPO form guide minimum requirements. Potential expansion of this list could consider feedback information from the case study participants, such as patient disease history. Some participants suggested adding demographical and geographical disease-related information.

SerViU validation in this study is limited: prior to the Covid-19 pandemic, TM services had only been newly implemented in Canadian hospitals and healthcare institutions; this limited access to participants with experience in TM. Only six case study participants validated SerViU, and all belonged to the same institution (the Canadian hospital). Thus, this study is limited to a sole institution's perspective; nevertheless, the study included participants with different expertise and professional experiences. Future research could expand across different providers to include city-wide or region-wide health institutions. Such an arrangement could shed light on different providers' resource-driven priorities, personalization trends, and specialties.

Only healthcare professionals (i.e., clinician case study participants) participated in the research because SerViU, as a method, is meant to be used by professionals rather than by patients. While in a real-life setting patients would be engaged in the SerViU personalization process, (e.g., willingness in Phase 3, perceived usefulness, and perceived ease-of-use in Phase 2), it was challenging to engage patients as study participants because of time and healthcare resource constraints. It is recommended that future research engage patients, especially regarding self-dependence, ability to interact with telehealth technologies, feelings of disconnectedness, and lack of trust in technology; addressing these concerns could improve patients' acceptability of and engagement with their telehealth services and, thus, their adherence.

The criteria used by the case study participants represent one way to evaluate the SerViU Personalize Tool, though other techniques could evaluate the use of technologies in telehealth, such as the technology acceptance model (TAM; (Bagot et al., 2020). Moreover, using a simplified software application to represent the SerViU Personalize Tool could have affected the evaluators' decisions, especially with regard to ease of use. The interactive Excel spreadsheet was designed to have a user-friendly, simplified interface to accommodate participants and, hence, mitigate potential bias. The participants may not be technically or equally skilled, which would have affected their evaluation of the tool. Nevertheless, some participants requested further explanation of the instructions and training on using the Excel spreadsheet. Future research is recommended to further explore a user-friendly interface design that suits telehealth clinicians.

The case study results show that the clinician could be driven by the availability of resources (human and nonhuman); participants requested that resource availability be indicated within the SerViU Personalize Tool (i.e., inventory and local storage-related information). The scarcity of resources across providers and jurisdictions is a concern and could influence personalization decision-making. The LPO provided business- and brand-related information, such as prices, but not inventory availability. Therefore, it is recommended that the providers link inventory information to their LPOs.

Each participant personalized two different TM services; SerViU allowed each participant to use their approach to implement their personalization options in the detailed decision-making (i.e., selecting the appropriate TM components, operating mode, and jurisdictions). This shows that SerViU is flexible enough to accommodate such differences. However, each participant did not personalize one of the three TM modes; because the sessions took place during the Covid-19 pandemic, participants were only asked to complete two modes out of respect for the value of their time. Future research recommends that each participant personalize all TM modes to obtain the maximum benefit of their participation and secure more personalized care plans (i.e., eighteen instead of twelve personalized services).

Moreover, the SerViU Personalized Tool was represented in an interactive spreadsheet and was coded by a research assistant who is not a professional coder. This arrangement might have limited the capabilities of the tool and its interface. These reasons may have contributed to the participants' evaluation of the SerViU Personalize Tool, especially concerning the sufficiency of information.

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Appendix 1: Definitions

This appendix includes conceptual literature-based definitions and interpretations utilized in this thesis.

Table A1.1. *Long-Term Adherence Factors*

	Factors	Description
Patient-related factors	Patients' preferences	This factor is about the patients' goals, and their acceptability of and willingness to use the telehealth technologies, take the treatment, and consider it to be useful (Dinesen et al., 2016). Patients can choose not to take the treatment. Such decisions are thought to be based on the patients' awareness of disease and treatment, such as technical challenges and treatment complexity (Lee et al., 2018).
	Patients' abilities	This factor is about the patient's physical and mental abilities to interact with the telehealth treatment/system and is expected to help to adjust the system (Hommel et al., 2015). It includes the perceptual motor cognitive abilities, as well as technical competence (Dinesen et al., 2016). It can be affected by the nature of the treatment, e.g., long sessions, long-term treatment plans, the complexity of technology, and polypharmacy. It can be addressed by continuous evaluation and consultation with patients to refine the treatment plan (Dinesen et al., 2016; Hommel et al., 2015; NICE, 2016).
Context-related factors	Stakeholder involvement	This factor is about the interests and concerns of stakeholders that can affect telehealth service offers and delivery. This includes users, caregivers, service providers, and third-party suppliers. Concerns can include business sustainability, data custody, technology, practice ethics, as well as resources—cost and availability (Dinesen et al., 2016; Wherton et al., 2015).
	Cross-sector integration	This factor is about improving collaboration between different healthcare sectors to act as a single organization (i.e., the hospital, district nursing, medication centers, and primary care providers; Dinesen et al., 2016). This collaboration should consider multidisciplinary practices to redesign chronic disease management practices to address nonadherence (Dinesen et al., 2016; Hommel et al., 2015).
	Resource management and optimization	This factor addresses the efficient use of healthcare resources, such as accuracy of data (e.g., the ubiquity and interpretability of information), cost-efficiency, as well as appropriate selection of technology (e.g., using chronic disease dashboards; Dinesen et al., 2016). These factors also apply to human resources, where the qualifying skilled human resource would improve the patients' adherence to the treatment (Jackson et al., 2012).
Technology-related factors	Technology innovation	This factor is about creating new knowledge by integrating data across sources and technologies, such as multiple devices, platforms, and databases. This includes data systems, infrastructure, and data analytics. For example, software algorithms can be applied to user-generated data and EHR to predict use and preferences, and then to refine the treatment process accordingly. This is thought to create a personalized, convenient, and patient-centered treatment (Dinesen et al., 2016).
	Technology improvement	This factor is about improving telehealth technologies to become user-friendly. This includes user interfaces, the weight and size of equipment, and mobility. It can also contribute to having shorter sessions (i.e., by improving sensor technologies to capture data faster; Dinesen et al., 2016).

Table A1.2

ICT Personalization Types: Adapted from Fan and Poole (2006)

Personalization support type	Description
Architectural	The ability of the service design method to provide and reallocate service resources, entities, and connect goals with tasks in a way that addresses individual patients' needs and interests. To fulfill a human being's needs for expressing themselves through the design and build of an immersive, functional, and delightful environment that is compatible with a sense of personal style. This can be via modeling and modularizing the service architecture to map the "cognitive, effective, and social-cultural aspects of users" (Fan & Poole, 2006, p.106).
Relational	The ability of the design methods to mediate between the patient's situation (abilities and preferences) and the service context to create a common convenient environment. To fulfill a human being's needs for socialization and a sense of belonging by mediating between the social context and relational aspects of the user (Fan & Poole, 2006), e.g., developing knowledge about patients' abilities and preferences and mediating with relevant aspects in the service context.
Functional	The ability of the design method to improve the patient's outcomes by providing tools that enhance quality, efficiency, and effectiveness of a patient's interaction with telehealth. To increase efficiency and productivity of system use, by means such as enabling, and utilizing useful, usable, and user-friendly tools (Fan & Poole, 2006).

Table A1.3

Long-Term Adherence in the Literature

Article			Patient		Service			Technology	
Author	Title	Text	Abilities	Preference	Stakeholder	Cross-sector	Resource	Innovation	Improvement
Dinesen et al.	Personalized Telehealth in the Future: A Global Research Agenda								
	p.4	Future research is needed to identify additional factors that promote telehealth acceptance, such as human–technology interaction, organization of the health care system, and social factors.	*	*		*			
	p.4	Most successful telehealth models require an extensive care team, including disease management nurses and other personnel. Independent practitioners may not be able to employ care teams and would potentially need to rely on an intensive service model, such as visiting nurses for home health care.			*	*	*		
	p.9	Ultimately, there must be a match between technology, personalization, and the patients' needs and wishes. Providers must match the proper device and data management approach to the proper patient.	*	*	*		*	*	*
	pp. 16–17: the research agenda	**12 items elaborated in Dinesen's sheet in this file:** patient, home, healthcare professionals, healthcare system design/organization, technology, data systems infrastructure, data analysis, developing new telehealth technologies, research methods, financing, privacy and security, and public policy.	*	*	*	*	*	*	*
Hommel et al.	The Telehealth Enhancement of Adherence to Medication in Pediatric IBD (TEAM) Trial: Design and Methodology								
	p.1	Lack of sufficient health care resources and patient/family time commitment for weekly treatment are primary barriers to receiving appropriate self-management support.		*			*		
	p.2	Reasons for nonadherence in adolescents with IBD are largely behavioral and include forgetting, being too busy, interference of the medication with an activity, and being away from home.	*	*					
	p.3	Technologically based means of communication play an integral role in the lives of adolescents. Using technology to deliver adherence interventions to youth across the country may result in the advent of more generalizable, cost-efficient, and acceptable treatments.		*	*		*		
	p.12	Partnerships with multidisciplinary practices and hospitals will be critical to disseminating the application of telehealth approaches to treating nonadherence in the near future.				*			
	p.14	The existing policies pertaining to licensure reciprocity and reimbursement must be revisited as the development and application of technology in health care is advancing at a faster rate than health care insurance and law.		*	*		*		

Harvey et al.	Factors influencing the adoption of self-management solutions: An interpretive synthesis of the literature on stakeholder experiences								
	p.1 (patient)	Implementers need to pay attention to factors including (a) cost: how much resource will the intervention cost the patient or professional; (b) moral: to what extent will people adhere because they want to be "good" patients and professionals; (c) social: the expectations of patients and professionals regarding the interactive support they will receive; (d) motivational: motivations to engage with the intervention; and € cultural: how patients and professionals learn and integrate new skills into their daily routines, practices and cultures.	*	*	*				
	p.4 (health care professionals (HCPs))	Factors influencing HCPs' adoption included evidence that the solution works; the solution's alignment with goals of the organisation within which the HCP worked; the integration of the solution into existing systems and practices; adaptability of the solution to learning and incorporating change; transfer of decision-making power to patients and the effect of the solution on patient–doctor relationship, time and resource constraints; incentives and motivation to use the solution; how the solution is promoted to the organisation within which the HCP worked; HCPs' appraisal of level of patient skill; and interest in the solution and adaptability of the solution to current roles and responsibilities.			*	*	*		
	pp.5–8 (managers)	Factors affecting implementation included ability to deliver intended benefits of the solution, engaging effectively with business models, sustainable funding and resources, creating effective policies such as making adoption mandatory for HCPs, compatible commissions process across sectors, and buy-in of senior leadership or active champions.			*	*	*		
Hirani et al.	Quantifying beliefs regarding telehealth: Development of the Whole Systems Demonstrator Service User Technology Acceptability Questionnaire								
	p.5	The results indicate that six important dimensions of TH user acceptability can be delineated (and taken as a definition of TH acceptability), each with satisfactory internal reliability. These are:							
		(i) enhanced care – beliefs about how the kit can improve the care patients received from the HCP (health care professional);		*	*		*		
		(ii) increased accessibility—beliefs indicating how the kit has facilitated the receipt of care from the HCP;			*				
		(iii) privacy and discomfort—beliefs regarding the concern patients have with how the kit impinges upon them and safety of information monitored by the kit;		*					
		(iv) care personnel concern—beliefs regarding concern about the skills and continuity of the personnel looking after a patient;		*	*				
		(v) kit as substitution—beliefs about how the kit may be an alternative to regular care; and		*					
		(vi) satisfaction							

Appendix 2: Results of the Systematic Literature Review

The identified service design methods in the systematic literature review are firstly listed with their references, evaluated in terms of ICT personalization support they provided to long-term adherence factors, categorized, then cross-compared in terms of the ICT support provided by each category to long-term adherence factors.

Table A2.1

List of the Identified Service Design Methods

#	Method description name	References
1	Affinity diagrams	Grenha Teixeira et al., 2016; Atiq et al., 2017
2	Agent-based web design	Chhabra & Lu, 2007
3	Aligning value and implementation	Golnam et al., 2010
4	An agile approach to service responsibility and interaction design method	Millard et al., 2007
5	Bi-level optimization algorithm	Soto et al., 2017
6	Business–IT alignment (BITAM-SOA)	Chen et al., 2010
7	Business process modeling (BPM)	van Meeuwen et al., 2015; Efendioglu & Woitsch, 2017; Cardoso et al., 2009; Xu et al., 2011; Stuart & Tax, 2004
8	Capturing services as an R&D object	Bullinger et al., 2003
9	Collaborative service design	Baek et al., 2018
10	Component business architecture	Ramljak, 2017
11	Composite service design	Elhag et al., 2015
12	Computational thinking of service systems: Dynamics and adaptiveness modeling	Qiu, 2009
13	Consumer information systems as service modules	Tuunanen et al., 2011
14	Co-production in practice	Wherton et al., 2015
15	Designing and redesigning medical telecare services	Gortzis, 2007
16	Designing hybrid products	Gudergan et al., 2009
17	Discrete event simulation	Kawata, 2010
18	Dynamic use of service sharing	Arena et al., 2015
19	e3Value	Efendioglu & Woitsch, 2017; Godart et al., 2009
20	Environment-centered approach	Ohno et al., 2013
21	Event-based approach	Lemahieu et al., 2003
22	Experience-based collaborative service system model	Atiq et al., 2017
23	Fuzzy modeling	Kannan & Proença, 2009; Badinelli, 2012; Shaojing & Hong-Bin, 2016
24	Fuzzy-QFD	Shaojing & Hong-Bin, 2016; Yan et al., 2016

#	Method description name	References
25	Heterogeneous production arrangements coupling agribusiness machines industry	Dutra et al., 2014
26	Theatre-based	Stuart & Tax, 2004
27	Intentional modeling	Lessard, 2015; Drăgoicea et al., 2015; Chhabra & Lu, 2007; Nurcan et al., 2010
28	Interactive service design using computer simulation	Makino et al., 2009
29	Internet service engineering	Alter, 2012; Cardoso et al., 2009
30	IT-based participatory design	Menschner et al., 2011
31	Lexical expression for conflict solving	Akiyama et al., 2008
32	MINDS	Grenha Teixeira et al., 2016
33	Model-driven techniques for SOA	Stav et al., 2013
34	Modular service design synthesis	Løkkegaard et al., 2016
35	Multilevel service design (MSD)	Patrício et al., 2011
36	Multidimension service design synthesis	Løkkegaard et al., 2016; Aulkemeier et al., 2016
37	Multi-domain model integration	Fan et al., 2016
38	Multiscale service	Otake et al., 2011
39	Operational-based design	Alter, 2012
40	Persona modeling	Marcengo et al., 2009; Wärnestål et al., 2017
41	Platform design using adaptable service profiles	Chronaki et al., 2004
42	Process approach	Vassilakopoulou et al., 2016
43	Quality foundation development QFD	Simons & Bouwman, 2008; Wang et al., 2017; Shaojing & Hong-Bin, 2016; Sakao et al., 2006
44	Resource mapping	Campbell et al., 2011
45	Reusable process design	Erradi et al., 2007
46	Scenario-based context-aware service design	Lu & Hao, 2010
47	Sd4vn	Patrício et al., 2018
48	Service blueprinting	Lim & Kim, 2014; Wang et al., 2017; Patrício et al., 2011
49	Service experience	Mogre et al., 2009
50	Service flow modeling	Chou et al., 2012
51	Simplified four-dimensional structure	Sandin & Berggren, 2015
52	Simultaneous design of product and information systems	Metzger et al., 2017
53	Socio-technical systems engineering	Drăgoicea et al., 2015
54	Stakeholder mapping	Patrício et al., 2018; Yoo et al., 2015
55	Survey data for RFID platform design	Mogre et al., 2009
56	Tailored service solution with modular service architecture	Bask et al., 2014
57	Theory of inventive problem solving (TRIZ)	Chai et al., 2005; Wang et al., 2017
58	Three-dimensional requirement method	Kao et al., 2016
59	Unified modeling language (UML; class, activity, and sequence diagrams)	Erradi et al., 2007; Drăgoicea et al., 2015; Fan et al., 2016; Alter, 2012
60	User requirement notation (URN)	Amyot et al., 2008; Weiss & Amyot, 2005

#	Method description name	References
61	User experience (UX)	Yoo et al., 2015; O'Flaherty et al., 2013
62	Value exchange model	Tsai et al., 2013
63	Value-oriented service design	Sawatani, 2007; Liu et al., 2016; Weigand et al., 2009; Patrício et al., 2011; Stav et al., 2013
64	Variable service systems	Badinelli, 2012; Sun et al., 2010

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Table A2.2

ICT Personalization Supporting Long-Term Adherence Factors in Identified Service Design Methods

		Long-term adherence factors																				
		Patient-related						Context-related									Technology-related					
		Preferences			Patient abilities			Stakeholder			Cross-sector			Resources			Innovation			Improvement		
#	Method Description name	Architectural	Contextual	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
1	Affinity diagrams		*						*			*									*	
2	Agent-based web design																			*		
3	Aligning value and implementation			*						*			*									
4	An agile approach to service responsibility and interaction design method	*	*								*	*		*	*					*	*	
5	Bi-level optimization algorithm			*						*						*			*			
6	Business–IT alignment (BITAM-SOA)							*	*		*	*										
7	Business process modeling (BPM)	*	*	*				*	*	*	*	*	*	*	*	*						
8	Capturing services as an R&D object	*	*				*	*			*	*		*	*							
9	Collaborative service design		*						*													
10	Component business architecture	*	*					*	*		*	*										
11	Composite service design																			*	*	*
12	Computational thinking of service systems: Dynamics and adaptiveness modeling	*	*	*				*	*	*	*	*					*	*				
13	Consumer information	*	*					*	*					*	*					*	*	

		Long-term adherence factors																				
		Patient-related						Context-related									Technology-related					
		Preferences			Patient abilities			Stakeholder			Cross-sector			Resources			Innovation			Improvement		
#	Method Description name	Architectural	Contextual	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
	systems as service modules																					
14	Co-production in practice		*			*			*												*	
15	Designing and redesigning medical telecare services		*			*			*						*						*	
16	Designing hybrid products	*	*					*	*		*	*		*	*		*			*	*	
17	Discrete event simulation	*	*	*				*	*	*												
18	Dynamic use of service sharing		*	*																		
19	e3Value	*	*	*																		
20	Environment-centered approach		*	*					*	*					*	*		*	*			
21	Event-based approach	*	*					*	*											*	*	
22	Experience-based collaborative service system model	*	*		*	*		*	*		*	*		*	*							
23	Fuzzy modeling						*			*						*						
24	Fuzzy QFD						*									*						*
25	Heterogeneous production arrangements coupling agribusiness machines industry	*	*								*	*								*	*	
26	Theatre-based													*	*							
27	Intentional modeling	*	*					*	*		*	*		*			*					
28	Interactive service design using computer simulation																				*	*
29	Internet service engineering													*	*	*				*	*	*

		Long-term adherence factors																				
		Patient-related						Context-related									Technology-related					
		Preferences			Patient abilities			Stakeholder			Cross-sector			Resources			Innovation			Improvement		
#	Method Description name	Architectural	Contextual	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
30	IT-based participatory design		*	*		*	*		*	*											*	*
31	Lexical expression for conflict solving	*	*					*	*		*	*				*			*			
32	MINDS	*	*					*	*		*	*										
33	Model-driven techniques for SOA				*	*											*	*		*	*	
34	Modular service design synthesis										*	*		*	*							
35	Multilevel service design MSD	*	*					*	*		*	*										
36	Multidimension service design synthesis										*	*										
37	Multi-domain model integration									*	*	*										
38	Multiscale service	*	*			*		*	*		*	*		*	*							
39	Operational-based design	*	*					*	*		*	*										
40	Persona modeling		*			*			*												*	
41	Platform design using adaptable service profiles																*	*				
42	Process approach		*			*															*	
43	Quality foundation development (QFD)									*						*						*
44	Resource mapping	*	*					*	*		*	*		*	*							
45	Reusable process design										*	*										
46	Scenario-based context-aware service design																	*	*			
47	Sd4vn	*	*					*	*		*	*										
48	Service blueprinting	*						*			*						*					
49	Service experience								*	*					*	*					*	*

		Long-term adherence factors																				
		Patient-related						Context-related									Technology-related					
		Preferences			Patient abilities			Stakeholder			Cross-sector			Resources			Innovation			Improvement		
#	Method Description name	Architectural	Contextual	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
50	Service flow modeling	*						*			*											
51	Simplified four-dimensional structure										*	*										
52	Simultaneous design of product and information systems										*											
53	Socio-technical systems engineering	*	*	*				*	*	*				*	*	*		*	*			
54	Stakeholder mapping		*						*			*			*							
55	Survey data for RFID platform design	*	*					*	*					*	*					*	*	
56	Tailored service solution with modular service architecture	*	*					*	*											*	*	
57	Theory of inventive problem solving (TRIZ)															*			*			
58	Three-dimensional requirement method	*	*					*	*		*	*										
59	Unified modeling language (UML; class, activity, and sequence diagrams)	*	*	*				*	*	*	*	*	*	*	*	*				*	*	*
60	User requirement notation (URN)	*	*	*				*	*	*	*	*	*	*	*	*	*	*				
61	User experience (UX)		*	*		*	*														*	*
62	Value exchange model	*	*					*	*													
63	Value-oriented service design		*		*	*			*			*										

		Long-term adherence factors																				
		Patient-related						Context-related									Technology-related					
		Preferences			Patient abilities			Stakeholder			Cross-sector			Resources			Innovation			Improvement		
#	Method Description name	Architectural	Contextual	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
64	Variable service systems						*			*						*						

Table A2.3

Classification of Service Design Methods Based on the Approach-Based View

Design approach		#	Design method
Multi-level		22	Experience-based collaborative service system model
		32	MINDS
		35	Multilevel service design (MSD)
		38	Multiscale service
		47	Sd4vn
		58	Three-dimensional requirement method
Model-based		1	Affinity diagrams
		7	Business process modeling (BPM)
		8	Capturing services as an R&D object
		12	Computational thinking of service systems: dynamics and adaptiveness modeling
		17	Discrete event simulation
		19	e3Value
		26	Theatre-based
		27	Intentional modeling
		29	Internet service engineering
		37	Multi-domain model integration
		39	Operational-based design
		40	Persona modeling
		44	Resource mapping
		48	Service blueprinting
		50	Service flow modeling
		54	Stakeholder mapping
		59	Unified modeling language (UML; class, activity, and sequence diagrams)
		60	User requirement notation (URN)
		62	Value-exchange model
		63	Value-oriented service design
Design-for-service		9	Collaborative service design
		14	Co-production in practice
		15	Designing and redesigning medical telecare services
		28	Interactive service design using computer simulation
		30	IT-based participatory design
		42	Process approach
Computational based	Mathematical	3	Aligning value and implementation
		5	Bi-level optimization algorithm
		11	Composite service design
		12	Computational thinking of service systems: dynamics and adaptiveness modeling
		23	Fuzzy modeling
		24	Fuzzy QFD
		31	Lexical expression for conflict solving
		43	Quality foundation development (QFD)
		57	Theory of inventive problem solving (TRIZ)

		64	Variable service systems
	Data-driven	18	Dynamic use of service sharing
		20	Environment-centered approach
		30	IT-based participatory design
		46	Scenario-based context-aware service design
		49	Service experience
		53	Socio-technical systems engineering
		55	Survey data for RFID platform design
		61	User-experience (UX)
Module-based		2	Agent-based web design
		4	An agile approach to service responsibility and interaction design method
		6	Business–IT alignment (BITAM-SOA)
		10	Component business architecture
		13	Consumer information systems as service modules
		16	Designing hybrid products
		21	Event-based approach
		25	Heterogeneous production arrangements coupling agribusiness machines industry
		33	Model-driven techniques for SOA
		34	Modular service design synthesis
		36	Multidimension service design synthesis
		41	Platform design using adaptable service profiles
		45	Reusable process design
		51	Simplified four-dimensional structure
		52	Simultaneous design of product and information systems
		56	Tailored service solution with modular service architecture

Table A2.4

ICT Personalization Supporting Long-Term Adherence: An Approach-Based View

		ICT personalization support	Long-term adherence factors																				
			Patient-related						Context-related									Technology-related					
			Preferences			Abilities			Stakeholders			Cross-sector			Resources			Innovation			Improvement		
			Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional	Architectural	Relational	Functional
Design Approach	Multi-level		32, 22, 35, 47, 38, 58	32, 22, 35, 47, 38, 58		22	22, 38		32, 22, 35, 47, 38, 58	32, 22, 35, 47, 38, 58		32, 22, 35, 47, 38, 58	32, 22, 35, 47, 38, 58		22, 38	22, 38					22	22	
Design Approach	Model-based	Semi-formal language	7, 19, 59, 60	7, 19, 59, 60	7, 19, 59, 60				7, 59, 60	7, 59, 60	7, 59, 60	7, 59, 60	7, 59, 60	7, 59, 60	7, 59, 60	7, 59, 60	7, 59, 60	60	60			59	
Design Approach	Model-based	Graphic-based	50, 48, 59, 60, 7, 19, 27, 62, 12, 44, 53, 8, 17, 39	1, 40, 54, 63, 59, 60, 7, 19, 27, 62, 12, 44, 53, 8, 17, 39	59, 60, 7, 19, 17	63	40, 63		50, 48, 59, 60, 7, 27, 62, 12, 44, 53, 8, 17, 39	1, 40, 54, 63, 59, 60, 7, 27, 62, 12, 44, 53, 8, 17, 39	59, 60, 7, 17	50, 48, 59, 60, 7, 27, 12, 44, 8, 37, 39	1, 54, 63, 59, 60, 7, 27, 12, 44, 8, 37, 39	60, 59, 7, 37	60, 7, 27, 29, 44, 53, 8, 26, 59	54, 60, 7, 29, 44, 53, 8, 26, 59	60, 7, 29, 59	48, 60, 27, 12	60, 12		59, 29	1, 40, 59, 29	59, 29
Design Approach	Design-for-service			9, 42, 14, 15, 30	30		14, 15, 30	30		9, 42, 14, 15, 30	30					15						14, 15, 42, 28	28
Design Approach	Computational	Data-driven			3, 5, 12, 53			23, 24, 64			3, 5, 12, 23, 53, 64, 43			3			5, 12, 23, 24, 53, 64, 43, 57, 31			5, 57, 31			12, 24, 43, 11
Design Approach	Computational	Mathematical	55	20, 30, 61, 18, 55	20, 30, 61, 18,		30, 61	30, 61	53, 55	20, 30, 49, 55	20, 30, 49				55	20, 49, 55	20, 49		53, 20, 46	53, 20, 46	55	30, 49, 61, 55	30, 49 61
Design Approach	Module-based		16, 10, 13, 4, 21, 56, 25	16, 10, 13, 4, 21, 56, 25		33,	33,		16, 10, 13, 21, 56, 6	16, 10, 13, 21, 56, 6		16, 52, 10, 6, 36, 25, 34, 45, 51	16, 10, 6, 36, 25, 34, 45, 51		16, 13, 4, 34	16, 13, 4, 34		16, 33, 41	33, 41		2, 16, 33, 13, 4, 21, 56, 11, 25	16, 33, 13, 4, 21, 56, 11, 25	

Numbers in this table refer to the identified service design method as ordered in table A2.1

Appendix 3: Case Study Documents

This appendix displays the case study protocols and forms. In compliance with the ethics office constraints, official correspondence and approvals were not disclosed.

Document A3.a: Case Study Protocol

Research Background

Advancement of telehealth technologies has proven to reduce hospitalization, especially emergency room usage, and support remote monitoring; patients gain better access to healthcare resources because they and are no longer limited by time and distance. However, patients with long-term telehealth care plans choose not to adhere to these plans, which attenuates the benefits, increases mortality rates, and worsens the quality of life (Cruz et al., 2014; Helsel et al., 2018). Lack of long-term adherence is intentional behavior that is attributed to the patients' ability and willingness to interact with telehealth systems. This includes the technology, healthcare professionals, and the complexity of healthcare systems (Brown & Bussell, 2011; McDonald et al., 2013). Health–IT research agendas recommend adjusting telehealth care plans to fit the needs and abilities of individual patients: "personalization" (Hommel et al., 2015; Dinesen et al., 2016).

This research is part of a thesis where the research question is: How can telemonitoring systems be personalized in a manner that addresses long-term adherence? I developed a personalization framework that enables patients to contribute to personalizing their own care plans. This framework expanded an existing Multilevel Service Design (MSD) method (Patrício et al., 2011) in order to include service encounter levels. I also developed a service design method that can adopt this framework. Personalization, in the proposed method, is a value for both patients and care providers that can be achieved through involving individual patients in telemonitoring care plans. The outcome information of this involvement helps to adjust the care plans in a manner that improves long-term adherence.

Research terminology: The name of the service design method proposed in this research is Service Personalization through Value-in-Use (SerViU). It is motivated by the concept of value-in-use where the service users co-create the service with their providers and determine its value. We also differentiate, in this research, between telemonitoring care plans, telemonitoring scenarios, and personalized telemonitoring care plans. A telemonitoring care plan refers to a care plan prescribed by a medical specialist. A telemonitoring scenario refers to the sequence of events that take place as the patients encounter telemonitoring systems during the application of telemonitoring. This includes the ways they interact with the technology, access health care resources, and face uncertainties. In the context of SerViU, telemonitoring scenarios help to develop personalized care plans. For example, a telemonitoring scenario describes a patient who is unable to accurately answer the daily questionnaire required by her telemonitoring care plan. In the course of the telemonitoring process, the system records entry mistakes, connectivity errors, and lack of adherence to medication. The nurse at the hospital is alerted by the system and contacts the patient to evaluate the situation. The scenario mentions that the nurse attributes the entry mistakes and lack of adherence to dizziness the patient experiences as a side-effect of a certain medication. Telemonitoring scenarios are essential for personalization whereby SerViU provides a means to capture and exploit the information needed to personalize telemonitoring.

Research Gap

Personalization, in the existing literature, had only been addressed through technological approaches such as increasing the speed of data capture, improving user interfaces to be more friendly (van den Berg et al., 2012); providing educational support (Wens et al., 2008; Bal et al., 2016), and improving adherence measurement methods (Thompson et al., 2000). From an information systems point of view, designing personalized telemonitoring services in the way recommended by these research agendas, requires an appropriate framework and a method that is able to adopt this framework. We developed the required framework and looked to the literature for service design methods that could adopt it (i.e., support the personalization of telemonitoring services in a manner that addresses the long-term adherence challenge).

In the telemonitoring context, personalization support has not yet been provided in multiple dimensions (architectural, relational, and function) in a manner that addresses long-term adherence. I conducted a systematic literature review of the service design literature for methods that addressed or can address this gap. The identified candidate service design methods were evaluated in terms of their ability to address long-term adherence, cope with the complexity of the telemonitoring context, and capture the contribution of patients. Three methods stood out: multilevel service design (MSD) with its multilevel service system understanding, user requirements notation (URN) with its support of a complex service architecture, and a user-generated method to capture real-time information.

None of these methods could support the personalization of telemonitoring systems in a manner that addresses long-term adherence. One explanation is that in a service design method personalization capability was needed at more than one dimension (i.e., individual patient, service context, and technology). SerViU addresses this gap by utilizing the Fan and Poole (2006) multidimensional framework of ICT-service personalization with architectural, relational, and functional dimensions. This should enable service design methods to personalize telemonitoring services and utilize outcomes of patients' involvement to address the lack of long-term adherence for particular patients in particular situations (i.e., personalization).

Research Objectives

This study is part of a research thesis that it is based on an information systems research methodology framework called design science research methodology (DSRM; Peffers, et al., 2007). The main objective, at this stage of the research framework, is to "demonstrate"

SerViU's applicability for personalizing telemonitoring care plans in a manner that addresses long-term adherence. One way to achieve that is to simulate the decision-making process of SerViU to predict its behavior against a real-life situation by means of a telemonitoring case study (Eekels & Roozenburg, 1991; Peffers et al., 2012).

The objective of this case study, therefore, is to demonstrate the applicability of SerViU for personalizing telemonitoring care plans by evaluating Phase 3 (SerViU Personalize). This is to be achieved by conducting decision-making simulation sessions. Evaluating the whole SerViU method is beyond the scope of this case study.

This research is to be conducted in two steps: 1) validation of the telemonitoring scenarios by key informants, and 2) simulation of the decision-making activity by case study participants. The investigator will prepare a telemonitoring scenario for each telemonitoring mode, as well as a list of possible adjustments needed to personalize the telemonitoring care plans presented to case study informants and participants.

Methodology

A case study is a research strategy designed to help understand the dynamics of a setting by the means of a case(s) that represents its circumstances. This should help to address the complexities and particularities of that setting, and is relevant for investigating a contemporary phenomenon in its context (Eisenhardt, 2002; Runeson & Höst 2008). In this research, the case study helps increase knowledge about the rationale of a decision or set of decisions made in certain situations during the care plan implementation (Yin, 2017). This case study aims to demonstrate the applicability of SerViU (the artifact) for personalizing telemonitoring care plans in a manner that addresses long-term adherence (solves a problem; Peffers et al., 2007). Data will be collected in two phases: Phase 1—validating the case study scenarios; and Phase 2—

simulating decision-making. To this end, two types of participants are needed: 1) key informants for the validation phase, and 2) simulation participants for the simulation phase.

The Telemonitoring Service Context

The case study comprises three different telemonitoring modes (i.e. remote patient monitoring, remote medication management, and monitoring by a TM nurse). This study uses an embedded case study with multiple units of analysis (Yin, 2017). This means that the case study consists of multiple case studies that share the same context and take place at the same time. This provides the opportunity for a deeper understanding and analysis of the telemonitoring context, as well as more compelling findings regarding the rationale of personalization. Moreover, multiple case studies augment each other in sense that they 1) fill gaps in understanding of the context and results, and 2) reduce the potential uniqueness of artifactual conditions, such as special access to key information, resources, or skills that are available for one telemonitoring mode but not for another (Yin, 2017). In this case study, a nurse is responsible for orchestrating the telemonitoring care plans of 28 patients. This nurse is a specialized telemonitoring nurse trained to operate telemonitoring equipment and orchestrate patients' care plans. In this research this nurse will be called the "TM nurse."

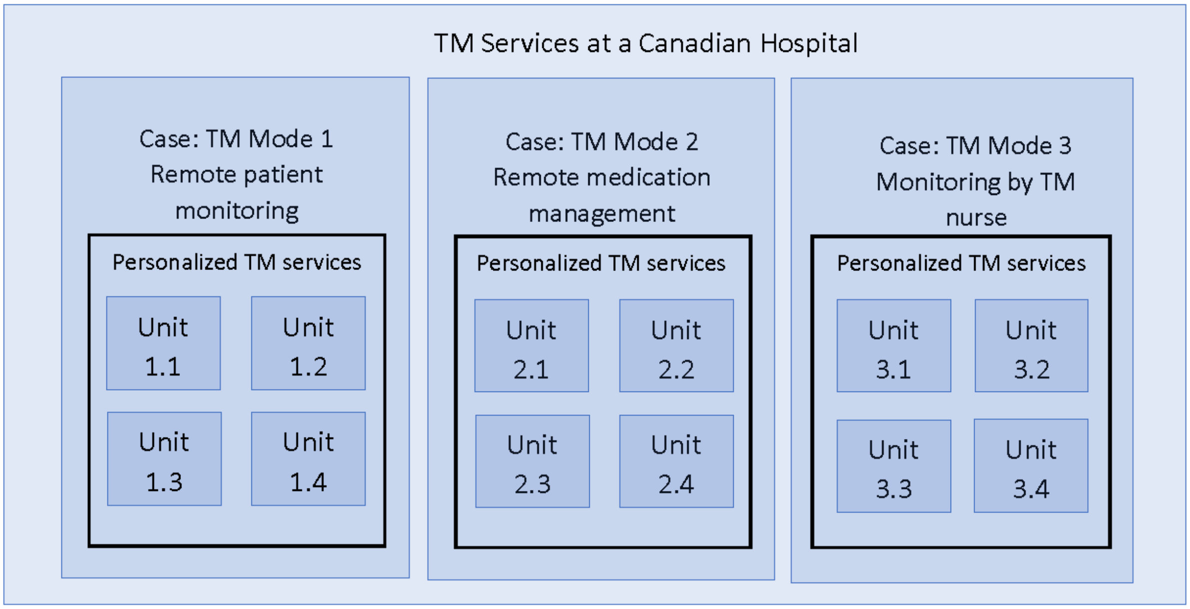
Unit 1 is remote patient monitoring: a telemonitoring mode that comprises an infrastructure supplied by the Ontario Telemedicine Network (OTN infrastructure). Telehomecare equipment is to be used by patients to measure their vital signs at certain times and frequencies according to their care plans. The Unit 1 telemonitoring system captures the patients' data and sends these to a central data center at the Canadian hospital. At the data center, the patients' data are analyzed on a daily basis and a report is generated that is accessible to the TM nurse. The TM nurse will be notified in the case of emergencies as well. In the case of emergencies or error entries, especially regarding patients' vital signs, the TM nurse will call the patients, their caregivers, or the related physician, if necessary.

Unit 2 is remote medication management: a telemonitoring mode that comprises a Medispense infrastructure where patients are responsible for taking their medication (in this case, pills) according to their care plan. The system automatically sends medication adherence data to the data center at the hospital. Patients' data are analyzed on a daily basis. The AGC nurse receives daily notifications and will call the patient and/or caregiver if necessary.

Unit 3 is management by a TM nurse: telemonitoring activities are performed at the Canadian hospital in the presence of the AGC nurse, during work hours. These are consulting activities that are performed virtually with doctors at a different location. The case study uses the OTN infrastructure for such a consultation, which is called an eVisit. This is similar to a regular doctor's appointment; the only difference is that patients use videoconferencing equipment to meet and speak with their doctors.

Figure A3.1

Telemonitoring Service Context at the Canadian Hospital



Participant Types

Key Informants. Key informants are experts with unique knowledge needed by the researchers to develop a better understanding about telemonitoring events and situations (i.e., telemonitoring scenarios; Bryman 2015). The key informants are needed to validate the telemonitoring scenarios pre-developed by the researchers. Both clinical and operational knowledge areas are needed, in the first phase, to understand the components and the implementation of telemonitoring care plans. Hence, the requirement process will target clinicians and technicians who are part of the Center of Clinical Excellence in Multimorbidity, but not necessarily involved in the telemonitoring service.

Simulation Participants. Simulation participants are clinicians who are working or have worked in the telemonitoring service. They will simulate personalization decision-making in SerViU because they have experience with actual telemonitoring situations in their telemonitoring service. Key informants can act as simulation participants if they were part of the telemonitoring service.

For francophone participants, simulation sessions can be facilitated by a francophone facilitator. Appropriate approvals will be pursued from the Canadian hospital regarding external facilitator(s).

Data Collection

Data will be collected in two phases: scenario validation and the decision-making simulation.

Table **A3.1** shows the utilization of different techniques relevant to each phase. This data will be triangulated and compared in the analysis phases.

Table A3.1

Research Phases, Participants, and Data Collection Methods

Research phase	Participants	Data collection method
Phase 1: Scenario validation	Key informants (1–2 participants)	Voice recorded semi-structured interviews. Interviewees will answer questionnaire about the correctness and completeness of the scenarios.
		Follow-up emails
Phase 2: Decision-making simulation	Simulation participants (3 participants)	Voice-recorded simulation sessions
		Selected personalization options
		Priority percentage: scores resulting from SerViU Personalize Tool
		Likert 5-point score from the evaluation questionnaire
		Evaluation feedback
		Follow-up emails

Phase 1: Scenario Validation

Semi-structured interviews will be conducted with key informants to validate the telemonitoring scenarios prepared by the researchers. There will be three telemonitoring scenarios to be validated, one for each telemonitoring mode.

A consent letter will be sent to the key informant prior to the interviews. This letter invites the candidate to participate and informs them about the research objectives. Once participation is agreed, telemonitoring scenario(s) will be sent via email to the key informant. The key informant will have two to three weeks to review the telemonitoring scenarios.

In a 45–60 min recorded interview, the key informant will answer questions about the correctness and completeness of the three telemonitoring scenarios. The questionnaire script is provided in Document A3.b. The interviewer may change the order of the questions or focus on certain details within the time allowed. After the interview, a follow-up email(s) will be exchanged with the key informant if further explanations are needed by the researcher or a revised scenario was requested by the key informant. Permission to contact again will be requested at the beginning of the interview session.

Phase 2: Decision-Making Simulation

The simulation of the SerViU decision-making process is to be performed by simulation participants. Each telemonitoring mode (unit of analysis) will be simulated twice by two different simulation participants. Hence, three simulation participants will be needed and each will simulate two different TM scenarios. This will result in six personalized TM care plans: two for each TM mode (see

Table **A3.2**).

Table A3.2

Tasks of the Decision-Making Simulation

AGC Participant #	Participant 1		Participant 2		Participant 3	
Telemonitoring mode	Unit 1	Unit 2	Unit 1	Unit 3	Unit 2	Unit 3
Personalized care plan	Unit 1.1	Unit 2.1	Unit 1.2	Unit 3.1	Unit 2.2	Unit 3.2

Simulation sessions will take 60 min. In each simulation session, the simulation participant will simulate two TM scenarios according to this schedule:

- five minutes for signing the consent letter and permission to contact again,
- fifteen minutes introducing the tool and the process,
- ten minutes for the first decision-making simulation,
- ten minutes for the second decision-making simulation, and
- fifteen minutes for evaluation and review.

The introduction will guide the participant through the decision-making process and the tool. During the simulation, a voice recorder will be used and the simulation participant will be asked to talk loudly about the decision-making process. The simulation participant will firstly decide at a higher level the type of modification needed to the current care plan in light of the given scenario. SerViU provides three high-level options: 1) further education, 2) further assistance, or 3) technology improvement (i.e., improving software or hardware of the telemonitoring system). A subsequent detailed decision is made by selecting, adding, or replacing the current systems' components. Information about each component is provided in a list of options and represented in a Microsoft Excel software tool.

The Software Tool. Given the scope of this research, the SerViU tool is represented as a Microsoft Excel file that includes a list of modification (personalization) options. This list provides information about 1) technology-related telemonitoring system components; 2) operation-related components (e.g., by patient, clinician, automated, etc.); 3) business-related components (i.e., brand and price); and 4) accessibility-related components (e.g., accessibility of resources, regulation constraints, and additional approvals).

Evaluation Questionnaire. At the end of the simulation session, simulation participants will be requested to evaluate SerViU's decision-making facility. The evaluation will address the relevance of SerViU to the telemonitoring context, the correctness of the decision compared with ordinary adjustments, and the usefulness of SerViU for personalizing telemonitoring care plans. The evaluation form also contains space for the simulation participants to provide their feedback. Moreover, considering the learning curve, simulation participants will be allowed to revise previous decisions.

After the simulation session, follow-up emails are to be exchanged with simulation participants to address the evaluation notes. Permission to contact again is to be obtained at the beginning of each session.

Data Analysis

The subject of analysis is how SerViU helped and was utilized by simulation participants to personalize telemonitoring care plans. All types of data collected from the decision-making simulation sessions (

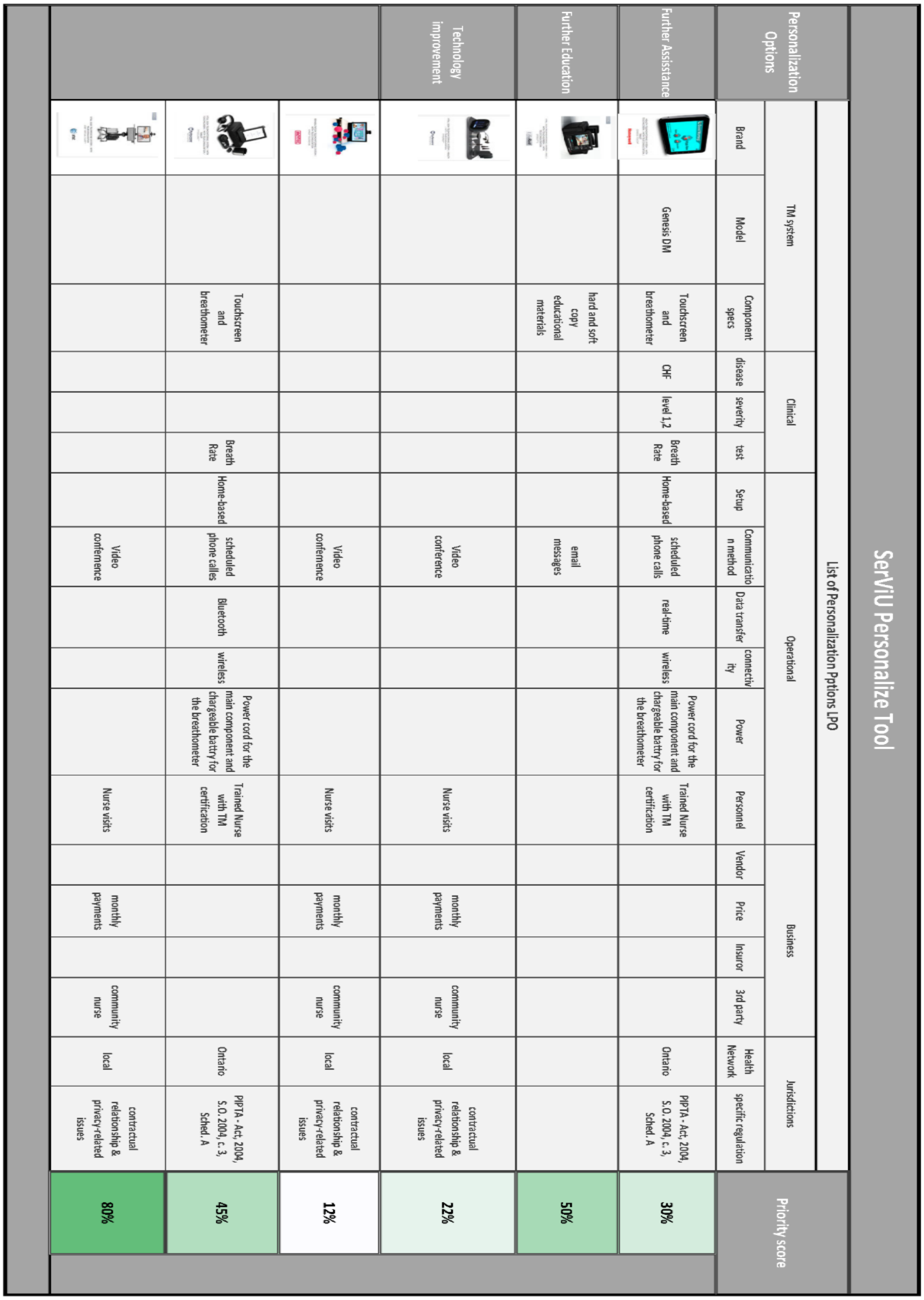
Table **A3.1**) will be triangulated and analyzed. Results will be compared within and across case studies: two case studies for each telemonitoring mode and all the telemonitoring modes (three units of analysis). This will determine whether SerViU was demonstrated to be applicable for personalizing telemonitoring care plans in a manner that addresses long-term adherence.

Data collected from the six personalized telemonitoring care plans (i.e., Unit 1.1 to Unit 3.2) consist of transcripts of the voice-recorded decision-making sessions, SerViU formula scores, and the evaluation results (i.e., feedback & 5-point Likert score). Moreover, identification of themes will be conducted manually using transcripts of the voice-recorded decision-making processes and evaluation feedback. All results will be tabulated as shown in Table 3.

The collected data will be represented in tabular format, with data arranged for easy viewing in one place. This sets the stage for cross-case and within-case analyses (Miles et al., 2019). Table 3 is a "case-ordered" matrix (Miles et al., 2019) that combines numerical and non-numerical information, in rows, ordered by personalized care plans, in columns.

Figure A3. 2

Simulation Software Tool Interface



SerViU Personalize Tool

List of Personalization Pptions LPO

Personalization Options	TM system			Clinical			Operational						Business				Jurisdictions		Priority score
	Brand	Model	Component specs	disease	severity	test	Setup	Communication method	Data transfer	connectivity	Power	Personnel	Vendor	Price	Insuror	3rd party	Health Network	specific regulation	
Further Assisstance		Genesis DM	Touchscreen and breathometer	CHF	level 1,2	Breath Rate	Home-based	scheduled phone calls	real-time	wireless	Power cord for the main component and chargeable battry for the breathometer	Trained Nurse with TM certification					Ontario	PIPTA - Act, 2004, S.O. 2004, c. 3, Sched. A	30%
Further Education			hard and soft copy educational materials					email messages											50%
Technology improvement								Video conference				Nurse visits		monthly payments		community nurse	local	contractual relationship & privacy-related issues	22%
								Video conferemce				Nurse visits		monthly payments		community nurse	local	contractual relationship & privacy-related issues	12%
			Touchscreen and breathometer			Breath Rate	Home-based	scheduled phone calles	Bluetooth	wireless	Power cord for the main component and chargeable battry for the breathometer	Trained Nurse with TM certification					Ontario	PIPTA - Act, 2004, S.O. 2004, c. 3, Sched. A	45%
								Video conferemce				Nurse visits		monthly payments		community nurse	local	contractual relationship & privacy-related issues	80%

The numerical set of information consists of SerViU-produced scores for selected personalized care plans as well as the feedback evaluation scores. Non-numerical information consists of themes identified from transcripts of the voice-recorded decision-making simulations and the simulation participants' feedback.

This combination allows comparison of tendencies and evaluation across care plans, such as the tendency to rely on technology. Such trends can be supported by some identified themes, feedback, and the evaluation score. The same applies to price-driven adjustments and participant demographics.

Analyses will be conducted by comparing similarities and differences within-case and across cases using the data in Table 3. This enables the comparison of several categories at once and identifies trends within and across the analysis units, hence providing a sophisticated understanding at different levels (Eisenhardt, 1989). Within each unit of analysis, comparisons are to be made between the personalized care plans selected by participants and the initial care plan. For example, comparisons will be made between Unit 1.1, Unit 1.2, and Unit 1.3. At a higher level, comparisons will be conducted among the case study analysis units regarding the telemonitoring context. Moreover, demographic information of the simulation participants, such as expertise and experience, can help the within-case analysis because participants' decisions and evaluations could be affected by their expertise. Participants can make similar decisions regardless of the mode of telemonitoring. For example, care plans Unit 1.1 and Unit 2.1 (different modes of telemonitoring) are being personalized by a clinician who has many years' experience with telemonitoring. This should help to identify internal bias.

Simulation participants will evaluate SerViU based on a 5-point Likert scale for its correctness, relevance, and usefulness. The correctness aspect refers to the personalization decision compared with regular adjustments that participants used to make in similar situations (related to the AGC case study). Relevance refers to simulation participants' choices regarding the contextual information detailed in the Excel spreadsheet: the technology components of telemonitoring systems (hardware and software); operation method, business-related information (e.g., brand and cost); and healthcare network constraints. Usefulness refers to the evaluation of decision-making criterion and whether in real-life situations further adjustment is required and to what extent. The scores produced by the SerViU formula will help to carry out this evaluation in the sense that they priorities personalization options.

The feedback of simulation participants will allow interpretation of their numerical evaluations of SerViU and reveal further understanding about the providers' perception of personalization, especially regarding common adjustment strategies of telemonitoring care plans across different modes (analysis units). This can include technological improvements, brand selection, operational issues, or constraints in the healthcare network. This, however, is not expected to represent all care providers, but will highlight questions for future research about the way personalization affects the providers' telehealth service value proposition. Moreover, implementing results using the goal-oriented requirement language (GRL) tool is expected to contribute to the interpretation process, in the sense that it helps to identify the needed resources (including human and non-human) to personalize telemonitoring care plans. This is because input information of this tool relies on the outcomes of the assessments conducted by the telemonitoring nurse in the previous SerViU phase.

Figure A3. 3

Goal-Oriented Requirement Language Model

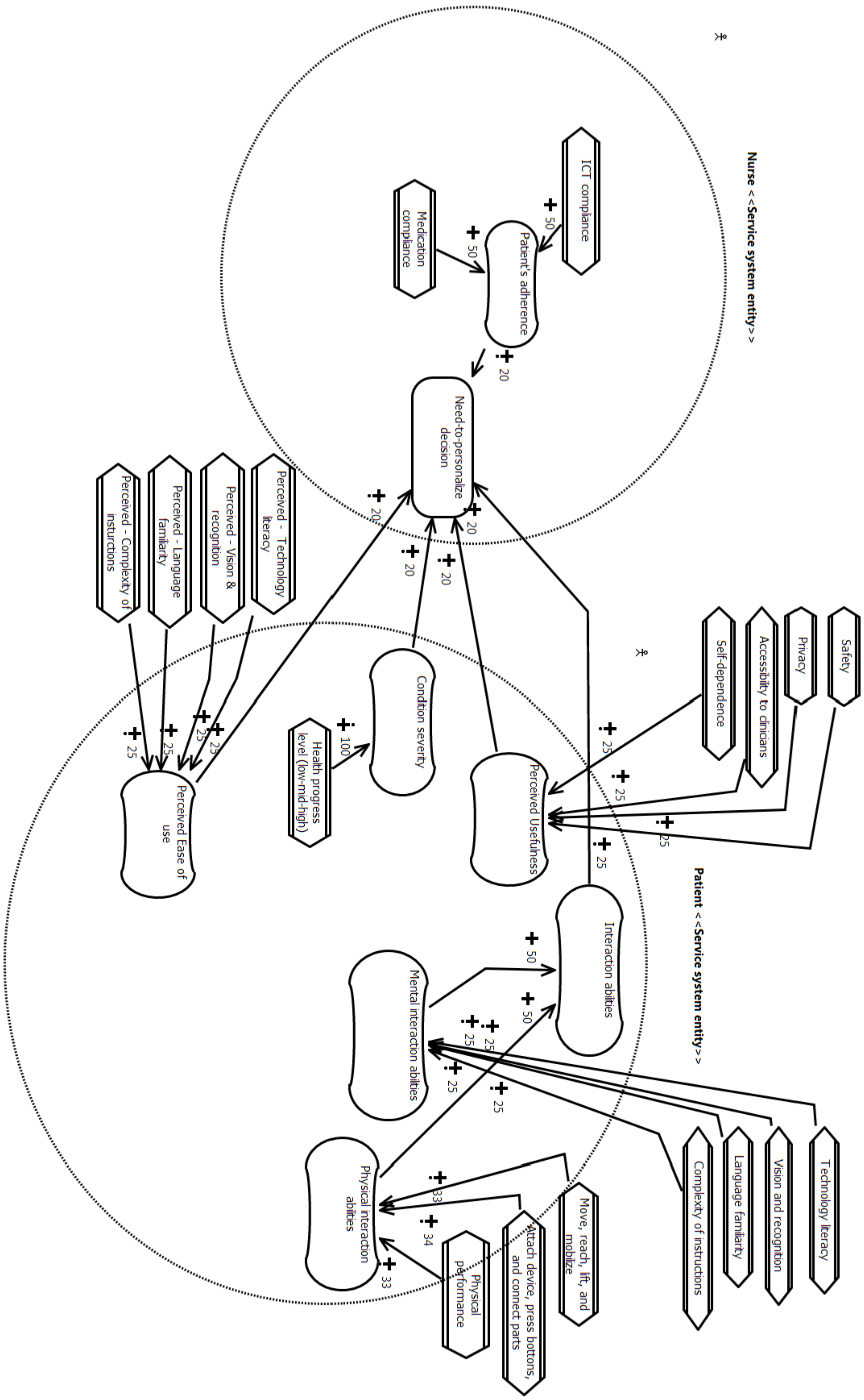


Table A3. 3

Cross-Case and Within-Case Comparison Matrix

Personalized care plans			Unit 1.1	Unit 1.2	Unit 2.1	Unit 2.2	Unit 3.2	Unit 3.2
Comparison subjects	SerViU score	ICT Applicability						
		Willingness						
		Accessibility						
		Overall						
	Themes	Theme #1						
		Theme #2						
		Theme #n						
	Participant demographics	Expertise						
		Experience						
	Evaluation Likert score	Correctness						
		Relevance						
		Usefulness						

Conclusions

In this section, the objective of the case study research will be discussed to determine whether the applicability of SerViU was demonstrated. This section will also discuss limitations and contributions, and make recommendation for future improvements for similar research work.

Research Team

Principal Investigator, Oday Aswad. Oday Aswad is a Ph.D. candidate in Electronic Business, holds a Doctorate in Business Administration (DBA), with an architectural engineering undergraduate degree. This diversified background helped Oday to bridge different disciplines. As the principal investigator, Oday reviewed different bodies of academic literature before conducting this case study research, including

- the multimorbidity context (specifically patient-centeredness in long-term treatment);
- health IT (specifically long-term adherence challenges that patients face when using ICT in healthcare); and

- service science, an interdisciplinary field of information systems (specifically service design methods and personalization of ICT services).

The first two bodies of knowledge enabled the investigator to identify a contextual problem where patients do not adhere to telehealth services in the long term. The investigator reviewed the service science literature to come up with a new ICT-service method, SerViU, which presents a solution by which telehealth can be personalized in a manner that addresses patients' long-term adherence factors.

Co-Investigator, Dr. Lysanne Lessard. Dr. Lysanne Lessard is an Assistant Professor at the University of Ottawa and holds a Ph.D. in Information Systems from the University of Toronto, Faculty of Information. Professor Lessard's research centers on service design. Her research is specifically focused on producing new models and methods for the design, transformation, and evaluation of knowledge-intensive services such as healthcare services. She is trained in qualitative research methods and has conducted numerous case studies, including in the health domain. As Oday's Ph.D. thesis supervisor, she will guide him throughout this case study research.

Ethics Considerations

Protecting Privacy and Confidentiality. Patient-specific information is not required because the purpose of the case study is to help to develop TM scenarios and to determine how these can be modified. Hence no access will be required to biomedical information, patient identities, or contact information.

Consent Method. The informed consent form will be sent to each participant via email before interviewing. Two copies of the informed form will be given to the participants to read and sign before the interviews or system demonstration start. The participants and study team will keep one signed copy each.

After the first data collection occurs during interviews and simulation sessions, the research team will provide an addendum to the consent form, authorizing the research team to re-contact the participant for follow-up questions. If the participant refuses, the research team will not contact the participant again. The purpose of follow-up questions is to obtain further understanding of the participants' feedback. The follow-up questions can be asked via email, phone call, video chat, or face-to-face meetings.

Compensation. Participants will not receive any compensation for taking part in this research.

Participant Withdrawal. Participants will be allowed to withdraw from the study at any time. The participants are free to stop the interview or withdraw from the study if they feel uncomfortable. Any data collected from participants who have withdrawn from this study will be destroyed and not used as part of the study. There will be absolutely no consequences for the participants if they decide to withdraw. The study team will protect their confidentiality as if they had completed the study.

Risks and Benefits

Potential Risks. The first potential risk for participants is the amount of time spent contributing to this study. This will be mitigated by optimizing the time needed for the interviews and simulation sessions. Firstly, the research team will email the needed information to the key informants to allow them to review the telemonitoring scenarios and allow 2–3 weeks for review. This should help the key informants to prepare notes and eliminate the need for additional time for further research.

The simulation participants will be briefed at the beginning of the session. Then they will be allowed to simulate two decision-making processes instead of one. However, they have the choice to split the session into two sessions with one simulation each to allow for the fact that they may be on call at the hospital and called away for duty. Moreover, a follow-up email will be exchanged instead of a second meeting so that participants can reply at their convenience.

The second risk is related to information security. The information participants share with the research team will be recorded using a digital recorder that can facilitate audio and video recording, if the participant consents. To ensure that recorded information is secure, the research team will transfer recorded files to RedCap, the secure online research platform provided by the Canadian hospital. Files on the digital recorder will be destroyed as soon as a copy has been placed in RedCap. Interview transcripts will also be stored in RedCap. A master list containing the names of the participants that correspond to each participant number will also be stored in RedCap. The research team will ensure the anonymity of participants in interview transcripts and other electronic or printed documents. The only way to refer to participants will be through numbers (e.g., Participant 1, 2, etc.).

Potential Benefits. If SerViU is validated in the manner described herein, this would help the personalization of telemonitoring services in Canada in a manner that improves patients' long-term adherence to telehealth. Sharing the case study and the overall report with Canadian hospitals could help to provide 1) an additional understanding of telemonitoring as a sociotechnical service and 2) managerial insight regarding procuring and outsourcing of telemonitoring services.

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Document A3.b: Scenario Validation Protocol

The key informant will be asked to review and comment on three telemonitoring scenarios (remote patient monitoring, remote medication management, and monitoring by a nurse). This should help to improve the telemonitoring scenarios, especially in terms of implementation and patient-related challenges.

Section 1: Scenario Validation Process

A general consent letter will be sent to the key informant prior to engaging with the validation phase. Once the letter is accepted, telemonitoring scenario(s) documents will be sent via email to the key informant.

Telemonitoring scenario document. The research team will send three telehealth scenario documents to the key informant via email; each represents a telehealth delivery mode, such as home monitoring. The telehealth scenario document describes the journey of a hypothetical patient when they use the telemonitoring service. This includes using the equipment, navigating the service, facing challenges, and making decisions about it. The document also describes the way the clinician adjusts (personalizes) the telehealth service to accommodate such situations.

The key informant will have two to three weeks to review the telemonitoring scenario document and provide comments. Questions about the scenarios' correctness and completeness will be provided as guidance (Section 2 in this document), but the key informant will have the liberty to express their feedback.

After receiving the key informant's feedback, follow-up communications might be needed, especially if further explanations are required by the research team, or a revised scenario was requested by the key informant. Permission to contact again will be requested at the beginning of the interview session via an addendum to the contact again consent form.

Section 2: Guidance Questionnaire

The aim of this section is to invite the key informant to comment on the correctness and completeness of the scenarios provided by the research team.

1. In the current TM scenario, is there any missing activity?

o A process, or technology (such as hardware or software)? Please elaborate.

----

o In what order? Please elaborate.

----

2. What sort of application challenges might be faced in the current scenario?

- o Clinical
- o Technical
- o Patient-related
- o Accessibility-related
- o Other/All of the above. Please describe.

----

3. What improvements do you think are needed in light of these challenges?

- o Clinical activities (e.g., adding, removing, or re-arranging the activities)
- o Technical improvements (e.g., replacing the hardware, software, or both)
- o Accessibility-related (e.g., using lightweight devices)
- o Further education is needed (i.e., for the patient, operator, or clinician).
- o Other. Please specify.

Document A3.c: Decision-Making Simulation Protocol

This session aims to simulate the use of the SerViU decision-making process by clinicians. This session will be conducted online using an MS Excel spreadsheet that will be sent to the participant prior to the session. This session will be voice-recorded, and it will last for a **maximum of 60 min.** The participant (clinician) will make generic and detailed decisions that personalize the telemonitoring care plan.

In each simulation session, the simulation participant will simulate **two scenarios** based on the below schedule:

- five minutes for signing the consent letter and the permission to contact again form,
- fifteen minutes introducing the SerViU Personalize Tool (represented in an MS Excel sheet) and the decision-making process,
- ten minutes for the first decision-making simulation,
- ten minutes for the second decision-making simulation, and
- fifteen minutes for evaluation and review (questionnaire and feedback).

The introduction will guide the participant through the decision-making process and the SerViU Personalize Tool. During the simulation, a voice recorder will be used and the simulation participant will be asked to think aloud about the decision-making process.

The simulation participants will have three high-level options to select from: 1) further education, 2) further assistance, and 3) technology improvement. The participant can select one or more high-level choices. Then, the participant will move further into the detailed personalization decision to select devices and operation methods. The SerViU Personalize Tool provides contextual telehealth information which includes technical descriptions of the available devices, relevant components/accessories, and their purpose of use, such as a touchscreen tablet to enable real-time communication with the patient. The SerViU Personalize Tool also informs the clinician about the brand, price, and jurisdictional constraints of using that particular device or component.

For example, a given scenario describes a patient situation where medication side-effects influence the patient's ability to use touchscreens, comprehend instructions, or recognize characters. The simulation participant can decide on a "technology improvement" by providing another feature that operates differently but serves the same clinical purpose, such as a text-to-speech feature that reads the instruction for the patient. A different simulation participant might find real-time communication to be more appropriate because many patients prefer in-person communication. The trade-off in this case is the clinician's time as a resource.

In the last part of the simulation session, the participants will be asked to provide their feedback about the SerViU Personalize Tool using an evaluation questionnaire form (Document A3.d). This form also contains space for feedback where the participants can write comments about the SerViU Personalize Tool (i.e., the decision-making process and contextual information about the telehealth service).

The SerViU Personalize Tool

This is an interactive spreadsheet (Microsoft Excel) that facilitates the decision-making process for clinicians personalizing telehealth services. The SerViU Personalize Tool guides clinicians through a decision-making process from high-level to detailed personalization decisions; contextual information, provided in the MS Excel spreadsheet, about the telehealth service will help the participant to select the appropriate components of the personalized telehealth care plan in line with the given scenario. For the scope of this research, the interface of the SerViU tool is represented as a Microsoft Excel spreadsheet which provides a table with high-level personalization options on the left and information about detailed contextual information on the right. Once the clinician selects a high-level option, irrelevant contextual information will be blocked, and the clinician can select from relevant contextual information to make a detailed decision.

The SerViU Personalize Tool provides a list of information about 1) technology-related telemonitoring systems components, 2) operation-related components (e.g., by the patient, clinician, automated, etc.), 3) business-related components (i.e., brand and price), and 4) accessibility-related components (e.g., accessibility of resources, regulation constraints, and additional approvals).

After the simulation session, follow-up emails may need to be exchanged with the simulation participants to address the evaluation notes. Permission to contact again is to be obtained at the beginning of each session (addendum of consent to contact again).

Document A3.d: Evaluation Questionnaire

Introduction

This session aims to collect the evaluations of participants regarding the SerViU Personalize Tool. This form is a MS Word document to be filled out by the participant by the end of the simulation session, then emailed to collaborator.

The simulation participant will be requested to evaluate how relevant the tool is to the telemonitoring context and whether the available information suffices to make a personalization decision. The simulation participant will be requested to give written feedback, as needed, about the decision-making criteria, missing information, and potential improvements.

The evaluation uses a 3-point scale that represents level of agreement with a statement.

Evaluation Questionnaire

Evaluation scale: 1 = do not agree with the statement; 2 = neutral; 3 = agree with the statement

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1. The decisions made using the SerViU Personalize Tool are relevant to the telemonitoring context

1		2		3	

Feedback

---

2. The SerViU Personalize Tool is useful for the involved stakeholders (i.e., clinicians)

1		2		3	

Feedback

---

3. There is enough information to make personalization decisions

1		2		3	

Feedback

Document A3.e: Validated Telemonitoring Scenarios

Introduction

Telemonitoring is part of many telehealth services provided by care providers (e.g., hospitals). This service is a physician-directed, nurse-managed service where the patient can be remotely monitored and followed up with through telephone and video communication. The hospital centrally hosts call and data centers that are at the disposal of a practitioner nurse who orchestrates the service and interacts with patients throughout their treatment process.

SerViU

SerViU (pronounced "Serve You") is a service personalization method that is based on the concept of value-in-use (ViU). The SerViU method allows users (patients) to use the service (telemonitoring) to develop their own experiences. SerViU will assess patients' experiences and accordingly personalize the service to fit each patient's needs, preferences, and abilities. SerViU can be used for ongoing personalization until the end of the care plan.

The telemonitoring services case study comprises a telemonitoring component that is prescribed within care plans. This can be regarded to be representative of telehealth technologies. The telemonitoring services case study consists of different telemonitoring modes. In research terms, telemonitoring services is an embedded case study with multiple units of analysis. Hence, the telemonitoring services case study consists of multiple case studies that share the same context (telemonitoring at a Canadian hospital), managed by the same actors (i.e., nurses and clinicians), and take place within a certain timeframe. Studying multiple case studies provides the research team with an opportunity for a deeper understanding and analysis of the telemonitoring context, as well as more compelling findings regarding the rationale of personalization.

Scenario 1: Unit 1–Remote Patient Monitoring

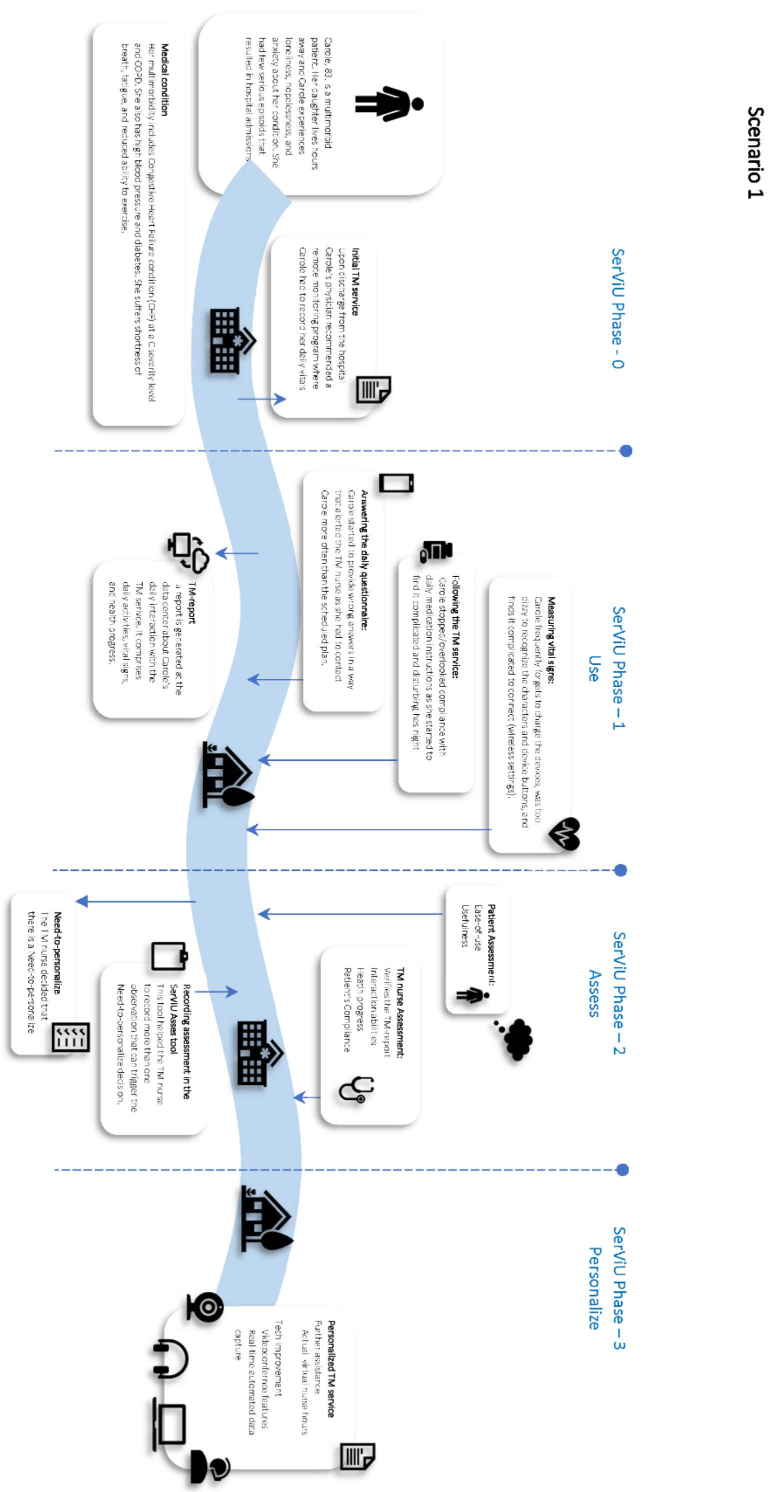
Upon discharge from the hospital, Carole's physician recommended a remote monitoring program (referred to as the initial TM care plan) where Carole had to record her daily vitals (including her weight), store the information, then authorize transfer of the data to the data center every morning. Carole also had to take a long list of medications for her CHF. Moreover, Carole had to answer a daily questionnaire about how she is feeling, symptoms, wellness, cough, sputum production (quantity and color), and breathlessness (shortness of breath) to allow for exacerbation detection.

Carole started to feel dizzy, which is a side effect of the medication. She started to mix medications, take medication at the wrong time and in the wrong order, and consider the technology to be too complicated.

Within two days, the nurse decided to apply SerViU and decided that Carole needed "further assistance" to guide her through the home medication process. Moreover, Carole would not be able to deal with "further education" because of her side effect of dizziness. To provide further assistance and guide Carole virtually, the nurse decided to add a videoconferencing feature.

Figure A3. 4

Scenario 1: TM Care Plan—Initial to Personalized



Scenario 2: Unit 2–Remote Medication Management

Carole starts to use a Medispenser that was prefilled by a community pharmacist. This device tracks Carole's adherence to medication and reports it to the data center at the Canadian hospital.

Problem 1. Carole thought that a mistake was made by the pharmacist regarding her medication dose. She called the nurse outside of working hours; then, Carole decided not to take the medication because she couldn't reach the nurse.

The next day, the telemonitoring services nurse reviewed the daily report and noticed the missed dose. She contacted Carole and discussed the matter and corrected the dosage.

Problem 2. A power outage took place during a storm, disrupting the Wi-Fi connection. As a result, the dispenser device's battery drained and was depleted.

Carole replaced the auxiliary battery but couldn't restore the Wi-Fi connection. She measured her vitals, but the information wasn't sent.

The nurse applied SerViU to decide the following:

To address problem 1, she determined that 24/7 contact needed to be available because Carole mixes up medication times and names; hence "further assistance" was the personalization option chosen.

To address problem 2, she determined that for emergency situations the patient needed to learn how to manage a wireless network connection, including alternative technologies, such as the cell phone network general packed radio service (GPRS); hence, "further education" was necessary to keep a live connection with the data center.

Scenario 3: Unit 3–Monitoring by TM Nurse

Carole started eVisit sessions where she and the nurse, at one location, communicated with a medical group* regarding the progress of her condition. Although Carol was being medicated and monitored from home, she often commuted to the hospital because of equipment availability required by the medical consortium.

However, Carole considered the eVisit sessions to be not useful for her. The consortium included three doctors who frequently had private conversations, disconnecting Carole from the conversation; sometimes noise was heard from kids and dogs. The doctors sometimes consumed food and coffee during the consultation sessions. Carole felt discontent and disrespected.

To address the problem, the nurse applied SerViU and decided to personalize Carole's care plan as follows:

The nurse found that Carole prefers more self-dependent solutions to protect her dignity and preferred to be in charge of reporting her symptoms; hence, "further education" was needed for Carole to learn to self-report. The support should include educational materials that help Carole to learn and a tablet device to use for learning and self-reporting.

*Medical groups can range from small practices with several doctors to very large organizations with hundreds of doctors.

Figure A3. 5

Scenario 2: Remote Medication

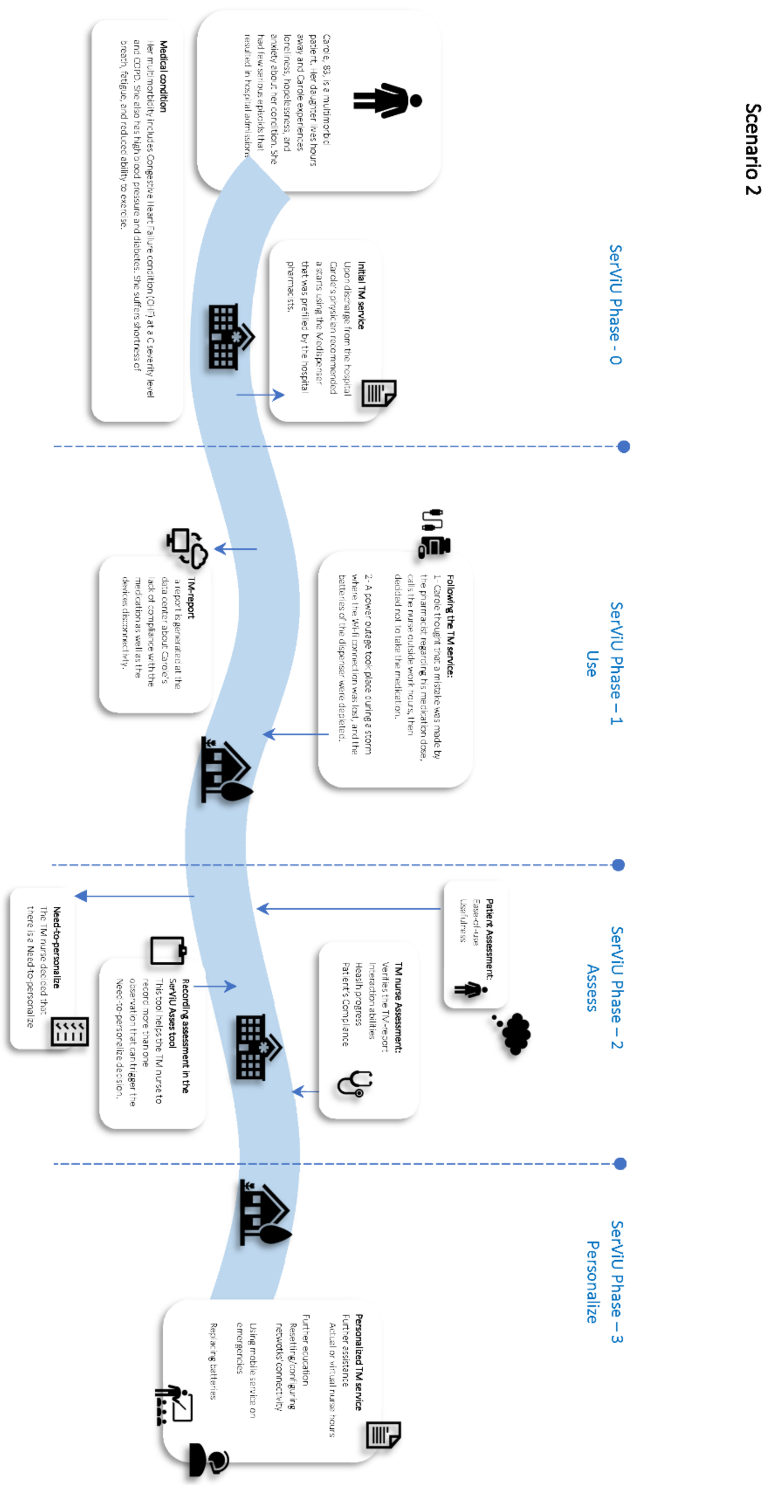
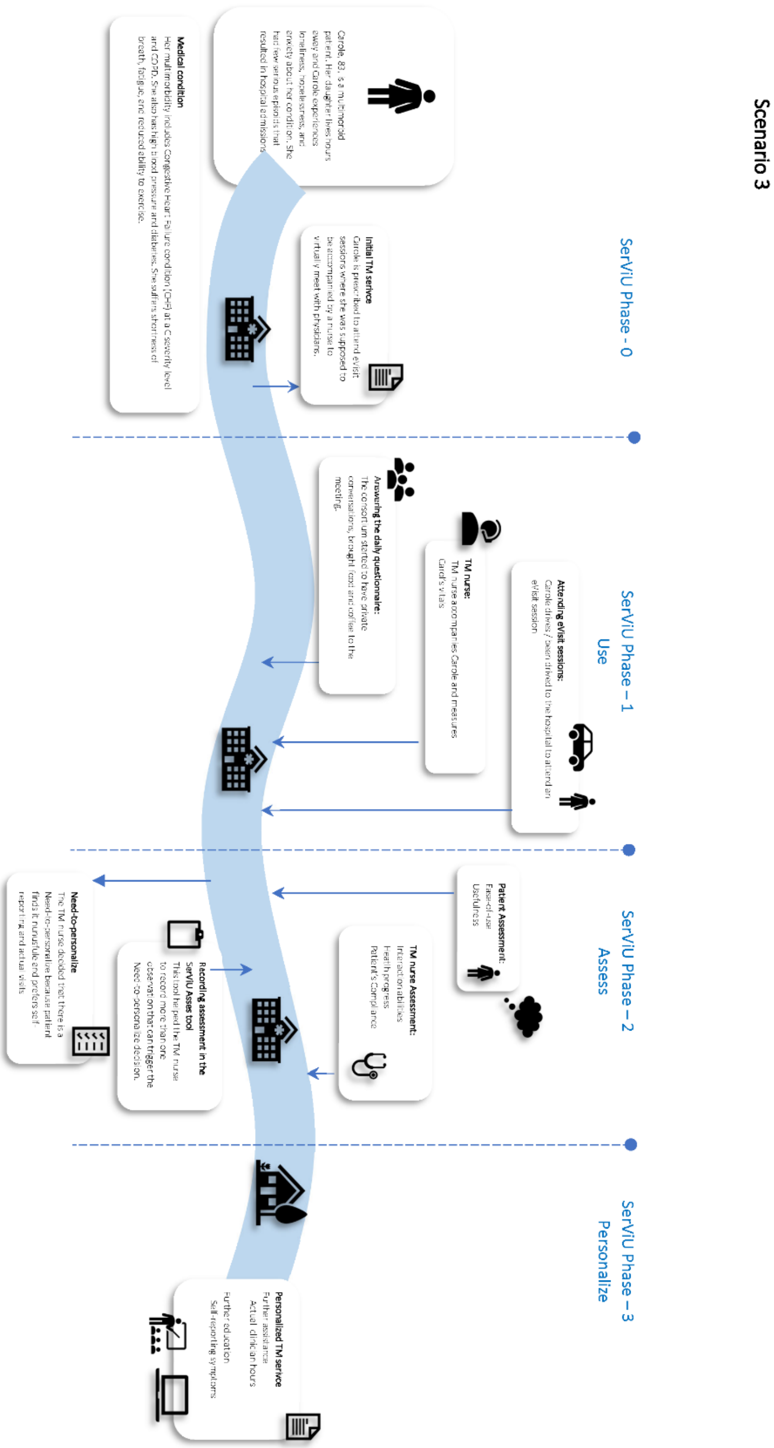


Figure A3. 6

Scenario 3: eVisit



Document A3.f: Office of Research Ethics Integrity—Letter of Administrative Approval

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

Lettre d'approbation administrative | Letter of administrative approval

Numéro de dossier / Ethics File Number	H-08-20-6120
Titre du projet / Project Title	Telehealth personalization using (SerViU) method: Validating the SerViU Personalize Tool
Type de projet / Project Type	Thèse de doctorat / Doctoral thesis
CÉR primaire / Primary REB	Hôpital Montfort / Hôpital Montfort
Statut du projet / Project Status	Approuvé / Approved
Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)	11/09/2020
Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)	18/08/2021

Équipe de recherche / Research Team

Chercheur / Researcher	Affiliation	Role
Oday ASWAD	École de science informatique et de génie électrique / School of Electrical Engineering and Computer Science	Chercheur Principal / Principal Investigator
Lysanne LESSARD	École de gestion Telfer / Telfer School of Management	Superviseur / Supervisor

Conditions spéciales ou commentaires / Special conditions or comments:

Montfort REB File number: 20-21-08-023

Université d'Ottawa
Bureau d'éthique et d'intégrité de la recherche

University of Ottawa
Office of Research Ethics and Integrity

L'Université d'Ottawa a signé une Entente, conforme aux exigences de la plus récente version de l'EPTC et tout autre règlement ou législation applicable, permettant au CÉR ci-haut nommé d'être désigné comme CÉR primaire pour les projets de recherche où

1) les activités principales de recherche sont menées sous l'autorité ou sous les auspices de l'établissement lié au CÉR primaire et

2) Une partie du projet est également réalisé sous l'autorité ou sous les auspices de l'Université d'Ottawa.

Cette lettre confirme que l'Université d'Ottawa a autorisé que le CÉR primaire soit le CÉR officiel pour l'évaluation et la supervision de ce projet de recherche. Ceci n'est pas une approbation éthique.

Afin de nous aider à garder votre dossier à jour, veuillez soumettre une copie de toutes demandes de modification, renouvellement d'approbation éthique etc. soumis à et approuvé par le CÉR primaire dès qu'elles sont disponibles.

Cette approbation administrative est valide pour la durée indiquée ci-haut et est sujette aux conditions énumérées dans la section intitulée « Conditions spéciales ou commentaires ».

The University of Ottawa has signed an Agreement, compliant with current TCPS guidelines and any other applicable guidelines or legislation regarding multisite review, allowing the REB named above to serve as Board of Record (BoR) for research projects where

1) the main research activities are conducted within the auspices or jurisdiction of the BoR's institution and

2) parts of the project are also conducted under the jurisdiction or auspices of the University of Ottawa.

This letter confirms that the University of Ottawa has authorized the REB named above to serve as Board of Record for the review and oversight of this research project. This is not an REB approval.

In order to help us keep your file up to date, please submit a copy of all amendment requests, project renewals or any other changes submitted to and approved by the BoR, as they become available.

Administrative approval is valid for the period indicated above and is subject to the conditions listed in the section entitled «Special conditions or comments».

Catherine PAQUET
Directeur / Director
Pour/For **Daniel LAGAREC** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences de la santé et sciences / Health Sciences and Sciences Research Ethics Board**

Appendix 4: Case Study Results

This appendix displays results from the within-case analysis based on results from each TM Mode.

Table A4.1

Results of Remote Patient Monitoring Mode

		Agreement	1,1	1,2	1,3	1,4
Personalization options	Further assistance	A	*	*	*	*
	Technology improvement	P	*	*		*
	Further education	A	*	*	*	*
Interaction abilities	Mental	A	*	*	*	*
	Physical	D			*	*
Telemonitoring components	Universal unit	P	*	*	*	
	Multi-devices	Pnot				*
	Touchscreen	D	*			*
	Mobile device	Pnot				*
	Videoconference device/feature	P	*	*		*
	SmartWare	P	*	*		*
	Hardware	Pnot		*		
	Mobile app	D			*	*
	Website	Anot				
	CD ROM	Anot				
	Paperback learning	A	*	*	*	*
Setup	Home-based	D	*		*	
	Mobile	D		*		*
Communication methods	Text	Pnot				*
	Email	Pnot				*
	SMS	Pnot				*
	Video call	A	*	*	*	*
	Phone call	A	*	*	*	*

Data transfer	Store-and-forward	Anot				
	Real-time	D	*			*
	Interactive	D		*	*	
Connectivity	Wired	Pnot	*			
	Wireless Wi-Fi	P	*		*	*
	Bluetooth	P	*		*	*
	GRPS	D		*	*	
Power	Cable cord	Pnot		*		
	Cord and chargeable devices	P	*		*	*
	All chargeable devices	Anot				
Personnel	By clinician	A	*	*	*	*
	By patient	A	*	*	*	*
	Automatic	A	*	*	*	*
Healthcare network	Initial plan	D	*		*	
	Hospital	D	*			*
	Canada	Anot				
	International	Pnot		*		
Willingness	Yes	A	*	*	*	*
	Neutral	Anot				
	No	Anot				

where agreement levels are calculated based on the following:

Code	Definition	Range
A	Agree to consider the option/component	4/4
P	Partially agree to consider the option/component	3/4
D	Disagree	2/4
Pnot	Partially agree NOT to consider the option/component	1/4
Anot	Agree NOT to consider the option/component	0/4

This table displays the level of agreement on options selected using the SerViU Personalize Tool. The personalization process was applied to four units within the remote patient monitoring mode.

Table A4.2

Results of Remote Medication Management Mode

		Agreement	2,1	2,2	2,3	2,4
Personalization options	Further assistance	A	*	*	*	*
	Technology improvement	D	*		*	
	Further education	A	*	*	*	*
Interaction abilities	Mental	A	*	*	*	*
	Physical	Anot				
Telemonitoring components	Universal unit	A	*	*	*	*
	Multi-devices	Anot				
	Touchscreen	D	*	*		
	Mobile device	Anot				
	Videoconference device/feature	D	*		*	
	SmartWare	Anot				
	Hardware	D	*		*	
	Mobile app	Pnot			*	
	Website	Anot				
	CD ROM	Anot				
	Paperback learning	A	*	*	*	*
Setup	Home-based	A	*	*	*	*
	Mobile	Pnot		*		
Communication methods	Text	Pnot		*		
	Email	Anot				
	SMS	Anot				
	Video call	A	*	*	*	*
	Phone call	P	*		*	*
Data transfer	Store-and-forward	Anot				

	Real-time	P	*		*	*
	Interactive	Pnot		*		
Connectivity	Wired	D	*			*
	Wireless Wi-Fi	A	*	*	*	*
	Bluetooth	D	*		*	
	GPRS	Pnot		*		
Power	Cable cord	Pnot				*
	Cord and chargeable devices	D	*		*	
	All chargeable devices	Pnot		*		
Personnel	By clinician	D	*		*	
	By patient	P	*	*	*	
	Automatic	A	*	*	*	*
Healthcare network	Initial plan	P		*	*	*
	Hospital	Pnot	*			
	Canada	Anot				
	International	Anot				
Willingness	Yes	A	*	*	*	*
	Neutral	Anot				
	No	Anot				

Where agreement levels are calculated based on the following:

Code	Definition	Range
A	Agree to consider the option/component	4/4
P	Partially agree to consider the option/component	3/4
D	Disagree	2/4
Pnot	Partially agree NOT to consider the option/component	1/4
Anot	Agree NOT to consider the option/component	0/4

This table displays the level of agreement on options selected using the SerViU Personalize Tool. The personalization process was applied to four units within the remote medication management mode.

Table A4.3

Results of Monitoring by TM Nurse Mode

		Agreement	3,1	2,2	3,3	3,4
Personalization options	Further assistance	D	*	*		
	Technology improvement	P	*		*	*
	Further education	P		*	*	*
Interaction abilities	Mental	A	*	*	*	*
	Physical	Anot				
Telemonitoring components	Universal unit	D	*	*		
	Multi-devices	D			*	*
	Touchscreen	D		*	*	
	Mobile device	Anot				
	Videoconference device/feature	P	*		*	*
	SmartWare	Pnot			*	
	Hardware	Anot				
	Mobile app	Pnot			*	
	Website	Pnot				*
	CD ROM	Anot				
	Paperback learning	D		*	*	
Setup	Home-based	P	*	*	*	
	Mobile	P		*	*	*
Communication methods	Text	P	*	*	*	
	Email	Pnot	*			
	SMS	Pnot			*	
	Video call	A	*	*	*	*

	Phone call	D			*	*
Data transfer	Store-and-forward	Pnot	*			
	Real-time	P		*	*	*
	Interactive	Anot				
Connectivity	Wired	P				*
	Wireless Wi-Fi	A	*	*	*	*
	Bluetooth	Pnot			*	
	GPRS	Pnot		*		
Power	Cable cord	Anot				
	Cord and chargeable devices	D			*	*
	All chargeable devices	D	*	*		
Personnel	By clinician	P	*		*	*
	By patient	A	*	*	*	*
	Automatic	P	*	*	*	
Healthcare network	Initial plan	D		*		*
	Hospital	D	*		*	
	Canada	Anot				
	International	Anot				
Willingness	Yes	P	*	*	*	
	Neutral	Pnot				*
	No	Anot				

Where agreement levels are calculated based on the following:

Code	Definition	Range
A	Agree to consider the option/component	4/4
P	Partially agree to consider the option/component	3/4
D	Disagree	2/4
Pnot	Partially agree NOT to consider the option/component	1/4
Anot	Agree NOT to consider the option/component	0/4

This table displays the level of agreement on options selected using the SerViU Personalize Tool. The personalization process was applied to four units within the monitor by nurse mode.

Appendix 5: Thematic Analysis

This appendix displays themes identified in the transcripts of the decision-making simulation sessions, presented as definitions followed by within-case thematic results.

Table A5.1

Theme Definitions

Theme	Definition
Appropriate resources	Clinicians want patients to have the best and most appropriate resources that fit with their situations and disease condition. "Definitely if she has symptoms which are from medications, it can affect her blood pressure. So, I would give her the blood pressure cuff in order to monitor her vital signs."
Conditional willingness	Clinicians assume that patients' willingness to adhere is conditional on personal preferences, availability of assistance, guidance, education, and technology improvement. "She said that the technology is too complicated. So, I think initially personalize it for her and make it simple for her." "She is thinking of maybe not continuing with the program; sometimes it's just because they do not understand you and find it complicated."
Data accuracy	Clinicians emphasize data accuracy. Clinicians also prefer automated data capture and transfer to avoid errors caused by patients. "We don't want the patient to modify it. It would be automatic."
Further assessment	Clinicians assume that detailed and updated information is needed to make personalization decisions (e.g. patients' symptoms, wellbeing, abilities, and preferences). "There are different aspects of Carole's life that I would like to know more about before making decisions." "We have to make sure she doesn't have physical exam. We've asked questions and we've eliminated some of the aspects that might be a trigger for that patient."
Improve self-management	Clinicians aim to help patients improve self-management by practicing TH-related tasks, making decisions, and maintaining contact with care providers. "I still want to give her some powers and she feels connected with her care plan."
Improve usability	Clinicians aim to improve patients' interactions with TH services by integrating additional features, easy to use technology, simplified tasks, friendly interfaces, practical solutions, enhanced remote monitoring, and secure information accessibility. "There's a lot of noise in the background that might compromise the consultation." "She did mention it was a little complicated to use…. That's why she's not willing to continue. So, I think that maybe the product that's being used, the software and the tools, are not so… user friendly." "A touchscreen is important to increase the accessibility and usage." "I would keep all options because not everyone feels comfortable communicating the same way." "If you have different devices all through the house, they get lost or they forget to connect one device to the main device."

Medical limitation	Clinicians assume that personalization decision is influenced by symptoms, age limitation, clinical diagnosis, or physician permission. Clinicians may also consider possible additional symptoms that could affect their decision. "If we're talking about getting out with permission, maybe just the home base would be a good option for her." "At her age, I would give her a paperback version for further education."
Patient education	Clinicians want to evaluate, ensure, support, and improve patients' knowledge of and familiarity with TH technology, disease-specific and medication-specific requirements, and providers' instructions. "I would also do further education on her CHF or her condition just to make sure to understand why she needs to take it and why she needs to take her blood pressure or rates or whatever vitals she needs to do."
Real-time data transfer	Clinicians prefer that patient biodata be immediately sent to data centers and care providers. Clinicians assume this would result in better accuracy and quicker help when needed. "I think something real-time would definitely be more accurate…[otherwise you might have the situation where] she sends her blood pressure four hours later than she should have, but it shows up as she did it at noon, but really she did it at 8:00am."
Resource availability	Clinicians prefer available, approved, and feasible resources to select from. This includes clinician hours, connectivity coverage, healthcare network jurisdiction, specialty, approvals, insurance coverage, or communication services. Clinicians assume some resources are available as a backup. "Definitely available here and local and easier to transfer data sources that could be very important." "I would not go for Canada or international at this point because of all of the HIPAA compliance and everything that needs to be done. I think it's too complicated. I would choose also Montfort hospital so you don't have to also check that." "If it fails, well, a phone call would be the backup."
Safety	Clinicians emphasize patients' safety. "A simple touch of a button or an application on a screen—that would be good for patient safety." "No power cords. She's going to trip and fall."
Secure power backup	Clinicians emphasize power availability to avoid losing device settings and maintain the flow of information. "Having some form of backup power, where it's not just the battery…." "I think a reliable source of electric energy would probably be the power cord. All those other extra multiple devices would have on a rechargeable battery, but the nurse would be in charge of ensuring that it's a full battery and not Carole."
Support mobility	Clinicians prefer to maintain patient's connectivity via support mobility (indoor and outdoor, as needed). "I think for her GPRS. She can have access to it anywhere, from my understanding. She could go to her daughter's. She can go outdoors. She's always connected."
Trust in technology	Clinicians assume that patients don't trust the outcomes of TH technology, including privacy, and feel disconnected, disrespected, and have dignity issues. "When providing patient care with virtual tools from a health care provider standpoint, you need to make sure that you're in a private room, that there's no background." "She needs to be taught how to use the machine properly and, if there's any problems, for this to be reinforced in order for her to trust."

	“She is feeling disconnected, so what would be the best option for her to feel a bit more connected? I think we can make a video call.”
Visual interaction	Clinicians assume that real-time video communication facilitates monitoring patients while performing tasks, improves guidance and connectivity. “I think something with a videoconferencing device so that she can hear well, see well, and be part of the appointment—like it was a real, present, in-life session.” “You can see her all the way, just to have a better picture of what’s going on in order to notify the doctor if needed.”

Table A5.2

Thematic Analysis: Remote Patient Monitoring (Units 1.1–1.4)

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Unit
Personalization options						2		3								1.1
								2								1.2
				1												1.3
						1		1		1	1					1.4
subtotal	0	0	0	1	0	3	0	6	0	1	1	0	0	0	0	
Interaction abilities								1								1.1
				1				1								1.2
							1									1.3
							2			2						1.4
subtotal	0	0	0	1	0	0	3	2	0	2	0	0	0	0	0	
TH Components						5					1				1	1.1
						3		1		1					2	1.2
	1					4	1			1					1	1.3
	2					2				1					1	1.4
subtotal	3	0	0	0	0	14	1	1	0	3	1	0	0	0	4	
Setup																1.1
					1											1.2
							1									1.3
										2						1.4
subtotal	0	0	0	0	1	0	1	0	0	2	0	0	0	0	0	
Communication methods									1							1.1
						1									2	1.2

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Unit
						1										1.3
						1										1.4
subtotal	0	0	0	0	0	3	0	0	1	0	0	0	0	0	2	
Data transfer									1							1.1
				1					1							1.2
	1								1							1.3
									1							1.4
subtotal	1	0	0	1	0	0	0	0	4	0	0	0	0	0	0	
Connectivity										1						1.1
													1			1.2
										1			1			1.3
						1		1								1.4
subtotal	0	0	0	0	0	1	0	1	0	2	0	0	2	0	0	
Power supply												1				1.1
						1										1.2
												1				1.3
																1.4
subtotal	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	
Personnel			1													1.1
								1								1.2
							1	1								1.3
							1									1.4
subtotal	0	0	1	0	0	0	2	2	0	0	0	0	0	0	0	
Healthcare network										1						1.1
	1									4						1.2
										1						1.3
										1						1.4
subtotal	1	0	0	0	0	0	0	0	0	6	0	0	0	0	0	
Willingness		2														1.1
		6														1.2
		4		2												1.3
																1.4
subtotal	0	12	0	2	0	0	0	0	0	0	0	0	0	0	0	
Total	5	12	1	5	1	22	7	12	5	15	2	2	2	0	6	Unit 1

Table A5.3

Thematic Analysis: Remote Medication Management (Units 2.1–2.4)

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Unit
Personalization options	1							1						1		2.1
								1								2.2
	1			1				3		1						2.3
						2		5				1				2.4
subtotal	2	0	0	1	0	2	0	10	0	1	0	1	0	1	0	
Interaction abilities								1								2.1
								1								2.2
														1		2.3
								1								2.4
subtotal	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	
TH Components	1					1		1							2	2.1
						1										2.2
						2				1					1	2.3
						3		1								2.4
subtotal	1	0	0	0	0	6	0	1	0	1	0	0	0	0	3	
Setup																2.1
										2						2.2
																2.3
						2										2.4
subtotal	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	
Communication methods	1														1	2.1
	1							1		1					1	2.2
								2								2.3
						1				1					1	2.4
subtotal	2	0	0	0	0	1	0	3	0	2	0	0	0	0	3	
Data transfer									1	2						2.1
	1														1	2.2
	1								1							2.3
									1							2.4
subtotal	1	0	0	0	0	0	0	0	3	0	0	0	0	0	1	
Connectivity	1									1						2.1
						1										2.2

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Unit
																2.3
						1										2.4
subtotal	1	0	0	0	0	2	0	0	0	1	0	0	0	0	0	
Power supply													1			2.1
												1				2.2
																2.3
																2.4
subtotal	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	
Personnel										1						2.1
										1						2.2
								1		2				1		2.3
						1										2.4
subtotal	0	0	0	0	0	1	0	1	0	4	0	0	0	1	0	
Healthcare network										1						2.1
										1			1			2.2
																2.3
						1				3						2.4
subtotal	0	0	0	0	0	1	0	0	0	5	0	0	1	0	0	
Willingness		1														2.1
		1					1									2.2
		1														2.3
		1														2.4
subtotal	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	
Total	6	4	0	1	0	15	1	18	3	16	0	2	0	3	7	Unit 2

Table A5.4

Thematic Analysis: Monitoring by TM Nurse (Units 3.1–3.4)

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Unit
Personalization options	1															3.1
				2												3.2
				1												3.3
				1		1		1						1		3.4
subtotal	1	0	0	4	0	1	0	1	0	0	0	0	0	1	0	
Interaction abilities																3.1
																3.2
					1	1										3.3
								1						1		3.4
subtotal	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	
TH Components						1	1			1					2	3.1
																3.2
	1				1	2		3						2		3.3
						3		1						1	1	3.4
subtotal	1	0	0	0	1	6	1	4	0	1	0	0	0	3	3	
Setup																3.1
				1												3.2
						1										3.3
						1										3.4
subtotal	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	
Communication methods																3.1
					1											3.2
				1		1										3.3
															1	3.4
subtotal	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	
Data transfer					1											3.1
																3.2
						1				1						3.3
									1							3.4
subtotal	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	
Connectivity							1									3.1
																3.2

SerViU Personalize Tool	Appropriate resources	Conditional willingness	Data accuracy	Further assessment	Improve self-management	Improve usability	Medical limitation	Patient education	Real-time data transfer	Resource availability	Safety	Secure power backup	Support mobility	Trust in technology	Visual interaction	Unit
																3.3
						1										3.4
subtotal	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	
Power supply																3.1
											1					3.2
						1				1						3.3
												1				3.4
subtotal	0	0	0	0	0	1	0	0	0	1	1	1	0	0	0	
Personnel				1												3.1
																3.2
																3.3
						1										3.4
subtotal	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	
Healthcare network										1						3.1
										1						3.2
																3.3
	1															3.4
subtotal	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	
Willingness		1														3.1
																3.2
																3.3
		2														3.4
subtotal	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total	3	3	0	7	4	15	2	2	1	5	1	1	0	5	4	Unit 3

Appendix 6: Evaluation

This appendix displays the themes identified from the feedback transcripts provided by the case study participants, starting with definitions.

Table A6.1

Feedback Theme Definitions

Feedback Theme	Definition
Usability	The clinician assumes SerViU needs partial or major improvements and modifications: missing features, functions, processes, decision-making options, and contextual information (patient- and healthcare-related). The clinician thinks that SerViU should be adaptable to different clinical settings. The clinician assumes that ease-of-use, swiftness, and clarity are essential for clinicians to use the tool to make telehealth personalization decisions.
Decision-making	The clinician's agreement is based on the decision-making process that SerViU provides to address telemonitoring scenarios and different patient situations.
Clinician education	The clinician assumes that telehealth clinicians need guidance, further clarifications, or education about utilizing SerViU. The clinician learns from SerViU additional aspects that will help enhance their knowledge about telehealth patients.
Patient-centeredness	The clinician emphasizes that SerViU maintains patient-centeredness with the tools and function it provides. Clinicians believe that SerViU should help in case management and patient communications to accommodate different situations, locations, and demographics.
Real-life	The clinician believes that SerViU addresses real-life situations and patient experiences, including the implications and limitations of using the service.

Table A6.2

Feedback Theme Identification (sorted by evaluation criteria: relevance, usefulness, and sufficiency of information)

Relevance			
Participant	Feedback	Perceived	Theme
1	SerViU seems like a good tool to use for telemonitoring. There are a few changes that I would suggest in order to better customize the care plan of patients.	Few improvements are needed for better customization	Usability
2			
3	Yes, I agree that the scenario and subsequent decisions available were quite relevant to the telemonitoring context.	Decision-making in SerViU is relevant to the telemonitoring context.	Decision-making
	Yes, I agree that the scenario and subsequent decisions available were quite relevant to the telemonitoring context.	The scenario is relevant to real-life situation.	Real-life
4	The tool permits reflection on what we might not have thought of or gives an overview of options. It is an indicator that gives you the option to think outside the box or expand from what you usually do on a regular basis.	SerViU helps address aspects beyond usual and enhances our knowledge.	Clinician education
5	From my personal experience, I think that it is important to make sure that the tools and functionalities offered to the patient in the context of remote monitoring respond to the patients' needs and that it remains patient-centered (like care when patient is in hospital).	Ensuring the patient-centeredness of the functions that SerViU provides.	Patient-centeredness
6	The case study provides real-life challenges with telemedicine and patient use [including] implications and limitations.	SerViU addresses real-life experiences.	Real-life

Note: Rationales for participants' agreement with the statement "The decisions made using the SerViU Personalize Tool are relevant to the telemonitoring context."

Usefulness			
Participant	Feedback	Perceived	Theme
1	I do agree that this tool will be helpful for clinicians to better manage their patient's health. It is a way to communicate with patients who might not be able to mobilize outside their homes to see their physicians.	Provides a better fit for patients' needs and abilities.	Patient-centeredness
2			
3	It can be quite useful or not at all in another clinical setting. The SerViU Personalize Tool needs to be adaptable.	SerViU Personalize Tool needs to be adaptable to different clinical settings.	Usability
	Also, I found that more detailed and clear, written information are needed for the participants prior to doing this simulation session.	More details and information is needed to make the personalization decision.	Clinician education
4	Depending on the professional, some might know of different devices, options, apps, etc. that are available, but a good majority of them do not know.	Majority of clinicians don't know about telemonitoring devices.	Clinician education
	I would add to your options a clear definition to be able to go back and read it and better understand what it means. Do not assume that people will know.	Clear definitions and instructions are needed to use the tool.	Clinician education
5	In order to provide better care and adherence to a regimen, we must be able to personalize the treatment plan (including the tool to some extent, based on patient population, health demographics etc.)	SerViU should enable personalization for different health demographics.	Usability
6	Quick and easy to use	Quick and easy to use.	Usability
	The description of definitions helps to situate the choices and to make a more personalized decision based on the patient's needs and limitations.	Description brought better guidance for using the tool.	Clinician education

Note: Rationales for participants' agreement with the statement "The SerViU Personalize Tool is useful for the involved stakeholders (i.e., clinicians)."

Information Sufficiency			
Participant	Feedback	Perceived	Theme
1	The information present is adequate to build a care plan for each patient, but I would add the option of having real-time data entry as well as interactive in case the patient needs to add new data regarding vital signs or medication. In my experience, when the clinician speaks	Additional features and options are needed for better case management.	Usability

Information Sufficiency			
Participant	Feedback	Perceived	Theme
	directly to the patient (when data entry is off the guidelines set for the patient) we sometimes ask the patient to retake their vitals and/or take extra medication. Therefore, it would be great to have the option for the client to manually enter their vitals or note that they took an extra medication. This will help the clinician better manage the care plan and have a record of the event should anything change in the patient's condition.		
2	I think it's relevant to consider that I've only a few months of experience with telemonitoring and not as a nurse but as a social worker.	SerViU can be used for non-clinicians.	Usability
3	Most of the time, yes, but some specific details and information were missing at times which would have helped in making some decisions. (e.g., availability of technical parts like in hospital, Canada, or outside the country).	Missing information such as which part is available in which network.	Usability
4	Would add a table with the word and what you are looking for in the answer or how you can guide the professional to expand the vision or the option.	Add a guidance table for the clinician.	Clinician education
	The scenarios are brief and open for reflection. The professional needs to keep the facts in mind.	Expand options. Further information about the patient is needed.	Usability
5	Would need patient's information regarding age category, surgical pathway, and social determinants of health (e.g., educational and financial levels).	Further information about the patient is needed.	Usability
6	The presence of the case study relating to the tool helps to guide.	Patients' information on the tool helps the clinicians.	Usability
	And the definition offered in the description is also a key guide.	Definitions and descriptions are key guides for using the tool.	Clinician education

Note: Rationales for participants' agreement with the statement "There is enough information to make personalization decisions."

Appendix 7: SerViU Personalize Tool Information

Table A7.1

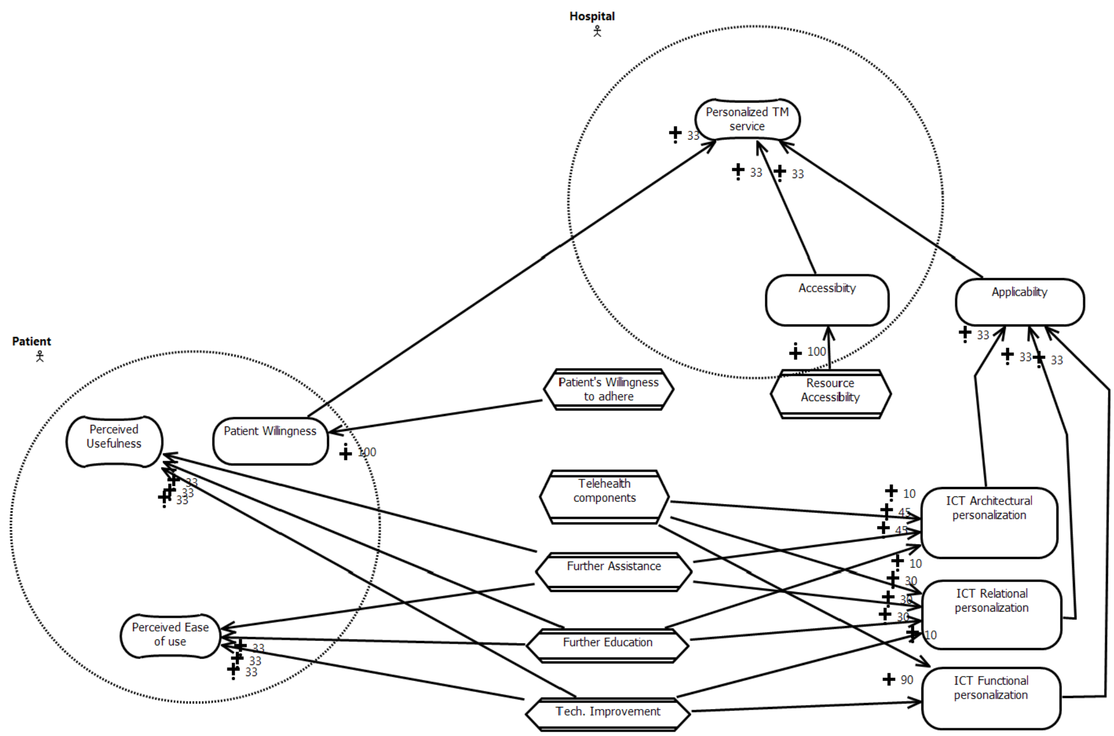
VBA Code Mapping from Conceptual Definitions

ICT Personalization Support Type	Architectural	Relational	Functional
Definition (Fan & Poole, 2006)	"The construction of the digital environment to create a pleasant user space and a unique experience for the user through arrangement and design of digital artifacts in a way that meets the user's needs and reflects his or her style and taste."	"The mediation of interpersonal relationships and utilization of relational resources to facilitate social interactions." "The relational perspective models the user's relational needs and the social context that satisfies them."	"The utilization of IS to enhance efficiency and personal productivity by providing, enabling, and delivering useful, usable, user-friendly tools in a way that meets the user's situated needs. Instrumental personalization focuses on the functionality of the system."
Application in SerViU Method	Allocate and rearrange telemonitoring components (digital artifacts) to meet the patient's preferences.	Consider the patient's interaction abilities, facilitate the appropriate personalization option.	Utilizing tools that improve the patient's outcomes, such as voice recognition software, automatic data capture and transfer.
SerViU Personalize Tool	Allocating human or non-human resources through further assistance or TM components.	Providers might choose to offer further education OR improve the technology to address certain physical abilities	Technology improvement, in general, or technology improvement was offered (software or hardware).
SerViU Formula	Architectural personalization AP = 1 if (further assistance = true) OR architectural personalization AP = (0.1 * AP) + AP for added TM components	Relational personalization RP = 1 if (further education = true) Relational personalization RP = 1 if (technological improvement = true) AND (interaction ability = physical)	Functional personalization FP = 1 if (technological improvement = true) OR functional personalization FP = 1 if particular components (SmartWare or hardware) = true
VBA Code	AP = IIf(ActiveSheet.Shapes("Rectangle 6").Fill.Visible = msoTrue, 1, 0)	RP = IIf((ActiveSheet.Shapes("Rectangle 22").Fill.Visible = msoTrue Or ActiveSheet.Shapes("Rectangle 23").Fill.Visible = msoTrue) And ActiveSheet.Shapes("Rectangle 44").Fill.Visible = msoTrue, 1, 0)	FP = IIf(ActiveSheet.Shapes("Rectangle 22").Fill.Visible = msoTrue And ActiveSheet.Shapes("Rectangle 47").Fill.Visible = msoTrue, 1, 0)

Note. This table maps ICT personalization from conceptual definition to the SerViU Personalize Tool code.

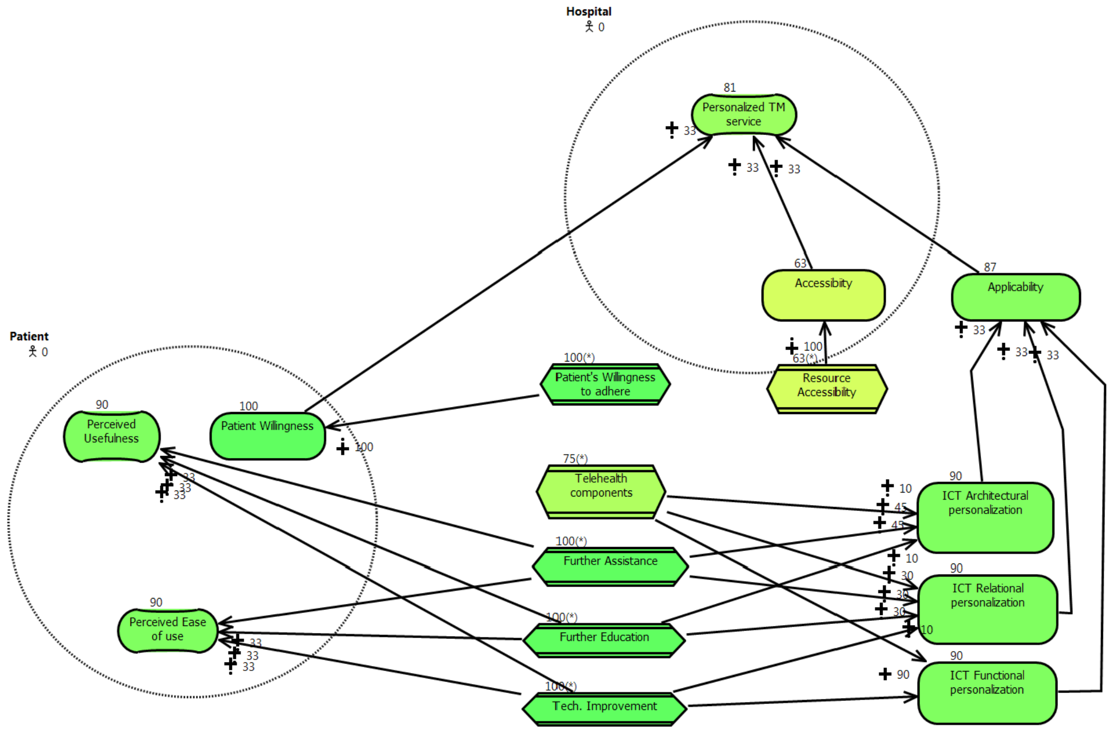
Appendix 8: Applying SerViU GRL-VE Tool

This section outlines the relationship between the SerViU Personalize Tool and SerViU GRL VE in Phase 3 (Personalize). This page displays the tools prior to being filled in by the TM nurse and TM team. Meeting the patients' value expectations could more successful than meeting the provider's value proposition, and vice versa.



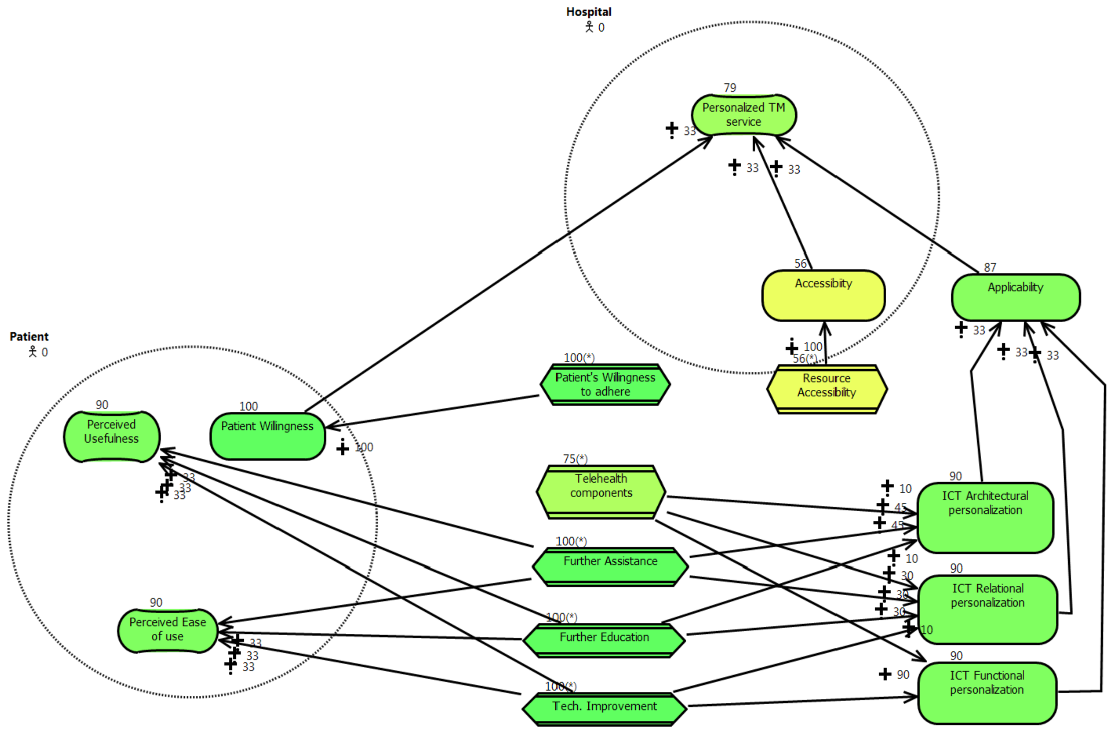
Personalization option		Telemonitoring	Operational						Healthcare	Patient
	interaction ability	Component	Setup	Communication method	Data transfer	connectivity	Power	Personnel	Network	Willingness
Further Assistance	mental	Universal unit (all in one)	home-based	text	store-and-forward	wired	Power cord	by clinician	initial telemonitoring care plan	Yes
Technology improvement	physical	Multiple devices	mobile	email	real-time	Wireless wifi	Power cord for the main component and chargeable battries for the other devices	by patient	Montfort hostpital	neutral
Further Education		Touchscreen		sms	interactive	Bluetooth	All devices with chargeable battries	automatic	Canada	No
Calculate Score		Mobile device (outdoor)		video call		GPRS			international	
Clear All		Video conference		phone call						
		Smartware								
		Haredware improvement								
		Mobile app								
		Website								
		CD ROM								
		Paperback learning								

Unit 1.1: The Relationship between the SerViU Personalize Tool and SerViU GRL-VE



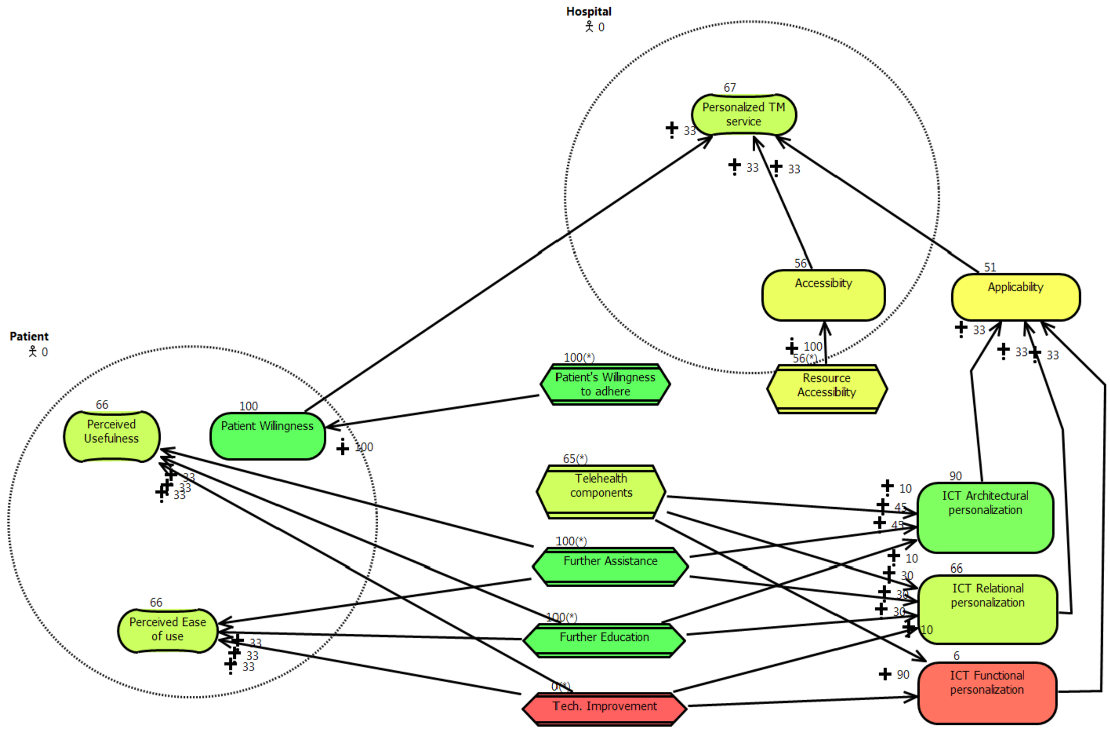
Personalization option	interaction abilities	Telemonitoring	Operation						Healthcare	Patient
		Component	Setup	Communication method	Data transfer	connectivity	Power	Personnel	Network	Willingness
☑ Further Assistance	mental ☑	Universal unit (all in one) ☑	home-based ☑	text ☐	store-and-forward ☐	wired ☑	Power cord ☐	by clinician ☑	initial telemonitoring care plan ☐	Yes ☑
Technology improvement ☑	physical ☐	Multiple devices ☐	mobile ☐	email ☐	real-time ☑	Wireless wifi ☑	Power cord for the main component and chargeable batries for the other devices ☑	by patient ☑	Montfort hostpital ☑	neutral ☐
☑ Further Education		Touchscreen ☑		sms ☐	interactive ☐	Bluetooth ☑	All devices with chargeable batries ☐	automatic ☑	Canada ☐	No ☐
Calculate Score		Mobile device (outdoor) ☐		video call ☑		GPRS ☐			international ☐	
Clear All		Videoconference device ☑		phone call ☑						
		Smartware ☑								
		Haredware improvement ☐								
		Mobile app ☐								
		Website ☐								
		CD ROM ☐								
		Paperback learning ☑								

Unit 1.2: The Relationship between the SerViU Personalize Tool and SerViU GRL-VE



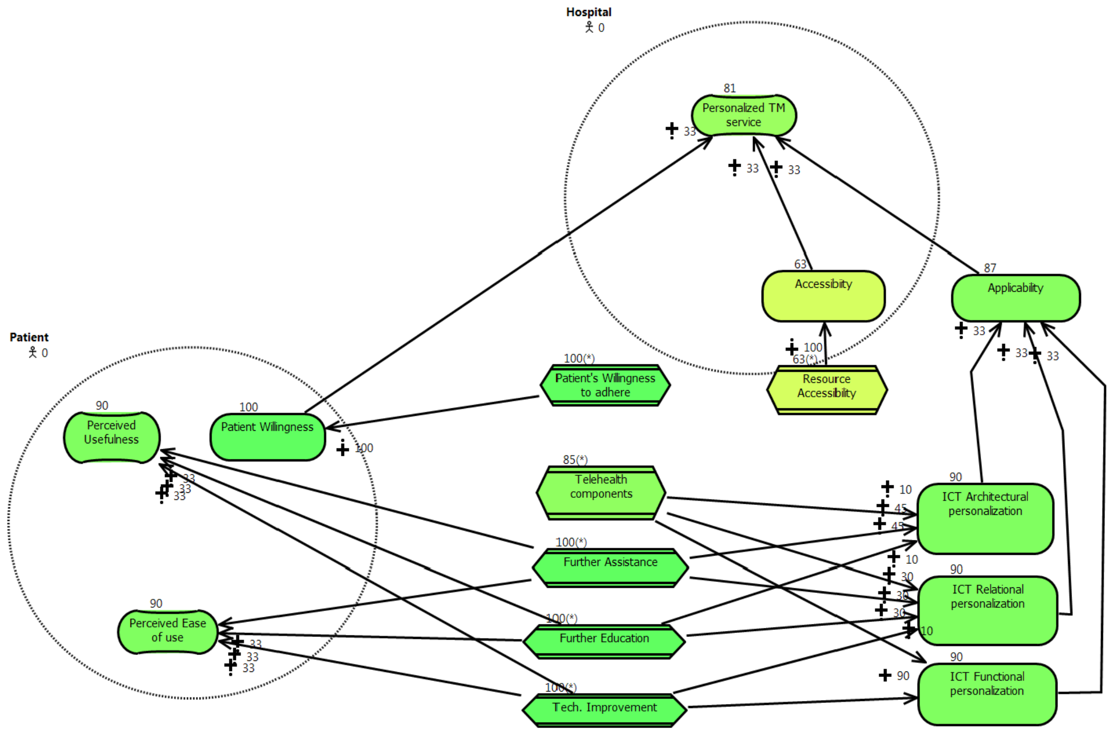
Personalization option	Interaction abilities	Telemonitoring: Component	Operation: Setup	Operation: Communication method	Operation: Data transfer	Operation: connectivity	Operation: Power	Operation: Personnel	Healthcare: Network	Patient: Willingness
☑ Further Assistance	mental ☑	Universal unit (all in one) ☑	home-based ☐	text ☐	store-and-forward ☐	wired ☐	Power cord ☑	by clinician ☑	initial telemonitoring care plan ☐	Yes ☑
Technology improvement ☑	physical ☐	Multiple devices ☐	mobile ☑	email ☐	real-time ☐	Wireless wifi ☐	Power cord for the main component and chargeable batries for the other devices ☐	by patient ☑	Montfort hospital ☐	neutral ☐
☑ Further Education		Touchscreen ☐		sms ☐	interactive ☑	Bluetooth ☐	All devices with chargeable batries ☐	automatic ☑	Canada ☐	No ☐
Calculate Score		Mobile device (outdoor) ☐		video call ☑		GPRS ☑			international ☑	
Clear All		Videoconference device ☑		phone call ☑						
		Smartware ☑								
		Haredware improvement ☑								
		Mobile app ☐								
		Website ☐								
		CD ROM ☐								
		Paperback learning ☑								

Unit 1.3: The Relationship between the SerViU Personalize Tool and SerViU GRL-VE



Personalization option	interaction abilities	Telemonitoring	Operation						Healthcare	Patient
		Component	Setup	Communication method	Data transfer	connectivity	Power	Personnel	Network	Willingness
☑ Further Assistance	mental ☑	Universal unit (all in one) ☑	home-based ☑	text ☐	store-and-forward ☐	wired ☐	Power cord ☐	by clinician ☑	initial telemonitoring care plan ☑	Yes ☑
Technology improvement ☐	physical ☑	Multiple devices ☐	mobile ☐	email ☐	real-time ☐	Wireless wifi ☑	Power cord for the main component and chargeable batries for the other devices ☑	by patient ☑	Montfort hospital ☐	neutral ☐
☑ Further Education		Touchscreen ☐		sms ☐	interactive ☑	Bluetooth ☑	All devices with chargeable batries ☐	automatic ☑	Canada ☐	No ☐
Calculate Score		Mobile device (outdoor) ☐		video call ☑		GPRS ☑			international ☐	
Clear All		Videoconference device ☑		phone call ☑						
		Smartware ☐								
		Haredware improvement ☐								
		Mobile app ☑								
		Website ☐								
		CD ROM ☐								
		Paperback learning ☑								

Unit 1.4 The Relationship between the SerViU Personalize Tool and SerViU GRL-VE



Personalization option	Interaction abilities	Telemonitoring Component	Operation Setup	Communication method	Data transfer	connectivity	Power	Personnel	Healthcare Network	Patient Willingness
☑ Further Assistance	mental ☑	Universal unit (all in one) ☐	home-based ☐	text ☑	store-and-forward ☐	wired ☐	Power cord ☐	by clinician ☑	initial telemonitoring care plan ☐	Yes ☑
Technology improvement ☑	physical ☑	Multiple devices ☑	mobile ☑	email ☑	real-time ☑	Wireless wifi ☑	Power cord for the main component and chargeable batries for the other devices ☑	by patient ☑	Montfort hospital ☑	neutral ☐
☑ Further Education		Touchscreen ☑		sms ☑	interactive ☐	Bluetooth ☑	All devices with chargeable batries ☐	automatic ☑	Canada ☐	No ☐
Calculate Score		Mobile device (outdoor) ☑		video call ☑		GPRS ☐			international ☐	
Clear All		Videoconference device ☑		phone call ☑						
		Smartware ☑								
		Haredware improvement ☐								
		Mobile app ☑								
		Website ☐								
		CD ROM ☐								
		Paperback learning ☑								

List of Personalization Options (LPO) Form

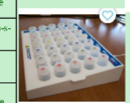
This form is a tool to guide the TM team in the LPO development process. An example of a filled form is provided below in Figure A8.1.

Telemonitoring system			**Clinical purpose**			**Operational**						**Business**			**Jurisdictions**		**Other information**	
Brand	Model	Component	Disease	Severity	Test	Setup	Communication method	Data transfer	Connectivity	Power	Personnel	Price	Insurer	3rd party provider	Health network	Specific regulation	Online link	Photo

List of Personalization Options (LPO) Example

Figure A8.1

Example of the LPO

Telemonitoring system			Clinical			Operational						Business			Jurisdictions			
Brand	Model	Component	disease	severity	test	Setup	Communication method	Data transfer	connectivity	Power	Personnel	Price	Insuror	3rd party supplier	Health Network	specific regulation	Reference link	photo
Honywell	Genesis DM	Touchscreen and breathometer	multiple conditions (hypertention, CHF, COPD)		Breath Rate	Home-based	scheduled phone calles	Real-time	GPRS (cellphone network)	Power cord for the main component and chargeable battry for the breathometer	Trained Nurse with TM certification				NJ, USA	PIPTA - Act, 2004, S.O. 2004, c. 3, Sched. A	https://www.medicalexpo.com/prod/honeywell/product-78321-815037.html	
		Tablet			Blood presure				GPRS (cellphone network)		patient (self-management)							
		pulse oximeter				Home-based	email messages		GPRS (cellphone network)									
		scale (500lbs)							wired and Bluetouth									
		Website - self-management				Home-based	Video confernence (for consultation)		GPRS (cellphone network)		Nurse visits	monthly payments		community nurse		contractual relationship & privacy-related issues	https://www.dicardiology.com/product/honeywell-hommed%E2%80%99s-genesis-dm-monitors-congestive-heart-failure	
		LifeStream platform																
		Home alert sysetem																
MedSignals	electronic pill box	pill dispenser	four drugs (separated)			home-based	email		wireless		patient				Canada		https://www.medicalexpo.com/prod/medsignals/product-83945-530707.html	
		cellular communicator (small screen)																
		timely alert					text / fax		bluetooth									
		cloud-resident					automated phone calls											
		SmartCharts TM system to report adherence									Care provider							
Eocene	electronic pill box	medication reminder	chronic diseases						bluetooth (health device protocol)		patient				Florida, USA		https://www.medicalexpo.com/prod/eocene-systems/product-119340-818800.html	
		shares time stamp with care provider						secured HIPAA health cloud			patient						secured HIPAA health cloud which analyzes the time stamp based on the contingency architecture approved by the patients healthcare provider.	
H&S	smart compliance	light and sound alert					mobile portal	store-and-forward			patient				Italy		https://pdf.medicalexpo.com/pdf/h-s-qualita-nel-software-spa/h-s-smart-compliance/107368-169139.html#open	
		light and sound alert					sms				patient							
		Website - to the care provider									care provider						The product is based on a technology that communicates with the Hermes Huband sends a luminous signal to the position of the tablet blister that each patient needs at the exact time preset Removal of the pill mutes the alarm and sends a compliance feedback and increase the adherence to the therapy of the patient. (the care provider monitors the patient's adherence via web portal)	