A method supporting the initial assessment of digital process innovation ideas using service-dominant logic

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A Method Supporting the Initial Assessment of Digital Process Innovation Ideas

Using Service-Dominant Logic

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Executive summary

Driven by the the potential for large costs savings and efficiency gains, organizations want to make bolder changes and take bigger leaps in technology. The evaluation of innovative ideas, however, often takes place based on incomplete information, resulting in a somewhat intuitive and ad hoc selection process as objective evaluation criteria are lacking. This while the early phases—i.e. front-end—of the process innovation process are crucial to the success of the innovation and most costs incurred during the innovation process are determined by decisions made in these first phases.

With process innovation in general being the least studied phenomena in innovation management, there are very few studies focusing on the front-end of digital process innovation. There is still very little known on how the activities corresponding to this front-end can best be performed and structured. As the scope of this thesis is limited to the assessment of ideas, the aim is to provide guidance as to how digital process innovation ideas could be assessed. In order to provide this guidance in a structured and comprehensive manner, the goal of this thesis was the development of a step-wise method for the description and evaluation of digital process innovation ideas.

In order to achieve this goal, the Design Science Research Methodology [Peffers, Tuunanen, Rothenberger, and Chatterjee, 2007] was applied. Accordingly first the objectives for a solution were defined. Subsequently related research was consulted to provide a basis for the method design. As little information could be found regarding the evaluation criteria of digital process innovation ideas and which types of knowledge should be present during the assessment, interviews with experts and practitioners were held. This way, the important aspects to take into account when assessing digital process innovation ideas and the type of knowledge ought to be required when assessing these ideas were identified. Subsequently the interview results and literature findings were compared to come to a comprehensive framework of evaluation criteria. Based on the information gathered so far, a first version of the method was developed. This was done by defining three phases, each comprised of a number of activities. The method was then discussed with and improved multiple times, resulting in the alpha version of the method. This alpha version was tested via a demonstration with a real idea in cooperation with a pharmaceutical organization. Based on this demonstration the method was evaluated via semi-structured interviews with experts and practitioners on its efficacy, clarity, understandability, completeness, utility, and its ease of use. Based on the evaluation results a number of minor improvements were made to the alpha version of the method, leading to the method's final version.

The method's final version provides support in the process of assessing digital process innovation ideas in a structured and comprehensive way and takes an exploratory approach into doing so. This way, more informed decision making is facilitated. The method defines multiple activities, grouped into three phases. These phases are 1) *exploration*, 2) *contextualization*, and 3) *evaluation*. A graphical outline of the method is given in figure i.

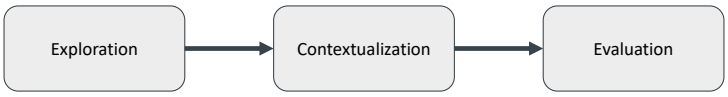

Figure i: Method Outline

The aim of the first phase is to identify additional applications for the digital technology in the organization. In order to prepare the method's users in doing so, a number of activities are to be performed first. Having identified all possible applications, represented as a value proposition, an initial evaluation is to be performed. For this, a set of evaluation questions is given. An overview of the activities related

to the exploration phase of the method, and the sequence in which they should be performed, is given in figure ii.

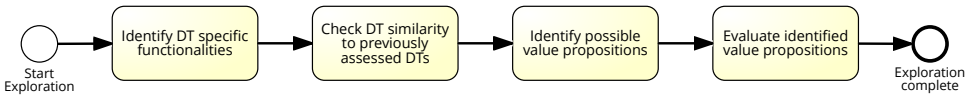

Figure ii: Exploration phase

The second phase's aim is to place the value propositions into their context. This is done by representing each value proposition as a business model, making use of the service-dominant business model radar (SDBM/R) as tool to do so. The activities related to the contextualization phase of the method are given in figure iii. Although the activities are generally performed in an iterative nature, an indication of the sequence in which they should be performed is also provided in this figure.

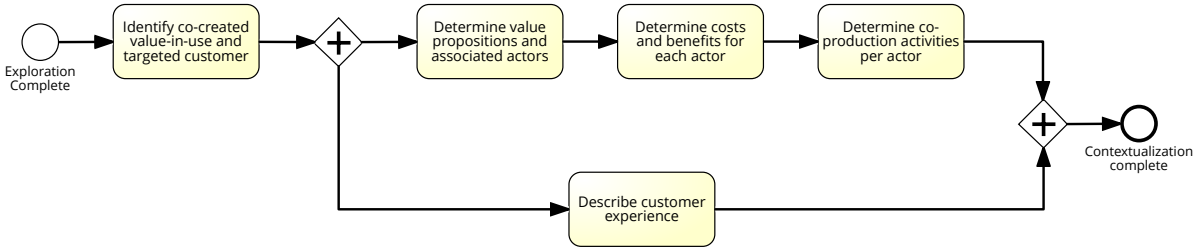

Figure iii: Contextualization phase

The aim of the third phase is to evaluate the contextualized value proposition and present the results in a comprehensible way. This is being done firstly by using a tool to evaluate the contextualized value proposition—i.e. the service-dominant business model design (SD-BMD)—in a qualitative manner. For this, a set of business model evaluation questions is provided in the tool. This tool, however, has been extended to better capture the current context. Secondly, the evaluation results are to be quantified in the form of a 'score'. An overview of the activities related to the evaluation phase of the method, and the sequence in which they should be performed, is given in figure iv.

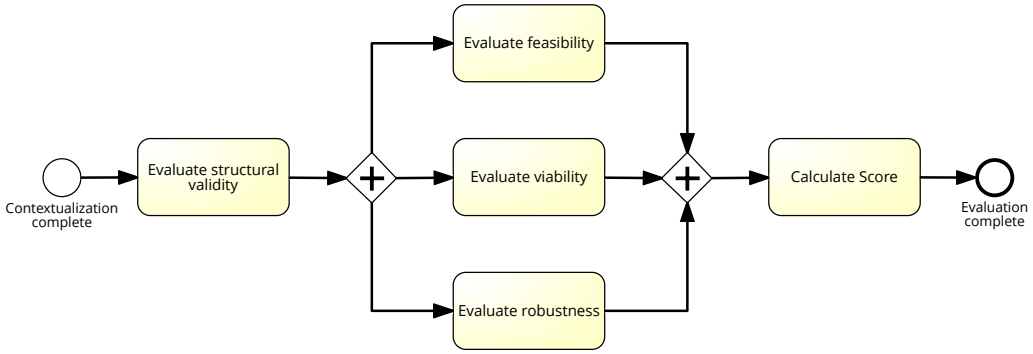

Figure iv: Evaluation Phase

In order to validate its ability to meet its goal, the method was demonstrated. This was done by applying the method once. The digital technology used for the demonstration was smart-glasses. As stated earlier, not the final version but an alpha version of the method was used for this. Based on the digital technology, a number of value propositions were identified. One of these was chosen for the demonstration of the contextualization and evaluation phases, namely phase three training. After having performed the contextualization activities, the evaluation questions were answered by two practitioners and for the purpose of demonstration, the weights were calculated based on input from one of these practitioners. Overall this led to the calculation of the final score.

With the demonstration complete, the method was evaluated by interviewing a number of experts and practitioners. First the method was explained in detail and the output of each activity performed during

the demonstration was discussed. After the method was discussed, the actual interview began as a set of semi-structured artifact evaluation questions were asked. The results of these interviews are as follows:

- Overall the interviewees were very positive regarding the method's efficacy. It was stated the method triggers its users to take a holistic perspective and it is clarified which problem or opportunity is being addressed and enabled by the use of the digital technology. In doing so, it facilitates a more fact-based decision making process. Aside from the positive responses, some concerns were raised. Firstly, when people are really convinced of a certain digital technology, they can work towards a desired outcome. Secondly, it was mentioned a couple of times that additional demonstrations of the method are needed in order to be certain of the method's efficacy.

- The overall clarity and understandability was stated to be ample by most of the respondents. It was, however, stated multiple times that the business model evaluation questions left a lot of room for individual interpretation. In addition to this, it was mentioned by one interviewee that it would be helpful to have additional guidance as to how and when to use the method.

- All interviewees stated the method was complete. Like with the efficacy, however, it was stated that additional demonstrations are needed to be certain. In addition to this, it was mentioned the exploration phase could be further specified by explicitly mentioning an activity for the identification of the digital technology's functionalities. Lastly, it was stated some sort of reflection activity at the end of the method, where you compare the actual outcome with what was expected, would be interesting to have.

- The ease of use was deemed ample by some, while others stated the ease of use to be not optimal. It was stated this concern could be addressed in a significant way by including some sort of easy to handle template, which would automatically calculate the eventual score.

- Lastly, the method's utility was also deemed ample. Again, however, it was stated additional demonstrations of the method would be needed to be certain.

Based on the evaluation results, a number of improvements were made to the alpha version of the method, which resulted in the final version stated earlier. The first improvement made was the explicit mentioning of the DT functionality identification activity during the first phase of the method. Secondly, the business model evaluation question response options have been elaborated in more detail to decrease room for individual interpretation. Lastly, a form which automatically calculates total score based on the business model evaluation question responses has been developed and included.

By providing a step-wise method which allows its users to think in a more networked and holistic perspective during the description and evaluation of an idea, the method facilitates a more fact-based decision making process later on. Thus, the selection process of ideas can be performed on a more informed base, which ultimately is likely to lead to an increase in the success rate of digital process innovation implementations.

With the little research performed in the area of digital process innovation, this research provides a basis for researchers to build upon in future research. This way further guidance can be provided in the same or related research fields. Practitioners can use the findings to structure parts of the front-end of their process innovation process, with this method being especially beneficial to organizations where the initial selection process of digital process innovation ideas is still very unstructured, intuitive, and ad hoc.

To address the limitations of this research, future research could re-validate the design decisions made based on new insights in the fields of digital process innovation and the SD logic, when these become available. Also, by applying the method in other organizations and industries, future research could further validate the method's efficacy, completeness, and utility.

"The value of an idea lies in the using of it."
Thomas Edison

Preface

This master thesis is written as part of the master program 'Innovation Management' (IM) at the Eindhoven University of Technology. The aim of the research was to develop a method supporting an initial assessment of digital process innovation ideas. This would not have been possible without the help of others and therefore I would like to take this opportunity to thank the persons who have supported me throughout the thesis project.

First of all, I would like to thank my supervisors from the university. A special thanks to my first supervisor, Baris, for his continued support and guidance. The discussions and feedback has been really helpful. Also, I would like to thank Rick for his in-depth insights and dedicated feedback.

Secondly, I would like to thank my company supervisor from Atos, Reinoud. Although the project incurred some delays, he helped me from start to end and was always available if I had any problems or questions. Furthermore, I would like to thank my supervisors from MSD, Michiel and Jelle. Although Michiel left halfway, his input in the beginning formed much of the final product. I would like to thank Jelle for taking over Michiel's role and even though we did not meet often, the feedback and discussions were very welcome. Additionally, I would like to thank Ineke for her enthusiasm throughout the project and for the opportunity to conduct my thesis at MSD. I also want to thank all other employees from Atos and MSD for taking the time for the interviews.

Lastly, I would like to thank my fellow IM student and friend Dennis for the vivid discussions we've had.

Hans Wammes,
Eindhoven 2020

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List of Abbreviations

AHP	Analytic Hierarchy Process
DPII-EC Framework	Digital Process Innovation Idea Evaluation Criteria Framework
DSRM	Design Science Research Methodology
DT	Digital Technology
GD	Goods-Dominant
MCDA	Multi Criteria Decision Analysis
SD	Service-Dominant
SD-BM	Service-Dominant Business Model
SD-BMD	Service-Dominant Business Model Design
VP	Value Proposition

Chapter 1

Introduction

Innovations play an important role for the competitiveness of companies [Adams, Bessant, and Phelps, 2006; Kaschny and Nolden, 2018; Parida, Patel, Frishammar, and Wincent, 2017] and will still do so with even more importance in the future [Bullinger, 2009]. Furthermore, for the national economy it has a far-reaching significance [Kaschny and Nolden, 2018]. Yet, the process of innovating can be quite difficult for one to master and apart from the difference between incremental & radical and product & process innovations [e.g. Zmud, 1982; Parida et al., 2017; Ettlie, Bridges, and O'Keefe, 1984], there are still many forms of innovation possible [Bullinger, 2009].

When thinking of the innovation process in general, a distinction between the front-end and back-end of the process is made. The front-end of innovation refers to the early phases of the innovation process [Kurkkio, Frishammar, and Lichtenthaler, 2011]. It starts when there is an idea of some sort and ends when the organization decides to either disregard the idea or launches a formal development project. With respect to product development, the front-end precedes the 'formal' stage-gate approach [Kurkkio et al., 2011]. Repeatedly the front-end is mentioned to be crucial to the success of the innovation [Christiansen and Gasparin, 2016; Parida et al., 2017]. Christiansen and Gasparin [2016, p. 500] even state the fuzzy front-end to be "the most critical phase of the innovation process". Also in terms of costs the front-end plays an important part as "80 percent of the costs are determined by decisions taken during the early stages, i.e. the first 20 percent of the innovation process" [Bullinger, 2009, p. 2]. The evaluation of innovative ideas, however, takes often place based on incomplete information while there is still high uncertainty, resulting in the selection process to be somewhat intuitive and ad hoc [Bullinger, 2009; Montoya-Weiss and O'Driscoll, 2000]. Many of the front-end idea selection decisions take place lacking objective evaluation criteria [Montoya-Weiss and O'Driscoll, 2000]. According to Bullinger [2009], the assessment and selection of innovative ideas is not yet fulfilling its potential and only few academically developed methods are available.

With most of the attention in literature placed on product innovation, process innovation is "one of the least studied phenomena in innovation management" [Parida et al., 2017, p. 1984]. This while process innovation is critical to an organization's competitiveness due to its focus on creating and implementing new ideas and practices into the manufacturing processes, and with this achieving a superior operational competence.

With the little research available in the area of process innovations, research into the front-end of this specific type of innovation process is even more limited. Kurkkio et al. [2011] state the detailed examination of front-end activities in process development literature—of which process innovation is part—is largely neglected. This while the front-end of process innovation is likely to be subject to the same arguments regarding its importance as the broader concept of innovation stated in the previous paragraph. As a matter of fact, Frishammar, Lichtenthaler, and Richtnér [2013] mention the importance of the early phases of process innovation due to the potential for large cost savings and efficiency gains. Parida et al. [2017, p. 1986] even state the front-end to be "vital to the success of process innovation projects". Also the logic from the product innovation domain of having deficiencies early in the innovation process resulting in costly and fatal problems at later phases, is stated to be applicable for process innovations [Parida et al., 2017]. However, as with innovations in general, still little is known regarding the early phases of process innovation [Frishammar et al., 2013]. Yet, many firms want to make bolder

changes, which are beyond minor improvements and adjustments, and take bigger technology leaps in their renewal of manufacturing processes [Parida et al., 2017].

Since digitalization is considered one of the most powerful drivers of innovation, with its potential to "trigger the next wave of innovation" [Gürdür, El-khoury, and Törngren, 2019, p. 153], digital technologies are already playing an important role when it comes to process innovations. According to Denner, Püschel, and Röglinger [2018, p. 333], digitalization is already a "fast-moving, global megatrend that transforms value networks across all industries". Organizations should not ignore its existence merely because the need to improve and change is not felt. One can say digitalization is gaining an increasing amount of importance [Burchardt and Maisch, 2019]. However, when the need for change is not felt within an organization, it may be difficult for them to invest in digitalization due to the high cost often associated with it. This is in line with a major problem felt when dealing with process innovations. Process innovation projects are managed proactively toward addressing future challenges in comparison to be reactive in solving daily problems [Parida et al., 2017]. With the potential value obtained from addressing future challenges being less apparent in comparison to solving daily problems, it is challenging for organizations to recognize the potential value of process innovations making use of digital technologies as limited guidance is available for doing so.

While it may be difficult for organizations to recognize the need process innovations making use of digital technologies, there are other difficulties to take into account as well. With manufacturing firms being specialized in executing their processes, the competence regarding underlying process technologies is typically limited [Parida et al., 2017]. This whereas firms who are conducting process innovation revamp their process manufacturing technologies significantly. As stated before, they try to take large leaps when it comes to technology. In the current digital age this includes the adoption of a large amount of information technologies (IT) since, as stated by Morabito [2016], organizations nowadays rely on complex IT to increase their competitive advantages. However, even though the use of Information and Communication Technologies (ICTs) is generally believed to positively impact organizational performance, negative consequences can arise [Morabito, 2016]. Often the project's expectations are failed to be met or are not materialized at all and implemented systems may for example remain underutilized [Morabito, 2016]. However, Kohli and Melville [2019] found very few studies focusing on the early part of this process—i.e. the front-end—while performing their scientometric and systematic literature review in the area of digital innovation.

Altogether, there seems to be a strong need for guidance during the early part of the process innovation process making use of digital technologies, while still very little is provided.

1.1 Problem Definition and Research Goal

When looking at the information stated in the previous paragraphs, there seems to be little known regarding the early phases of the process innovation process making use of digital technologies. Therefore organizations involved in this are unlikely to find guidance on how to perform their activities, while the early phases of this process are of utmost importance. In order to provide the guidance needed, the level of abstraction should be relatively low. To achieve this, the scope of this thesis has been limited to the first selection of ideas—this is, ideas have been generated but a first selection is to be made as not all ideas can be further specified due to resource constraints. The selection itself, however, is merely the last activity of what some could call the selection process. In order to make well-informed decisions on with which ideas to continue, some information needs to be at hand—e.g., regarding the potential value, the costs, and its feasibility. When this is not the case, selecting ideas would be like flipping a coin when deciding whether an idea should continue to the next phase. Therefore the main focus of this thesis is not the isolated selection activity itself, but the information gathering activities performed beforehand—i.e. the assessment of ideas. All in all, as there is still little guidance as to how process innovation ideas making use of digital technologies—from now on referred to as digital process innovation ideas—can be assessed, the problem statement can be formulated as follows:

Little guidance is present regarding the initial assessment of digital process innovation ideas.

The main consideration when selecting ideas, and thus for which an assessment is required, is whether the value expected to be generated weighs up to the costs expected to be incurred. This value and these costs are not dependent on a single actor as multiple actors need to work alongside each other to realize the ideas. For example, the value for the organization as a whole is not generated simply because its IT department rolls out a new digital technology. It is generated when this new technology is actually used by the organizational departments. As the service-dominant (SD) logic re-conceptualizes value from 'value-in-exchange' to 'value-in-use' and 'value-in-context' [Vargo and Lusch, 2017], more emphasis is placed on the value network as a whole instead of being more limited to the focal organization or department.

Given the complex context with which organizations are dealing, it is often important that this value network as a whole is taken into consideration when determining the potential value the realization of an idea can have. To achieve this, the boundaries between departments must be permeated so people think beyond their own organizational silo. By including the SD logic, the organization is stimulated to think about the different (organizational)actors regarding a project and emphasis will be placed on the co-creation of value by these actors, where traditionally only major stakeholders are taken into account. In the end, a network of actors impact the decisions around—and the later realization progress of—the ideas. As a matter of fact, in process innovation the co-creation of value for the customer and the ecosystems of equipment providers plays an essential part [Sjödin, 2019].

The SD logic emphasizes on the interactions between actors in this value network as they co-create value through collaborative processes [Turetken, Grefen, Gilsing, and Adali, 2019]. In doing so, by taking a perspective from the SD logic, the team assessing ideas can be stimulated to think beyond their initial scope and outside of their organizational silos. This is of great importance since organizations typically do not have all the capabilities and resources required for the successful implementation of digital innovations. By partnering up with a party that does have these capabilities, value for the organization can be co-created. So by taking SD perspective, with the co-creation of value by multiple actors in its core, organizations can better consider the value and costs an idea may yield as they are stimulated to think of effects to the system as a whole instead of merely the isolated parts of the organization where the realization of the idea initially would induce changes. Altogether, by adopting the SD logic the selection can be made on a more informed, and arguably better, base.

To address the problem as stated earlier, the aim of this thesis is to provide guidance as to how digital process innovation ideas could be assessed. In order to achieve this, a method has been developed by which organizations are able to describe and evaluate ideas in a structured way while adhering to the SD logic. In doing so, ultimately the success rate of digital process innovation implementations can be increased—i.e. the realization of unprofitable projects is lessened and of profitable ones increased. The research goal was therefore formulated as follows:

To develop a method supporting the process of describing and evaluating digital process innovation ideas while stimulating service-dominant thinking throughout this process.

1.2 Research Questions

In order to support in the achievement of the research goal stated in the previous section, the main research question is formulated as follows:

How can organizations describe and evaluate digital process innovation ideas while following the service-dominant mindset?

The main research question calls for a method so organizations can be guided in the process of assessing

digital process innovation ideas. Additionally, service-dominant (SD) thinking throughout this process is to be stimulated. However, before being able to develop the method, more information is required. In order to guide the research process and decrease its complexity, multiple sub-research questions are formulated.

In the design of the method it is important to place an emphasis on the aspects which seemingly are most important to the success of these digital process innovation ideas. By cultivating these aspects during the development of the method, the method can further differentiate itself from existing methods found in other disciplines and will be more effective in the current research context. By translating these aspects into criteria for evaluation, the ideas can be evaluated on these aspects. The first sub-research question is therefore drafted to be:

SQ1: *What are important aspects of digital process innovation ideas and how do these translate into evaluation criteria?*

As the designed method itself is merely supporting the assessment process of digital process innovation ideas and not performing the assessment by itself, the outcomes when following the method for certain ideas can differ based on the users of the method. In order to be certain, to some extent, that the assessment is performed correctly, the people following the method—i.e. assessors—must have some knowledge of the matter being discussed during the method's activities. Therefore defining the kind of knowledge or organizational roles needed to be present among the assessors is a necessary part of the method's design. Therefore, the second sub-reasearch question is formulated as follows:

SQ2: *What type of knowledge or organizational roles should be present when assessing digital process innovation ideas?*

Subsequently, to design a more comprehensive method, tools are required so the different elements and aspects of the ideas can be systematically described and evaluated—i.e. assessed. Already existing tools were available either in- or outside of the current discipline's literature. In order to prevent the method from being developed from scratch—which would have been an incredible amount of effort—these tools were used as 'building blocks' for the developed method. Hence, the third sub-research is formulated as follows:

SQ3: *Which tools and techniques should be used when assessing digital process innovation ideas in a service-dominant context?*

Lastly, in order to provide guidance in assessing digital process innovation ideas, it is not sufficient to simply accumulate the information gained from answering the previous sub-research questions. A structure in which this all fits is needed. Therefore the last sub-research question is formulated to be:

SQ4: *What activities should be performed when assessing digital process innovation ideas?*

1.3 Research Design & Thesis Structure

With the goal of this research being the development of a method, the Design Science Research Methodology (DSRM) is followed [Peffers et al., 2007]. In general, this methodology provides structure to the research process and is used for conducting design science (DS) research in information systems. With the DSRM providing structure to the research process of this thesis, the structure of this thesis is provided by the publication scheme for DS research [Gregor and Hevner, 2013].

In this chapter, an introduction was given my means of stating the research context, its corresponding problem statement, and the research questions. The remainder of this thesis is organized in the following way; The next chapter provides background information and related research on the areas of innovation in general and its front-end, process innovation in general and its front-end, digital innovation & IT innovation, digital process innovation, and the service-dominant (SD) logic. In chapter three a more detailed explanation of the DSRM is given as well as information on how the research and design activities were conducted. In chapter four the developed method—i.e. artifact—is introduced and elaborated.

The design choices which lead to the final version of the method are stated in thereafter. Information regarding, and the results of, the demonstration and evaluation of the artifact is provided in the fifth chapter. Lastly, in chapter six the the main conclusions, implications, limitations and opportunities for future research are stated.

Chapter 2

Background and Related Research

2.1 Innovation

Becker and Whisler [1967, p. 463] suggest that innovation is "the first or early use of an idea by one of a set of organizations with similar goals". More broadly, however, organizational innovation is usually defined as "the adoption of an idea or behavior that is new to the organization adopting it" [Daft, 1978, p. 197]. According to this definition, the idea does not have to be new, as long as the idea is new to the adopting organization [Daft, 1978]. In compliance to this broader definition, O'sullivan and Dooley [as cited in Jin and Cedrola, 2019] state the core essence of innovation is making changes to products, processes, and services, resulting in something new being introduced for the organization. They specify this to contribute knowledge to the organization or adds value to it's customers.

In contrast to product innovation–which is concerned with what is done, process innovation is concerned with how work is done [Parida et al., 2017]. E.g., product innovation can be about a new product to be sold, while an innovation related to the manufacturing process of that product is an example of process innovation. Despite the differences between product and process innovation, digital technologies can be linked to both. They can, for example, be an outcome of the innovation process of products while they can be used as input for the innovation process of processes. As stated in chapter 1, the latter will be the focus of this thesis.

2.1.1 Process Innovation

Process improvement and process innovation are often seen as the "two ideal" types of process development [Frishammar et al., 2013, p. 215]. As a type of process development, process innovation adheres to the key process development characteristics, defined by Frishammar et al. [2013], which are: 1) since a deliberate improvement efforts is made, careful planning is required, 2) since process development spans multiple functions and is organizationally complex, changes frequently influence other parts of the organization—e.g., processes and activities, 3) process development objectives can be both internal—e.g., cost reductions—as external—e.g., product quality, and 4) new elements are introduced to the process—e.g., new equipment, knowledge or input materials. Frishammar et al. [2013] state the difference between the two types of process development to be continuous improvements in contrast to all-encompassing changes. Parida et al. [2017] state process innovations to create or improve methods of production, however, the exact outcome varies depending on the focus during the innovation project. Jin and Cedrola [2019, p. 2] give a hint of the outcome of process innovation in their definition; "a new or significantly improved way of doing things in a business that typically increases production levels and decreases costs". In line with the fourth key process development characteristic, as stated by Frishammar et al. [2013], Jin and Cedrola [2019] state process innovations may come in the form of new equipment, processes or techniques, or software. Both Frishammar et al. [2013] as Parida et al. [2017] focus mainly on production processes, in this thesis, however, the scope is not limited solely to the production processes as all organizational processes can be subject to process innovation. Technological Process Innovation (TPI) is not narrowed down to solely production processes as is explicitly stated in its definition by Milewski, Fernandes, and Mount [2015, p. 1314]: "the development and implementation of new or significantly improved opera-

tions, including production, product development, and administration, which involves the introduction of new technology". With TPI being a broad concept which relates to the introduction of both hardware and software, as well as changes to organizational structures and procedures, TPI remains closely related to the other fields of process innovation.

The value generated by process innovation is not limited to the organization itself as process innovation can create value to external parties as well—e.g., partners, customers, or end-users [Jin and Cedrola, 2019]. Also, it has been shown that by improvements made in the manufacturing process domain, an enhancement of a firm's ability to benefit from product innovation can be achieved and vice versa [Parida et al., 2017].

Steps during the process of process innovation

Linton [1998] states there are two parts to the innovation life-cycle, with the first part being from an inventor's perspective and the second part of the user's perspective. Linton [1998] states that when taking the user's perspective, his innovation model describes how the innovation—being a new product or process—does or does not become part of the user's daily routine. With this thesis' scope limited to process innovation rather than product innovation, the model provided in Linton [1998] describes, in general terms, the steps taken during the process of process innovation. The five steps defined by Linton [1998] may occur out of order and several iterations of one or more steps is possible. These steps are 1) awareness, 2) matching/selection, 3) adoption/commitment, 4) implementation, and 5) routinization. These steps range from the initial awareness of the innovation to the actual integration or abandonment of the innovation. Although the scope of this thesis is narrowed down to encompass only the second step of Linton's model, all of the steps are further elaborated in the next paragraph to provide better understanding of the process overall.

The first step, namely 'awareness' refers to the process of a potential user realizing that an existing unfilled need may be satisfied by an innovation. Subsequently possible solutions are matched to existing problems and a single solution is selected to solve the corresponding problem. Having selected a solution the next step is the decision to adopt the solution, this decision can be made when a solution is selected or at any point later in time. Once the final decision to adopt is made commitment to the adoption is made. The next step is the implementation of the innovation. The implementation step is comprised of all activities performed between the point in time when the commitment to adopt has been made and the point in time when the innovation is no longer stated to be an innovation. The latter can be a result of two possibilities. Either the innovation is abandoned by the organization, or it is adopted by the organization and ceases to be an innovation. When an innovation ceases to be an innovation depends on the definition of 'innovation' one is using and as the implementation step of the innovation process is left out of scope during this thesis, no further attention is given to this. When the product is not abandoned and the implementation being complete, the last step refers to the innovation becoming a part of the organization's daily routine.

2.1.2 Front End of the Innovation Process

When looking at innovation in a broader perspective, the fact that a large number of ideas are necessary in order to achieve only a limited number of successful innovations, is a shared belief among business practice and research [Bullinger, 2009]. Since organizational resources are often not sufficient to investigate all of these ideas fully and in detail, an early selection must be made in order to focus organizational resources on the most promising ideas [Bullinger, 2009]. This takes place during the front-end of the innovation funnel as the main objective of this phase is to pursue the most promising ideas in an efficient and effective way [Schrauder, Kock, Baccarella, and Voigt, 2018]. In contrast to the later phases of the innovation process, which can be characterized by defined processes—and with this clear procedures and documented responsibilities, the Front-End of Innovation (FEI) is often described as 'fuzzy' since it frequently involves informal, unstructured, and chaotic processes [O'Brien, 2020]. With regard to the fuzzy front-end of product innovation, Gassmann and Schweitzer [2014] identified six activities generally being performed. Namely, 1) trends scoping strategic arena, 2) idea generation, 3) idea evaluation, 4) concept generation, 5) concept evaluation, and 6) iterations. Linking this back to the model provided by Linton [1998], these activities relate to the first three steps—awareness, matching/selection, and adoption/commitment. The six activities generally performed during the front-end of innovation

should be managed as inter-functional and interdisciplinary as possible to improve the project's strategic cornerstones [Gassmann and Schweitzer, 2014] and proficient idea refinement and screening procedures should be in place [Frishammar et al., 2013]. While structuring the front-end activities too much can kill creativity, too little will negatively affect performance [Gassmann and Schweitzer, 2014]. Finding the right balance is crucial.

The same arguments most likely affect the fuzzy front-end of the more narrowed down field of process innovation as well. This, however, remains unverified due to the absence of detailed knowledge about the early phases of process development—of which process innovation is a sub-type [Frishammar et al., 2013]. Front-end activities have been barely studied specifically in the process development literature as this literature largely neglected to examine the front-end activities in detail [Kurkkio et al., 2011].

Steps during the front-end of process innovation

With the front-end activities being largely neglected in the process development literature, Kurkkio et al. [2011] performed research with regard to what specific activities take place during the front-end of process innovation. They state both formal and informal activities take place and define four phases which comprise the front-end of process innovation. These phases are: 1) informal start-up, 2) formal idea-study, 3) formal pre-study, and 4) formal pre-project. They state, however, that the use of this model by the organizations studied depended on the degree of novelty. The model was used more rigorously for projects with a higher degree of novelty, as these often required higher investments in new process technology, and less rigorously for projects exercising incremental developments [Kurkkio et al., 2011].

The first phase of the front-end of process innovation is the informal start-up phase. As ideas for process development are often still fuzzy and unclear during this phase, a key activity is idea generation and refinement, with the latter being done through mostly informal conversations between colleagues—e.g., during coffee breaks—and discussions between persons from different functional departments [Kurkkio et al., 2011].

The second phase of the front-end of process innovation, the formal idea-study, refers to the first 'formal' phase. During this phase the idea is further specified, typically done by means of group discussions and/or a formal literature review [Kurkkio et al., 2011]. In the context of production processes, Kurkkio et al. [2011] state that during their research a key question asked during this phase was whether the properties of the final product would be affected by the process change and, if so, in what way. Therefore, a key activity during this phase is the anticipation of end-product changes. Although the research performed by Kurkkio et al. [2011] is focused on process innovation in a production context, the view of an end-product is not limited to merely a materialized product—e.g., consumer goods—but is seen as the co-created value of the activities performed by all the actors in the network. Other key activities stated by Kurkkio et al. [2011] are the creation of a preliminary process concept and the definition of project objectives.

The formal idea-study is regarded highly theoretical, i.e. most work is conceptual [Kurkkio et al., 2011]. Prior research and knowledge are regarded as key inputs during this phase as still few practical tests are performed [Kurkkio et al., 2011]. When considering incremental process development projects, organizations stated this phase to be of less importance, while this phase was thought to be the most important when considering more radical projects. [Kurkkio et al., 2011].

During the formal pre-study phase of the front-end of process innovation the idea-study, being the outcome of the previous phase, is further explored [Kurkkio et al., 2011]. In comparison to the formal idea-study phase, more detailed, fine-graded and rigorous empirical tests are being performed, further specifying the project idea. Typical activities being performed during the pre-study phase are different types of risk analyses. A multi-functional project group is normally assigned to perform the pre-study phase's activities.

During the concluding phase of the front-end of process innovation the first key activity being performed is the specification and selection of the final process concept, after which a feasibility analysis is performed and a project plan made [Kurkkio et al., 2011]. To further verify the process change, full-scale experiments can also be held and, when new process equipment is needed, prototypes of this equipment are tested.

2.1.3 Digital Innovation & IT Innovation

IT innovation is defined by Swanson [1994, p. 1072] as "innovation in the organizational application of digital computer and communications technologies (now commonly known as information technology, or IT)". One can find the term IT innovation to be closely related to and intertwined with digital innovation. Yoo, Henfridsson, and Lyytinen [2010] altered the definition of IT innovation given by Swanson [1994], by laying the focus on product innovation rather than process innovation, and used this new definition to define 'digital innovation'. Fichman, Dos Santos, and Zheng [2014] later expanded the digital innovation definition provided by Yoo et al. [2010] to incorporate, among others, process innovation. The altered definition by Fichman et al. [2014, p. 330] is "a product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT". Because of the relationship between them, the terms digital innovation and IT innovation are seen as interchangeable during this research. Two closely related terms to digital innovation and IT innovation are digitalization and digital technologies. They are described next.

Digitalization and Digital Technologies

The emergence of digital technologies—i.e. computer based products or solutions—gave rise to new process improvement and innovation opportunities and since its emergence, the area of digital technologies have been subject to vast amounts of research. Generally, the terms digitization, digitalization, and digital transformation are used when discussing the appliance of digital technologies and although some claim a significant difference between the terms, others use them interchangeably [Buer, Fragapane, and Strandhagen, 2018]. Based on findings in literature Buer et al. [2018, p. 1036] keep the definitions separate and have suggested the definition of digitization to be the "conversion from an analog format into a digital format", of digitalization to be the "use of digital data and technology to automate data handling and optimize processes", and of digital transformation to be "creating new business opportunities through the use of digital data and technology". In accordance to these definitions, three levels are defined and linked; the digitization term is linked to the data level, the digitalization to the process level, and the digital transformation is to the business level [Buer et al., 2018]. Gürdür et al. [2019, p. 153] state that digitalization refers to "enabling, improving, and transforming operations, functions, models, processes, or activities by leveraging digital technologies". When comparing the definitions of Digitalization to the definitions of digital innovation, it seems the main difference between digitalization and digital innovation is the degree of novelty.

2.1.4 Digital Process Innovation

As the definitions on digital innovation seem to vary depending on whether the focus is on product, process, business models, or a combination these, and TPI is not limited to the embodiment in or enablement by IT, the term digital process Innovation is proposed in this thesis for clarity purposes. A digital process innovation in this thesis is defined as the development and/or implementation of operations new to the organization, requiring a significant change on the part of the adopters, and being embodied in or enabled by IT. Its definition is based on the earlier stated definitions of 'innovation', 'process innovation', 'IT innovation', 'digital innovation', and 'TPI'. The aim for digital process innovations, and therewith the use of IT to enable the change, is to create or improve processes. The exact benefits achieved by doing this, however, may still be somewhat vague. Therefore, a list of benefits named most often as a result of digital process innovations has been drafted. Some of these can be related to each other—e.g., an increased production yield can lead to lower production costs, however, the named benefits can occur independently as well. Note, these benefits are not exclusive to digital process innovation as they can also occur as a result of non-digital process innovations. The list is as follows:

- Lower production costs [Milewski et al., 2015; Jin and Cedrola, 2019; Frishammar et al., 2013; Hollen, Van Den Bosch, and Volberda, 2013]
- Accelerated time-to-market [Milewski et al., 2015; Frishammar et al., 2013; Hollen et al., 2013]
- Improved product and/or service quality [Milewski et al., 2015; Jin and Cedrola, 2019; Frishammar et al., 2013]

- Increased environmental sustainability [Milewski et al., 2015; Frishammar et al., 2013; Hollen et al., 2013]
- Turnover growth [Jin and Cedrola, 2019; Frishammar et al., 2013]
- Improved operational flexibility [Milewski et al., 2015]
- Increased controllability [Milewski et al., 2015]
- Increased production yield [Milewski et al., 2015]
- Reduced production time or time it takes to perform a service [Jin and Cedrola, 2019]

Challenges and Aspects of Digital process Innovation

In search of what aspects could be of importance when assessing digital process innovation ideas, no research was found directly stating the aspects being of importance when realizing digital process innovation ideas. However, in literature related to technological process innovation the importance of certain aspects is discussed. For example the need for complementary skills, support systems, procedures, and social structures when implementing IT [Milewski et al., 2015]. In line with the stated need for complementary skills, the fit between new technology, job performance requirements, and operator skills is stated to be of importance, as well as the fit of the new technology with existing IT infrastructure. Therefore not only the adaptation of the new technology to the focal organization must be thought of, but also the challenge of adapting the focal organization to the new technology [Milewski et al., 2015]. The latter is, among others, because a change in a process' components often results in changes to the process' surroundings [Milewski et al., 2015] as processes are often linked to one another. Therefore there is a possibility of broad ramifications while the impact of the changes may appear localized at first [Sjödin, 2019]. This is referred to by Milewski et al. [2015] as systemic impact and this is seen as a principal challenge in process innovation [Sjödin, 2019]. In their article, Milewski et al. [2015] state mutual adaptation to be another component underlying technological process innovation. This refers to the congruence between the technology and the organization. It is concerned with the reconfiguration of both the existing organization and the new technology, so a fit between them is achieved. Ettlie et al. [1984] state this aspect to be a pre-innovation condition for radical process innovations. For incremental process innovations this aspect may not be as critical as for radical ones, still Milewski et al. [2015] stated it to be key to successful technological process innovations. As a matter of fact, Milewski et al. [2015, p. 1324] suggest mutual adaptation to be "an important conceptual perspective for outlining and selecting solutions during early innovation ILC[1] stages". As it is initially difficult to grasp the new technology and its consequences, equivocality and technological, financial, and social uncertainty can arise [Milewski et al., 2015]. This challenge is also recognized by Sjödin [2019], as he states integrating and sharing knowledge across both functional and organizational boundaries, to reduce the inherent uncertainty, is subject to vast challenges.

Sjödin [2019] state four dimensions being influential in explaining value co-creation outcomes. Thus, these dimensions can be seen as aggregated aspects of importance to the success of process innovations. These dimensions are: 1) technological challenges, 2) procurement approach, 3) knowledge-processing requirements, and 4) joint knowledge processing. These four dimensions are comprised of several themes—in this thesis referred to as aspects. The technological challenges dimension is comprised of the aspects complexity, novelty, and customization. The procurement approach dimension is comprised of the aspects relationship development and contracting approaches. The knowledge-processing requirements dimension is comprised of uncertainty and equivocality. Lastly, the joint knowledge processing dimension is comprised of open communication, joint problem solving, and end-user involvement. An exact description of each of these aspects can be found in the article by Sjödin [2019].

2.2 Service-Dominant Logic

In this section the service-dominant (SD) logic itself is elaborated into more detail, after which a tool for the design of service dominant business models is introduced as well as a tool for the ex-ante evaluation of service dominant business models.

[1] Innovation lifecycle

2.2.1 SD Logic Explained

A shift in economy from an industrial to service economy has been taken place over the past decades [Yan, Ye, Wang, and Hua, 2010]. To match this shift, a more realistic and transcending view of human exchange systems is required than was provided by the traditional goods-dominant (GD) logic. The service-dominant (SD) logic has been developed as a new mindset to provide this realistic, transcending view in a simplifying manner [Vargo and Lusch, 2016].

In the SD logic service exchange gains a central role in the improvement of individual and collective wellbeing by viewing applied and specialized skills & knowledge as the focus of economic exchange instead of goods [Vargo and Lusch, 2017]. Goods are not the focus of economic exchange anymore as they are seen as mechanics needed to provide the service. Traditionally, in the GD logic, services are seen as units of output. In the SD logic, however, a service is now defined as "the application of competencies (knowledge and skills) for the benefit of another party" [Yan et al., 2010, p. 2222]. It is seen as a process during which something is done for another party. Therefore, in the SD logic the intangible unit-of-output has been abandoned for the adoption of a more process meaning [Vargo and Lusch, 2017].

By following the SD logic, as opposed to the GD logic, a shift takes place from thinking about value in terms of operand resources (often tangible, static, and finite resources that require action to make them valuable, e.g., raw materials) to operant resources (often intangible, dynamic, and infinite resources that are capable of creating value, e.g., core competences or organizational processes) [Vargo and Lusch, 2004; Yan et al., 2010]. Furthermore, instead of thinking of value being created by one actor, value is seen as being co-created by activities performed by multiple actors, which may be unaware of each other, contributing to each other's wellbeing [Suratno, 2020].

Since its introduction in 2004 the SD logic has been extended, allowing a more holistic and realistic perspective of value creation [Vargo and Lusch, 2016]. However, instead of being a completely separate logic, the SD logic transcends the traditional, fundamental, GD logic as the GD logic is "integral to and nested in the SD logic, rather than being distinct from it" [Vargo and Lusch, 2016, p. 10]. Therefore, the SD logic encompasses a broader perspective by nature.

The essence of the SD logic is captured in five core foundational premises, which have been identified as five axioms [Vargo and Lusch, 2017, 2016]. These five axioms are stated in table 2.1 and are further elaborated in the coming paragraphs.

Table 2.1: Five Axioms of the service-dominant logic

Axiom 1	Service is the fundamental basis of exchange
Axiom 2	Value is co-created by multiple actors, always including the beneficiary
Axiom 3	All social and economic actors are resource integrators
Axiom 4	Value is always uniquely and phenomenologically determined by the beneficiary
Axiom 5	Value co-creation is coordinated through actor-generated institutions and institutional arrangements

With service referring to the application of operant resources (knowledge and skill) for the benefit of other parties [Yan et al., 2010], the first axiom states this is the fundamental basis of exchange. This means service is exchanged for service, implicating goods are seen as appliances for service provision. As service is the basis for exchange, another implication is all businesses being service businesses and all economies being service economies. As often money is involved in exchanges, money is representing rights to future services.

In the more traditional GD logic the firm is seen as the creator of value. In contradiction however, the second axiom states value is being co-created by multiple actors. More specifically, the second axiom suggests value is being co-created through interactions between actors, directly or indirectly through goods [Suratno, 2020]. Value arises from the use of service offerings in conjunction with resources provided by other service providers, not from a firm's or producer's internal processes. Therefore the service-oriented view is inherently relational.

As the resources needed throughout the network of actors can come from a variety of sources and value is being co-created through the integration of these resources, all social and economic actors are resource integrators, i.e. the third axiom. The integration does not occur only with resources directly available

to the actors involved in an exchange, as indirectly resources are provided by other actors in a network of resource-integrating actors [Suratno, 2020].

The fourth axiom strengthens the contextual and experimental nature of value in the SD logic [Suratno, 2020]. Also a move from pre-designated roles, e.g. those of producers and consumers, is reflected by highlighting the generic nature of actors by making use of the term *beneficiary* instead of a set role.

The fifth axiom refers to the coordination between actors through institutions and institutional arrangements, with institutions individual rules like norms, laws or practices is meant [Suratno, 2020]. Interrelated sets of institutions, facilitating the coordination of the value-co-creating systems, are referred to as institutional arrangements. As stated in the fifth axiom, value co-creation is coordinated through actor-generated institutions and institutional arrangements, suggesting economic networks tend to be self-governed and self-adjusting.

2.2.2 Service-Dominant Tools

SDBM/R

In light of existing business modelling approaches falling short of addressing the SD logic premises, Turetken et al. [2019] developed the service-dominant business model radar (SDBM/R) as a visual template by which service dominant business models can be represented. The template exists of different elements, namely the *value-in-use* at its core—representing the added value to be realized by a network of actors, surrounded by the *actor value proposition*, *actor co-production activity*, *actor cost/benefit*, and lastly the *actor* itself. The template is given in figure 2.1.

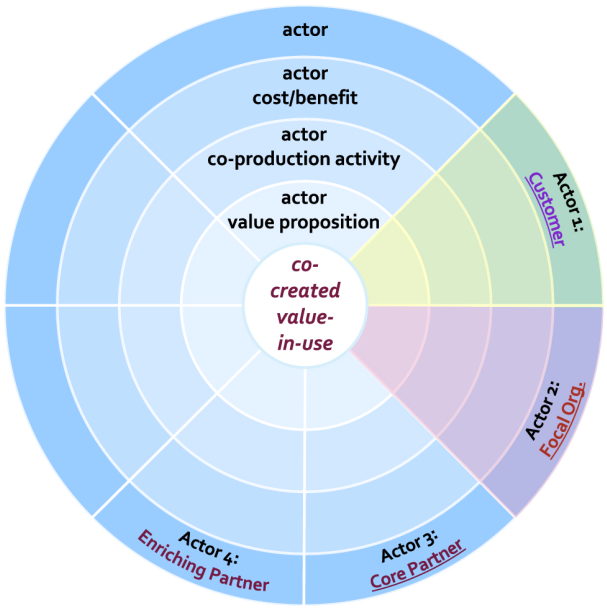

Figure 2.1: SDBM/R Template

In addition to the template itself, a method of use has also been developed to guide the service dominant business model development. According to Turetken et al. [2019], a service dominant business model design (SD-BMD) using the SDBM/R involves five design steps of which four are directly used for filling in the radar itself. These four are as follows:

1. Identification of the co-created value-in-use and, from a business modelling perspective, the eventual customer.

2. Determination of the value-in-use's components and associated actors.

3. Determination of the costs and benefits for each actor.

4. Determination of the high-level activities realizing the value propositions identified in the second step, for each actor.

The business model defines both a concrete value-in-use for a concrete customer segment and a specification of its realization [Turetken et al., 2019]. The former is being done in the first four design steps. The latter—the value-in-use's realization specification—is the focus of the fifth design step. This step typically starts right after the first design step and runs in parallel with the design of the radar. The realization specification of the business model can be rephrased as the "way the customer experiences the creation and delivery" of the earlier stated value-in-use [Turetken et al., 2019, p. 18]. An informal scenario can be taken as basis for inspiration after which, throughout the rest of the business model design process, this is refined into a description of a *customer experience* [Turetken et al., 2019]. Overall, the high-level operation and future realization of the designed business model should be briefly described in the *customer experience*. This is often done in verbal form during multiple iterations and can continue until the radar design is considered complete. The fifth design step is as follows:

5. Description of the customer experience.

The business model defines both a concrete value-in-use for a concrete customer segment and a specification of its realization[Turetken et al., 2019]. The former is being done in the first four design steps. The latter—the value-in-use's realization specification—is the focus of the fifth design step. The realization specification of the business model can be rephrased as the "way the customer experiences the creation and delivery" of the earlier stated value-in-use [Turetken et al., 2019, p. 18]. An informal scenario can be taken as basis for inspiration after which, throughout the rest of the business model design process, this is refined into a description of a *customer experience* [Turetken et al., 2019]. Overall, the high-level operation and future realization of the designed business model should be briefly described in the *customer experience* [Turetken et al., 2019]. This is often done in verbal form during multiple iterations and can continue until the radar design is considered complete [Turetken et al., 2019].

One can iterate through the design steps of the SDBM/R as new insights come to mind in subsequent steps. The design steps relate to the five levels of the radar; 1) co-created value-in-use, 2) actor value propositions, 3) actor co-production activity, 4) actor cost/benefit, and 5) actor. Counting outwards, the first step relates to the first level of the radar (co-created value-in-use). The second step relates to the second and fifth level of the radar (actor value proposition and actor). The third step relates to the fourth level of the radar (actor cost/benefit). Lastly, the fourth step relates to the third level of the radar (actor co-production activity).

Service-Dominant Business Model (SD-BM) Evaluation method

As the design of business models is characterised by significant uncertainty in the early phases of the design process [McGrath, 2010], the design decisions and quality of preliminary business model designs should be evaluated [Gilsing, Turetken, Ozkan, Adali, and Grefen, 2020]. This is best done in a qualitative manner as the data needed for quantitative evaluations is typically unavailable or uncertain in the early phases of design. Current methods, however, are not addressing the exchanges between and needs of concurrent actors. In the GD logic the evaluation is considered from the perspective of the focal organization instead of taking the joint consideration of all stakeholders into account, which is required for the evaluation of service dominant business models Gilsing et al. [2020]. Since limited work is available on business model evaluation taking the SD logic's characteristics into account, Gilsing et al. [2020] developed a method for the qualitative evaluation of service dominant business models during the early phases of business model design. For readability purposes this method is from now on referred to as the service dominant business model design evaluation method, the 'SD-BM evaluation method' in short.

The evaluation method is designed to be used before the business model is put into use—i.e. ex-ante. There are four quality attributes on which the business model should be evaluated, namely the business model's 1) structural validity, 2) feasibility, 3) viability, and 4) robustness [Gilsing et al., 2020]. In the context of evaluating service dominant business models, the structural validity refers to the adherence to the SD logic principles and the logical validity in the business model design. Feasibility regards whether the implementation of the business model is actually achievable. Viability refers to aspects indicating whether the business model is desirable. Lastly, robustness relates to the 'firmness' of the business model

and therewith its stability. The evaluation of the robustness attribute aims to capture and understand the uncertainty incurred and the business model's tolerance for design changes and variations.

The method provides a set of questions to guide the evaluation of each attribute—which can be found in appendix A. Based on the application of the evaluation method, it can be apparent to make changes to the business model design. As the business model components are interrelated of nature it is possible the change impacts other elements as well, resulting in the need for re-evaluation. The evaluation process is therefore often an iterative process [Gilsing et al., 2020].

Chapter 3

Research Methodology

In contrast to the behavioral-science paradigm, which seeks to develop and verify theories explaining or predicting human or organizational behavior, the design-science paradigm creates new and innovative artifacts in its pursuance of extending the boundaries of human and organizational capabilities [Hevner, March, Park, and Ram, 2004]. Given the nature of the current research, the design-science paradigm, in comparison to the behavioral-science paradigm, seems a better fit. However, due to the many similarities between the design-science paradigm and the action research perspective [Peffers et al., 2007], the latter might also be used in the current research context. The primary focus in action research is the organizational context and the active search for solutions to problems arising in this context [Peffers et al., 2007]. In design-science research, however, the primary focus is on the design and its proof of usefulness [Peffers et al., 2007]. Since the primary focus of this research is the development of an artifact, namely a method, following the design-science research paradigm will be the best way forward.

By applying the Design Science Research Methodology (DSRM) for information systems research [Peffers et al., 2007], a comprehensive method in line with the service-dominant logic has been developed so the process of assessing digital process innovation ideas is supported. According to Peffers et al. [2007] there are multiple entry points into the DSRM process possible, as can be seen in figure 3.1. In this thesis the process sequence is followed from the beginning, hence a 'Problem Centered Initiation'. The DSRM is composed out of the following six activities:

1. *Problem identification and motivation*
2. *Define the objectives for a solution*
3. *Design and development*
4. *Demonstration*
5. *Evaluation*
6. *Communication*

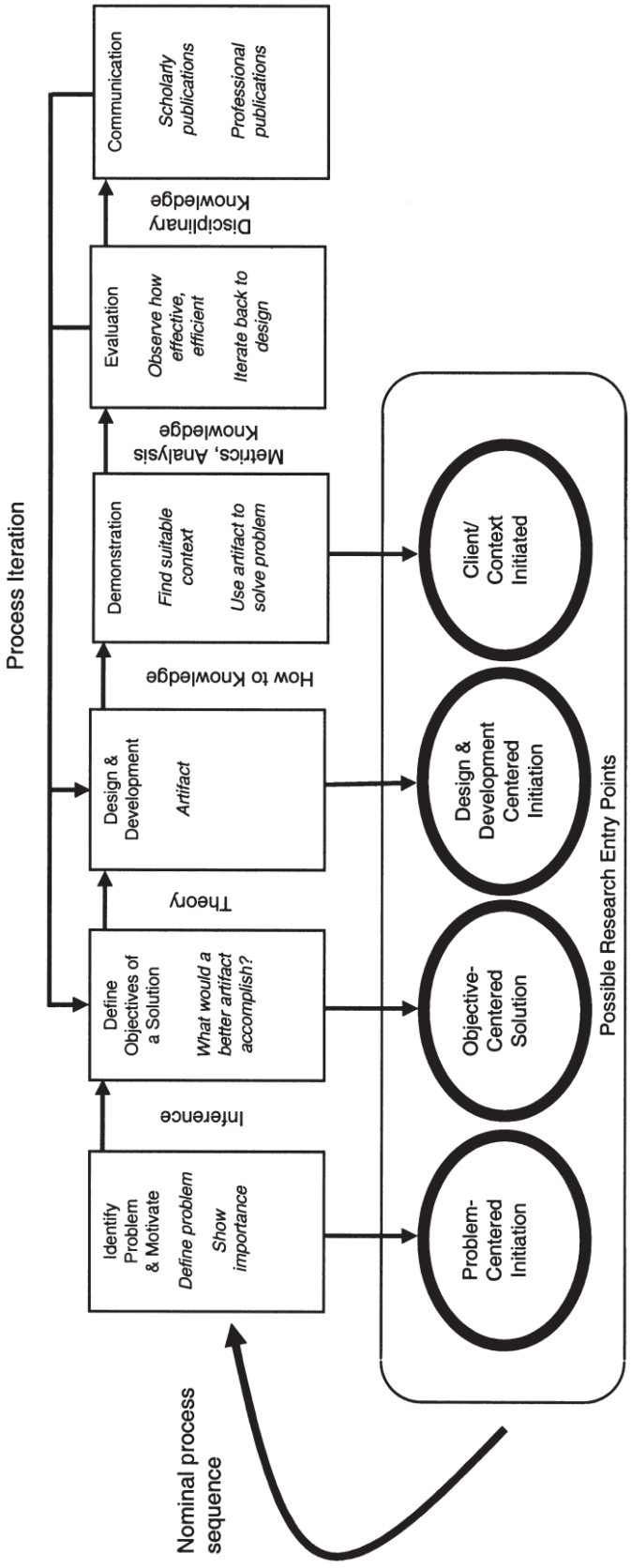

Figure 3.1: DSRM Process Model

3.1 Problem Identification and Motivation

The first activity is related to the identification of a specific research problem and the justification of the value of a solution. As the resources required for this activity to be performed successfully are knowledge of the state of the problem and the importance of the problem's solution [Peffers et al., 2007], information regarding the current state of the digital process innovation process, and more specifically its front-end, was needed. This information has been collected by searching the TU/e's discovery system named 'LibrarySearch', of which the collected knowledge is represented in chapter 1.

Based on the knowledge gathered the problem has been identified to be a lack of guidance regarding the initial assessment of digital process innovation ideas, while the early phases are of the utmost importance to the success of these ideas.

3.2 Define the Objectives for a Solution

Based on the problem specification as stated in the previous section, a design objective and multiple design requirements have been formulated. By evaluating the designed artifact based on this objective and these requirements during the artifact's evaluation, it is made sure that the designed solution indeed addresses the defined problem.

As stated before, the method must guide its users through the process of assessing digital process innovation ideas. Therefore a step-wise method guiding the user through the process of describing and evaluating digital process innovation ideas is proposed. Accordingly, the main design objective has been formulated as follows:

The artifact should support the process of describing and evaluating digital process innovation ideas.

This objective consists of two important components: 1) supporting the process of describing and evaluating digital process innovation ideas and 2) the service-dominant (SD) logic. While the first component states the method's main function, the second emphasizes the logic, and therewith mindset with which the method was developed. By stating this explicitly in the main design objective, it was made sure the focus remained on the development of a more comprehensive method by incorporating tools stimulating SD thinking. To safeguard the process of supporting the description and evaluation of the ideas in congruence with the main design objective, a number of requirements have been set. These were later also used to evaluate and discuss the developed artifact's performance. Based on the information stated in chapter 1 & 2, the following requirements have been defined:

R1: *The method should facilitate value creation for the organization.*

R2: *The method should support the captivation of thinking in terms of value co-creation.*

R3: *The method should lead to informed decision making.*

In order to effectively guide its users through the process of describing and evaluating digital process innovation ideas, the method should define the activities needed to be performed during this process. Also, as argued in chapter 1, section 1.2—regarding SQ2—the type of knowledge and/or organizational roles involved in the activities should also be stated. Therefore the following design requirements have been drafted in addition to the earlier ones:

R4: *The method should clearly define the required activities for describing and evaluating digital process innovation ideas.*

R5: *The method should clearly define the knowledge types or roles to be involved during the activities.*

As the method's users will take guidance from the method's activities in describing and evaluating ideas, the method should start with a conceptual or abstract idea and facilitate its users, via the earlier mentioned activities, in elucidating this idea. Therefore the following requirement is added as well:

R6: *The method should facilitate its users to transform an abstract idea into a more concrete and evaluated form.*

To ensure the adoption of the method will not be limited due to e.g. the use of unfamiliar terms and modelling tools for its representation, the last requirement is set as follows:

R7: *The method should be easy to understand and uncomplicated in use.*

3.3 Design & Development

According to Peffers et al. [2007], existing theories and knowledge should be searched for the development of the artifact in order to come up with a solution to the defined problem. During the design and development phase of the Design-Science Research Methodology (DSRM), the artifact has been created. With the artifact being a step-wise method, the artifact is a series of activities to be performed—i.e. a process. According to Peffers et al. [2007], knowledge of theory is one of the resources required for moving objectives to design and development. Therefore, for the development of the artifact, knowledge has been collected from both experts & practitioners—working at MSD & Atos—and prior literature. This knowledge collection process was guided by the sub-research questions stated in section 1.2.

Aside from the knowledge collection, other activities were performed for the development of the artifact. All of the performed activities are further elaborated in this section. A list of the performed activities is as follows:

1. The exploration of prior research regarding innovation in general, process innovation, the front-end of process innovation, and digital innovation & IT innovation, as well as the challenges with and important aspects of digital process innovation.
2. Interviewing experts and practitioners regarding the challenges with and important aspects of digital process innovation.
3. The exploration of Prior research regarding possible tools which could be used as 'building blocks' during the design of the method.
4. The development of the first and second version of the DPII-EC framework.
5. The expansion of the SD-BM evaluation method.
6. The determination of the then still-to-be developed method's phases.
7. The more in-depth specification of the method's phases.

Why and how each of these activities were performed is elaborated in the next subsections.

3.3.1 Prior Research on Digital Process Innovation and its Challenges & Aspects

To get a clearer picture of digital process innovation in general, prior research was sought on innovation in general, process innovation, the frond-end of process innovation, and digital innovation & IT innovation. Also, prior research was sought regarding the challenges with- and important aspects of digital process innovation. With the description and evaluation of ideas in need of support, it is of importance to know which aspects to take into account during that process. In pursuit of a comprehensive list of aspects also challenges to realization were sought as these can be translated into aspects.

The exploration of prior research was done by searching the TU/e's discovery system as mentioned in section 3.1.

3.3.2 Expert and Practitioner Interviewing

As little research could be found directly stating the challenges and important aspects, interviews were held early on to gain a better insight into digital process innovation. These interviews were primarily guided by the first two sub-research questions as the aim of the interviews was to further explore the *challenges* arising when realising digital process innovation ideas, the *aspects* thought to be important for an initial evaluation of these ideas, and lastly the *knowledge types* or *roles* which should be present during the assessment of these ideas.

Interviews can be done in numerous ways—e.g., synchronous or asynchronous, written or spoken, and structured, semi-structured or unstructured. Although the asynchronous interview mode allows informants more time to construct their responses, the synchronous mode has been used due to the ability to probe, check, and clarify information throughout the interview [Mann, 2016]. Additionally, since it is hard for any written form of interview to have the engagement of conventional spoken interviews and since telephone responses are generally less in-depth, the interviews regarding the first two sub-research questions have all taken place face-to-face. Structure-wise it is of importance to leave room for discussion and expansion since these sub-questions are of exploratory nature. Whilst a structured interview might limit this, a semi-structured format actually provides this [Mann, 2016]. An unstructured interview, on the other hand, will provide too little guidance, which could lead lead to the interviewee driving the interview [Mann, 2016]. With this, the interview could lose its focus on what is needed for this research. Therefore the interviews were semi-structured. Combining these elements, the interviews were synchronous face-to-face and semi-structured.

As the information required was thought to be most likely multidisciplinary of nature and could be best extracted from interviewees having, to some extent, experience with digital process innovations, experts from Atos as well as practitioners from MSD have been interviewed. In total four experts from Atos have been interviewed and eight practitioners from MSD. The four interviewees from Atos all have expert knowledge in the field of IT and/or digital process innovations. From the eight interviewees working at MSD, four are from operations, two from manufacturing-IT, one from operational excellence, and one from finance. The interviews were recorded so they could later be analysed in a structured way and translated—as they were held in Dutch.

Having performed the interviews in a qualitative, semi-structured, manner, the recorded interviews needed to be processed to provide the insights and knowledge required for the artifact design. The steps taken to process the interviews are based on the content analysis steps stated in Erlingsson and Brysiewicz [2017].

The initial step taken was to listen and re-listen to the recordings. This way a general understanding of what was being talked about was gained. The interviews were then divided into to meaningful units, which subsequently were condensed further into *statements*. These statements are a shortened version of the same text, still conveying the main message. In basis, the statements often a summarized version of something the interviewee said and is sometimes written in a slightly different form to better capture the context in which the interviewee stated his or her point.

To be able to add the extra information generated during the next steps to each statement in an easy way, the statements were placed in Microsoft Excel as this provided a tabular structure. The next step taken was the development of standardized codes by which the statements can be labeled subsequently grouped. The process of coding was very iterative of nature as a lot of re-thinking and re-coding was done.

During the last step the codes were sorted into categories based on the three main subjects aimed to explore during the interviews, namely *challenges*, *aspects*, and *knowledge types* or *roles*.

As a result of these processing steps, the information provided by the interviews is represented in a structured, usable, format. An example of a number of statements, their coding, and their categorization is given in table 3.1 and the overall interview results are stated in appendix B.

3.3.3 Prior Research on Tools

Prior research was being searched for tools which could be used as 'building blocks' for the development of the method. This process was guided by the third sub-research question. With the aim to

Table 3.1: Three statements, their coding, and their categorization

Statement	Code	Categorization
People almost always rely on the 'enabler'. You are doomed to fail when you are using technology pure for the sake of the technology.	Benefits	Challenge
When multiple information systems have to work together, complexity rises exponentially. E.g., retrieving data from one system is still doable but the more systems are involved the harder it gets.	System Integration	Aspect
Certainly multidisciplinary.	Multidisciplinary	Knowledge type

develop a method guiding its user in describing and evaluating digital process innovation ideas—i.e. assessing—while stimulating service-dominant (SD) thinking throughout this process, tools supporting the components of this process have been sought in literature related to the SD logic. As this thesis is focusing on the formal idea-study phase in the front-end of process innovation, tools for this phase's key activities—as stated in 2.1.2—have been identified. As there is still little research available in the area of front-end activities with regard to the process innovation process, and especially while taking a SD mindset—emphasizing on the co-creation of value and more specifically the value-in-use—the field of product innovation was further explored when searching for useful tools to support the formal idea-study phase's key activities.

The Prior research was again searched by using the earlier mentioned TU/e's discovery system.

3.3.4 Development of the DPII-EC Framework

By comparing the findings of the literature search with the information obtained via the interviews, a list of aspects which should be taken into consideration when assessing digital process innovation ideas was drafted. In this list, however, the identified aspects are not all existing independently of each other as many directly influence, or when bundled together comprise, others. In order to provide a comprehensible overview of these aspects which includes the relation to one another, the Digital Process Innovation Idea Evaluation Criteria (DPII-EC) framework was developed. The connections between aspects have been identified through reasoning which were later validated by presenting the framework to two of the interviewees.

When the tools for supporting the description and evaluation of value propositions (VPs) were identified, the initial version of the framework was linked with these tools to develop a more complete framework. The tool identified for evaluating the VP—the SD-BM evaluation method—provided the final framework with its high-level structure while the information acquired from the interviews and other research lead to insights on a more lower level of abstraction. The high-level categorization was again done through reasoning. The validation, however, took place by discussing the identified links with one of the developers of the SD-BM evaluation method.

3.3.5 Expansion of the SD-BM Evaluation Method

As the article written by Gilsing et al. [2020] focuses on the evaluation of service-dominant business models in general and not specifically in the context of evaluating business models generated from digital process innovation ideas in an intra-organizational context, the SD-BM evaluation method has been expanded to better capture the lower level of abstraction present in the current research context and to better fit the intra-organizational context. This way this evaluation method could be used as an integral part of the then still-to-be developed method.

By comparing the evaluation questions provided in the SD-BM evaluation method with the DPII-EC framework, it was checked whether all aspects of the framework were represented by the evaluation questions presented in the evaluation method. Based on this comparison, the expansion was made as existing questions were changed or new ones were added.

3.3.6 Phase Determination

With the objective to develop a method which supports the description and evaluation of digital process innovation ideas, the then still-to-be-developed method had to include activities related to the description of ideas and the evaluation of them. Therefore it is of importance that the phases determined relate to these two concepts. Additionally, an exploratory prospective is taken as we do not want to limit ourselves solely to the use of the digital technology as being described in the collected ideas. This must therefore also be included when determining the method's phases.

Based on this information, a general method outline was developed in the form of the method's phases.

3.3.7 In-depth Specification of the Method's Phases

With the general method outline at hand—i.e. the method's phases—the specific activities which need to be performed during each of the phases were defined, resulting in an initial version of the method. This version was then discussed with practitioners at MSD, after which improvements were made. The development process was iterative as the method's design was discussed and improved multiple times before the final version was achieved.

The first phase was specified by including activities stated during early discussions—with one of the experts and two practitioners—as well as on the interview results. The second phase's activities were defined based on the business modelling tool selected for this phase. The activities of the last phase were defined mostly based on the expanded business model evaluation tool. The last activity of this phase, however, was based on input gained from discussions with one of the experts and two practitioners as a quantification of the qualitative evaluation results were desired.

3.4 Demonstration

After having developed the artifact, the next step when following the Design Science Research Methodology (DSRM) is the demonstration of the developed artifact. Generally, this is done by using the artifact to solve one or more instances of the problem [Peffers et al., 2007]. This DSRM step corresponds to one of the generic evaluation methods identified in [Prat, Comyn-Wattiau, and Akoka, 2014]—namely M1, which refers to the demonstration of artifact with one or several examples. When following this method, mainly the artifact's ability to meet its goal is verified. For this both fictitious or real examples can be used and generally there is no need for secondary participants—like practitioners—as only effective knowledge of how to use the artifact is required. During the demonstration step of the current research, however, practitioners have been included since a real example was used, requiring specified knowledge of the organization in question. More information regarding the demonstration step can be found in chapter 5.

3.5 Evaluation

During the evaluation step, following the artifact's demonstration, a measurement is made regarding how well the artifact is supporting a solution to the problem [Peffers et al., 2007]. Based on the design objective stated in section 3.2, this implies the extent should be measured as to which the developed artifact supports the process of describing and evaluating digital process innovation ideas.

In order to evaluate this, structured interviews were held with three experts from Atos and four practitioners from MSD. The three experts from Atos all have expert knowledge in the field of IT and/or digital process innovations. From the four practitioners working at MSD, two work in operational departments and the other two work in the manufacturing-IT department. The interviews were recorded so they could later be analysed and translated—as the interviews were held in Dutch.

During the interviews, first the developed method and its activities were explained in detail. Subsequently a set of artifact evaluation questions were asked, which can be found in table 3.2. These questions were drafted based on a set of criteria, which are also stated in table 3.2, and were open-ended.

The criteria were selected by matching the design requirements, as stated in section 3.2, to a number of artifact evaluation criteria defined in Prat et al. [2014]. Aside from the matched criteria one unmatched criterion is included, namely 'utility'. While the utility criterion in the artifact evaluation questions does not relate directly to any of the requirements, it is important to know whether the artifact's quality in practical use is sufficient. When this is not the case, the artifact is likely to remain unused. As the same is meant with utility and usefulness [Prat et al., 2014], the latter term is used in the artifact evaluation question as this was deemed a more familiar term.

Table 3.2: Artifact Evaluation Interview Questions

Requirement	**Criterion**	**Artifact Evaluation Question**
R1, R2, R3, and R6	Efficacy	What do you think of the developed method's efficacy?
R4, R5, and R7	Clarity, Understandability	What do you think of the developed method's clarity and understandability?
R4, and R5	Completeness	What do you think of the developed method's completeness?
R7	Utility, Ease of use	What do you think of the developed method's Usefulness and ease of use?

Based on the evaluation a last round of iteration regarding the method's design took place.

3.6 Communication

After the method was validated, the results have been communicated to both Atos and MSD via a presentation and a report. Further communication in the direction of other researchers and practitioners is provided via this final report being made public by Eindhoven University of Technology (TU/e). This report is formatted by taking the Design Science Research Publication Schema proposed by Gregor and Hevner [2013] as a guideline.

Chapter 4

Artifact Design

In this chapter, the final version of the developed artifact is introduced. Firstly an overview is given. Subsequently, in the second section, the artifact is explained on a higher level of detail. In the last section argumentation is given for the artifact's design.

4.1 Artifact Introduction

The method consists of three phases during which multiple activities are performed. These phases are 1) *Exploration*, 2) *Contextualization*, and 3) *Evaluation*. The phases should not be seen as strictly consecutive as room for iteration is available. A graphical overview is displayed in figure 4.1. These phases guide the method's users through the process of assessing ideas to use digital technologies in the focal organization as a facilitator of process innovation. In doing so, the method provides a structured way of tackling an early part of the process innovation process, enabling more informed decision making by facilitating its users in the assessment of digital process innovation ideas in a more comprehensive manner.

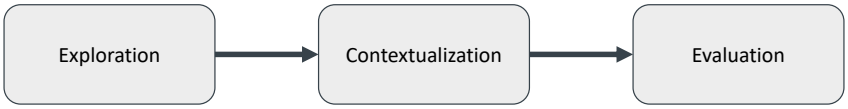

Figure 4.1: Method Outline

The method's activities are initiated when a digital technology (DT) has been chosen for further examination. With this, the input for the method is a single DT. How the trigger of the method is reached, however, remains out of scope as this does not matter for the general line of activities. For the purpose of comprehensibility, however, a number of instances are elaborated in Appendix C.

A short overview of the methods phases is as follows; During the first phase, possible applications for the DT are identified by stating them as value propositions (VPs). These value propositions are then further described and placed into the organizational context during the contextualization phase. During the last phase, these contextualized VPs are evaluated.

A textual overview of the three phases and their in- and outputs is given in table 4.1. As stated before, the method starts with a single DT as input. When the first phase's activities have been performed, at least one value proposition (VP) should be identified. If this is not the case the DT should be disregarded and the process terminated. When multiple VPs have been identified during the first phase, each VP is in need of contextualization and evaluation. Therefore the second and third phase need to be repeated for each VP.

Table 4.1: The method's phases

Phase	Goal	Input	Output
Exploration	To identify additional DT applications.	DT*	(Multiple) VP(s)*
Contextualization	To place value propositions in context by representing them a structured and comprehensive manner.	VP*	SD-BMD*
Evaluation	To evaluate the contextualized value proposition—i.e. business model—by means of a scoring so decision making is supported.	SD-BMD*	Scored SD-BMD*

**DT stands for Digital Technology, VP stands for Value-Proposition, and SD-BMD stands for Service-Dominant Business Model Design*

4.2 Artifact Description

In this section each of the three phases is elaborated in more detail as the activities comprising these phases are introduced.

4.2.1 Exploration Activities

A graphical overview of the activities corresponding to the exploration phase of the method is given in figure 4.2.

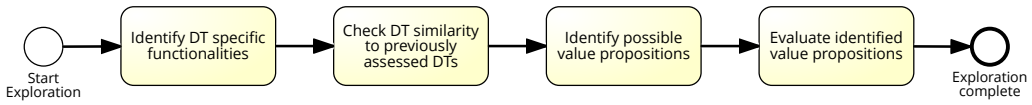

Figure 4.2: Exploration phase

The first activity of the exploration phase of the method aims to identify the specific functionalities a DT possesses—e.g., via brainstorming or an internet search. The output of this activity provides a basis for the subsequent activities in this phase as the DT's similarity to other DTs and its applications depend on the DT's functionalities. No requirements are set for the number of people performing this activity and their functional backgrounds.

The second activity of the exploration phase of the method aims to prevent similar digital technologies (DTs) from being assessed multiple times throughout time. If a similar DT has been assessed before, a complete assessment might not be needed again. The assessors must ask themselves whether a decision can already be made based on the existing assessments and if not, which of the aspects are different and need to be re-assessed. This way effort can be saved when only a part of the assessment is still needed. As this aspect is very straightforward and the execution of the corresponding activity can differ significantly per organization, no evaluation questions have been drafted to support the evaluation of this aspect. The only requirement for someone performing this activity is to have sufficient understanding of the already assessed and still to be assessed digital technologies and their functionalities. Therefore it is advisable the same person(s) performing the first activity performs this activity.

Having checked the DT's similarity to previously assessed DTs, the next activity of the exploration phase aims to identify all of the possible value propositions (VP) making use of the technology—e.g., via brainstorming—and provides a starting point on which later contextualization can be applied.

At least one VP should be identified. Identifying multiple VPs, however, is more desirable as this signifies the possibility of using the DT in multiple ways and in different parts of the organization. This, in comparison to using different DTs, can have positive effects on the realization of these additional VPs as the organization has already gained experience in applying the DT after having realized the first VP. In total at least one VP needs to be identified. If this is not the case, the DT should be disregarded since there is no added value nor starting point for the use of the DT. A multidisciplinary team with members from different functional backgrounds should perform the VP identification activity. The size of this team should be at least three and maximum ten members. As it is difficult to represent knowledge from all operational and supporting departments, a larger team than three is expected.

As the identified VP(s) form the basis of the next phase, the subsequent activity's aim is to ensure, to some extent, the quality of the identified VP(s). This is done by evaluating each VP using a set of evaluation questions. The evaluation questions and their response options are given in table 4.2. The VP evaluation activity should be performed by at least two members of the multidisciplinary team as introduced for the VP identification activity. At least one of the members should have a functional background regarding the department where the to be changed or implemented process is located.

Table 4.2: Value Proposition Evaluation Questions

Label	Evaluation Question	Response				
Q1	Is the digital technology explicitly stated in the VP?				No	Yes
Q3	Is the target customer explicitly stated in the VP?				No	Yes
Q2	Is the main value generated by using the digital technology explicitly stated in the VP?				No	Yes
Q4	Does value generated realistically follow from the use of the digital technology?				No	Yes
Q5	Is the identified value proposition significantly different from other, already stated, VPs?				No	Yes
Q6	To what extent is the target customer likely to be interested in the offering?	Very low	Low	Moderate	High	Very high
Q7	To what extent does the VP contribute to already planned or ongoing projects?	Very low	Low	Moderate	High	Very high
Q8*	To what extent does the VP conflict with already planned or ongoing projects?*	Very low	Low	Moderate	High	Very high

VP stands for Value Proposition
**Inverted Question*

4.2.2 Contextualization Activities

Having completed the exploration phase of the method, the following phase is about placing the value propositions (VPs) into context. As this is done for each VP individually, the first activity related to the contextualization phase has a single VP as input. When multiple VPs have been identified and approved during the preceding phase, one of these must be selected for contextualization before starting the contextualization activities. As all VPs approved during the exploration phase are subject to contextualization, the way this selection takes place is of no importance. This is therefore out of the scope of this thesis.

During the contextualization phase of the method the VP is represented as a Service-Dominant Business Model Design (SD-BMD). During this representation process the VP is placed in context and elaborated in more detail. With this a better understanding of the digital technology and its application is developed. The SD-BMD is comprised of the design of two main components, developed nearly simultaneously of each other during the contextualization phase's activities. The first component is the Service-Dominant Business Model Radar (SDBM/R). The second component is a description of the customer experience which is supplementary to the SDBM/R.

If information from previously contextualized VPs is useful for the current VP's contextualization, this information can be used in order to save effort. An overview of the activities related to the contextualization phase of the method is given in figure 4.3. Despite being displayed in a sequential form, the design should be applied as an iterative process [Turetken et al., 2019] as new information related to any of these activities can rise during any other activity. The same multidisciplinary team performing the VP identification activity during the exploration phase is to perform the contextualization activities. All of the design steps are further elaborated in the current subsection.

Identification of co-created value-in-use and the targeted customer

In the current context, the co-created value-in-use is the generated added value the realized value proposition (VP) will bring to the customer when the digital technology is being used. The customer also contributes to the creation of this value-in-use [Turetken et al., 2019]. With the more intra-organizational perspective present in the current context, the customer can very well be an actor within the focal organization.

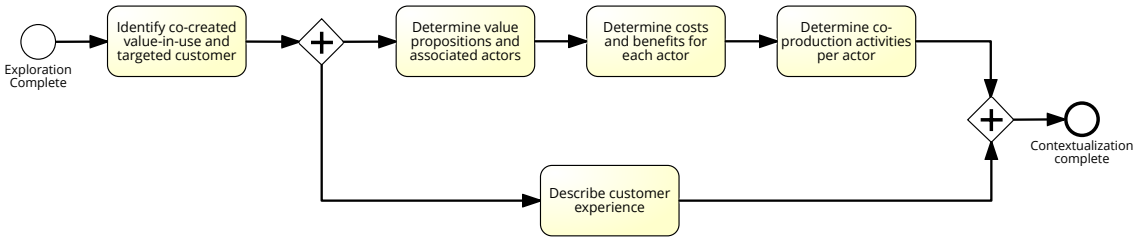

Figure 4.3: Contextualization phase

As the VP has already been identified in the exploration phase of the method, the customer is likely to be already identified as well as some value component. During the current design step, however, thinking from a more networked perspective is necessary which can result in the co-created value-in-use and the targeted customer to turn out different from what was earlier identified.

Determination of value propositions and associated actors

The value-in-use's components represent themselves through a value proposition for each actor. To reflect only the essence of the model, the focus should be on the core actors at the initial stages of the design [Turetken et al., 2019]. In the current research context, the service-dominant (SD) Logic is applied on a more internal level of an organization—i.e. intra-organizational—than its traditional inter-organizational application. Because of this the network comprising the business model may include multiple actors from the same, focal, organization. The actors are not likely to be all external, a large part of them may even be more internal of nature. Examples of internal actors could be the operational department acting as the customer, the IT department acting as software operator, and operators acting as the actual users of the new digital technology. Outsourcing tasks will lead to external actors joining the network, for example partnerships with software providers to handle the software development and operating activities will lead to an external actor joining the network.

Determination of the costs and benefits for each actor

Having determined the value propositions and associated actors, the next step is to determine the costs and benefits for each actor—i.e. the individual costs and benefits. The costs and benefits can be both financial or non-financial and are in the early stages most likely stated in qualitative terms. Costs and benefits can be of a recurring or one-off nature as there can be positive and negative effects during the realization of an idea and during the use of this realized idea, i.e. *realization costs or benefits* and *costs or benefits in use* respectively.

The benefits in use are benefits gained after the service-dominant business model design (SD-BMD) has been realized and the new digital technology is being used–e.g., an increase in a certain efficiency or an improved safety for workers. The realization benefits are benefits that are gained through realizing the SD-BMD. An example of a realization benefit can be knowledge building for a certain actor–e.g., by experimenting with the digital technology (DT).

The costs in use are the costs incurred when the SD-BMD is in operation. These can be more than just the run and maintain costs incurred to the party responsible for the operation of the system as they can also be some extra effort required by an actor in the network when working with the new DT. This can for example be the case when the user-friendliness of the DT is low, requiring extra effort from the eventual user when executing the process in which the technology has been implemented. The realization costs are the costs incurred when realizing the SD-BMD. They occur before the SD-BMD is in operation. An example is the effort it takes to integrate multiple systems with each other.

The identified costs and benefits should be placed on the SDBM/R at the corresponding actor.

Determination of high-level activities for each actor

Having determined the costs and benefits for each actor, the high-level activities realizing the actors' value propositions are to be determined. These high-level activities become part of the customer experience—which is elaborated in the next paragraph—and can be mapped to specific tasks executed by each actor [Turetken et al., 2019].

Description of the customer experience

The description of the customer experience refers to the high-level operation and future realization of the SD-BMD. Written from the perspective of the target customer, the customer experience is a story describing how the value-in-use is reached. This is often done in a verbal form and is improved and expanded during multiple iterations while the radar is being developed.

4.2.3 Evaluation Activities

During the last phase of the method, namely *Evaluation*, the value proposition (VP) represented via a service-dominant business model design (SD-BMD) is evaluated. Based on the evaluation, sufficient information is at hand to make more informed decisions. When multiple represented VPs have been evaluated, the comparison between them is also facilitated as the evaluation results are quantified.

The radar developed during the contextualization phase of the method serves as input for the evaluation activities of the method. The evaluation activities are based on the SD-BM evaluation method provided in Gilsing et al. [2020]. However, given the current research context being on a lower level of abstraction, the SD-BM evaluation method's components have in some cases been expanded to a higher level of detail in an effort to translate these components to the use in the current context. Argumentation for these changes is given later this chapter.

The SD-BM evaluation method consists of the evaluation of four quality attributes. These are as follows: 1) Structural Validity, 2) Feasibility, 3) Viability, and 4) Robustness. The activities corresponding with the evaluation phase of the method are illustrated in figure 4.4. As can be seen in this figure the structural validity is to be evaluated first, followed by the other quality attributes. During the evaluation, however, new information can come to mind which changes the SD-BMD. When this happens the already answered evaluation questions are to be checked for changes. A team of three to four members, composed of members from the team which performed the contextualization activity, is to perform the evaluation activities. This team should encompass knowledge on the main disciplines linked to facets of the designed business model. Note, this can differ per business model. As the evaluation questions are qualitative of nature, part of this team should be fixed in order to generate more standardized outcomes.

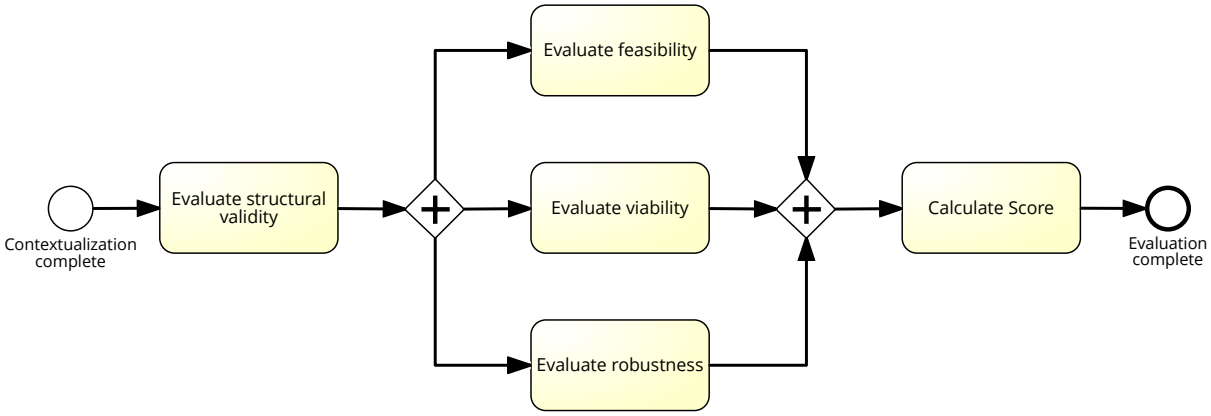

Figure 4.4: Evaluation Phase

In the rest of this subsection each of the evaluation phase's activities is explained in more detail and the to be used evaluation questions are given.

Evaluate Structural Validity

The structural validity of the business model is evaluated on four business model components, namely 1) value network, 2) value proposition, 3) value architecture, and 4) value finance. As no changes or additions have been made regarding the structural validity evaluation questions stated in Gilsing et al. [2020], the information provided in this article provides sufficient guidance as to how to perform this activity. The evaluation questions to be used when evaluating the SD-BMD's structural validity are given in Appendix A, table A.1. The evaluation questions response options are in a more closed form—a binary 'yes' or 'no'—than at the evaluation of the other quality attributes. When the structural validity of the business model is deemed insufficient as one or more of the evaluation questions receives a negative response, the design should be revised as it does not adhere the SD principles or its general logic is not valid.

Evaluate Feasibility

As one of the original evaluation questions with regard to the feasibility quality attribute, as stated in Gilsing et al. [2020], has been split into two separate evaluation questions. The new set of evaluation questions can be found in table 4.3. Additional information regarding the response options is given in Appendix D, table D.1.

Table 4.3: Business Model Feasibility Evaluation Questions

Label	Evaluation Question	Response				
Q19	To what extent does each actor in the SD-BMD currently possess the resources needed to conduct its activities?	Very low	Low	Moderate	High	Very high
Q20	To what extent are these resources available for the realization of the SD-BMD?	Very low	Low	Moderate	High	Very high
Q21	To what extent are communication and resource interfaces present between actors in the SD-BMD?	Very low	Low	Moderate	High	Very high
Q22*	To what extent do legal and technological barriers exist towards implementation of the SD-BMD?*	Very low	Low	Moderate	High	Very high
Q23	To what extent does trust or cooperation exist between actors in the SD-BMD?	Very low	Low	Moderate	High	Very high

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Evaluate Viability

The evaluation questions to be used when evaluating the SD-BMD's viability in the current research context also found their base in the questions provided in Gilsing et al. [2020]. However, due to the lower level of abstraction the current research context provides, a number of additions have been made. The new set of evaluation questions can be found in table 4.4. The sub-questions related to the twenty-fifth evaluation question (Q25) should be answered before the twenty-fifth evaluation question itself is answered, as the sub-questions stimulate the method's users to think of additional aspects to take into account when evaluating the relation between the benefits and costs. Additional information regarding the response options is given in Appendix D, table D.2.

As the organization's strategic goals differs per organization, a predetermined set of evaluation questions is always going to be on a relatively high level of abstraction. Therefore the questions drafted to evaluate this aspect can be further specified dependent on the organization in which they are used.

Evaluate Robustness

To evaluate the robustness of the business model as a whole, all of the business model's components should be included in the evaluation. These components have been introduced earlier in this section with regard to the structural validity. The questions provided in Gilsing et al. [2020] are therefore, like the questions for the evaluation of the model's structural validity, divided per business model component

Table 4.4: Business Model Viability Evaluation Questions

Label	Evaluation Question	Response				
	Costs & Benefits:					
Q24	To what extent can the costs and benefits per actor in the SD-BMD be measured or quantified?	Very low	Low	Moderate	High	Very high
Q25	To what extent is the value generated by the benefits per actor compensating for the actor's costs?	Very low	Low	Moderate	High	Very high
	Link to 'Business':					
Q25.1	*To what extent are the benefits gained when realizing the SD-BMD related to primary processes?*	Very low	Low	Moderate	High	Very high
	User-Friendliness of the Digital Technology:					
*Q25.2**	*To what extent is extra effort required by actors using the digital technology?**	Very low	Low	Moderate	High	Very high
	Costs due to Regulations:					
*Q25.3**	*To what extent are extra costs expected in order to comply with regulations?**	Very low	Low	Moderate	High	Very high
	Implementation Complexity:					
*Q25.4**	*To what extent are there costs expected due to the impact the realization of the SD-BMD has on other processes in the focal organization?**	Very low	Low	Moderate	High	Very high
*Q25.5**	*To what extent are costs expected due to the need of integration between multiple systems during the realization of the SD-BMD?**	Very low	Low	Moderate	High	Very high
*Q25.6**	*To what extent is decision making made more complicated due to the number of actors involved in the SD-BMD?**	Very low	Low	Moderate	High	Very high
*Q25.7**	*To what extent is the digital technology in need of change to fit the organization?**	Very low	Low	Moderate	High	Very high
*Q25.8**	*To what extent are costs to be expected due to the need to meet unmet prerequisites for the SD-BMD realization?**	Very low	Low	Moderate	High	Very high
*Q25.9**	*To what extent are there costs to be expected due to employees being unready for the changes occurring when realizing the SD-BMD?**	Very low	Low	Moderate	High	Very high
	Suitability:					
Q26	To what extent does the SD-BMD satisfy the strategic goals of each actor?	Very low	Low	Moderate	High	Very high
Q27*	To what extent does the SD-BMD conflict with the strategic goals of each actor?*	Very low	Low	Moderate	High	Very high

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

so the robustness for each of the components can be individually evaluated. As one of the original questions has been changed and one question has been split into two, the evaluation questions to be used when evaluating the SD-BMD's robustness are stated in table 4.5. Additional information regarding the response options is given in Appendix D, table D.3.

Table 4.5: Business Model Robustness Evaluation Questions

Label	Evaluation Question	Response				
	BM Component - Value Network:					
Q28	To what extent can network actors, having a realistic chance of stopping their participation in the SD-BMD, be substituted or replaced?	Very low	Low	Moderate	High	Very high
	BM Component - Value Capture:					
Q29*	To what extent is the actualization of the expected benefits listed per actor in the BMD subject to risk and uncertainty?*	Very low	Low	Moderate	High	Very high
Q30*	To what extent are the costs listed per actor in the SD-BMD subject to risk and uncertainty?*	Very low	Low	Moderate	High	Very high
	BM Component - Value Proposition:					
Q31	To what extent can the value-in-use of the SD-BMD be offered or catered to different customer segments?	Very low	Low	Moderate	High	Very high
	BM Component - Value Architecture:					
Q32*	To what extent are the actor activities subject to technological or legal developments?*	Very low	Low	Moderate	High	Very high

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Scoring activity

In order to quantify the business model evaluation results, a score is calculated. To determine this score, a Multiple Criteria Decision Analysis is to be performed. For this analysis, ratings and weights for all business model evaluation questions are required. Based on the responses given to the feasibility, viability, and robustness evaluation questions, these ratings can be determined based on the response option ratings stated in Appendix E. However, no predetermined weights are stated considering that these can differ significantly per organization. How these weights can be calculated is stated later this subsection. These weights are only to be determined the first time the method is applied as they should be re-used when scoring other represented value propositions. It is, however, advisable to redetermine the weights periodically—e.g., yearly—as the organization's goals, culture, and priorities can change over time.

The calculation of the total score is divided in two levels. First the score for the quality attributes feasibility, viability, and robustness are calculated. Thereafter the total score is calculated based on these. The rating for the feasibility, viability, and robustness can be calculated using the following formulas:

$$FeasibilityRating = \sum_{n=19}^{23} R_n * W_n \qquad ViabilityRating = \sum_{n=24}^{27} R_n * W_n$$

$$RobustnessRating = \sum_{n=28}^{32} R_n * W_n$$

With R being the individual question's rating—ranging from 1 to 5—and W being the individual question's weight—ranging from 0 to 1. Note, in the calculation of the 'ViabilityRating' the sub-questions of business model evaluation question twenty-five—i.e. Q25.1, 25.2, etc.—are not included as they are defined to provide a basis for answering the twenty-fifth question. The rating given to the twenty-fifth question should incorporate all the criteria evaluated via the sub-questions.

Based on the feasibility, viability, and robustness ratings, the total score can be calculated via the forllowing formula:

$$TotalScore = \sum_{n=1}^{3} R_n * W_n$$

With R_1 being the feasibility rating, R_2 the viability rating, R_3 the robustness rating, and W_n being the corresponding weights. If calculated correctly, the total score will be on a scale from 1 to 5. In order to present the total score in a more familiar format, it can be formatted on a scale from 1 to 10 by following the following formula:

$$= 9 * \frac{TotalScore - 1}{4} + 1$$

The weights can be calculated by following the Analytical Hierarchy Process (AHP). During this process all criteria are compared based on their importance. As the calculation is divided in two levels, this means there are four questionnaires related to the AHP. One for the determination of the quality attribute weights and three for the determination of the individual criterion weights linked to the feasibility, viability, and robustness attributes. These questionnaires are stated in Appendix F. For information on how the weights are calculated after having filled in the questionnaires, the article of Saaty [2008] can be consulted.

For the purpose of ease of use an Excel form has been developed in which the questionnaire responses can be entered of both the business model evaluation questions and the AHP questions. The weights, quality attrubute ratings, and total score is then automatically calculated. This form can be accessed using the following link: `https://drive.google.com/file/d/11OAvIS8EFQandE03_fRz73Q30wQH_i5E/view?usp=sharing`. In this form, the green cells are to be changed. the blue cells are locked.

4.3 Design Choices

The artifact's design steps, as stated in chapter 3, are described in this section, as well as each major design decision and its argumentation.

4.3.1 DPII-EC Framework Design

The aspects which should be taken into account when assessing digital process innovation ideas are displayed in a structured and comprehensible manner via the Digital Process Innovation Idea Evaluation Criteria (DPII-EC) framework. This framework is presented in figure 4.5. In the framework the aspects stated by interviewees have been marked by being colored green, the aspects stated in the prior research, including the quality attributes by Gilsing et al. [2020], are colored blue, the aspects stated both by interviews and in prior research are colored in a combination of blue and green, and lastly, the aspects colored white have been added for the purpose of categorization. A detailed elaboration per aspect is stated later in this section as the extension of the SD-BM evaluation method is described.

4.3.2 Phase Determination

As an exploratory perspective is taken in this thesis, we do not want to limit ourselves solely to the use of the digital technology (DT) as being described in the idea. Therefore the DT's other possible applications in the organization should be explored. This also results in the input of the method not being an idea but a DT. The activities corresponding to the identification of additional opportunities for using the DT comprise the first phase, namely *Exploration*.

Knowing this research's goal is the development of a method supporting the description and evaluation of digital process innovation ideas, two additional phases can be determined. Firstly, in order to describe

Figure 4.5: Digital Process Innovation Idea Evaluation Criteria (DPII-EC) Framework

the idea in accordance with the SD logic it is of vital importance to place the idea in its context. Therefore the subsequent phase, including the description of the idea and its surroundings, is named *contextualization*. Secondly, when more information is available regarding the idea and its context, an evaluation can be made. Therefore the last phase of the method has been named *Evaluation*.

4.3.3 Design of the Phases

Having the full set of evaluation criteria at hand via the DPII-EC framework together with the tools which were to be included in the different phases of the method, the individual activities comprising each phase were determined. With both prior literature—Gassmann and Schweitzer [2014]—and the interviewees stating the front-end activities should be managed as inter-functional and interdisciplinary as possible, ideally some sort of cross-functional team would be advisable to perform the method's activities so knowledge from multiple departments is present. Also it was stated during the interviews that the team performing the activities should have enough mandate to make the decisions, as otherwise bureaucracy could impair the process. Lastly, it was also stated during the interviews that there would likely be negative effects arising from including someone from the finance department. However, not including someone from the finance department will hinder the identification for using the digital technology (DT) in the finance department. Because of this as well as other arguments, the team performing the method's activities does not have to be the same for each activity.

With end-user involvement being particularly important to process innovation [Sjödin, 2019], the expected end-users using the to be implemented digital technology can be consulted if the need for more information arises. Yet, since it is still early in the process innovation process, there is still a very high level of uncertainty with regard to the business model itself and to how it will actually take form within the organization. With the possibility of equivocality increasing due to end-user involvement, as it typically adds another layer of differing views and interpretations [Sjödin, 2019], end-users should not be included in the teams performing the different activities of the method. Aside from prior research, it was also stated during the interviews, as presented in Appendix B, that no shop-floor employees should be included in the actual evaluation and decision making process.

Argumentation for the activities composing each of the three phases is given below. Also an argumentation for the composition of the teams performing each activity is given in this subsection.

Exploration

In order to gain insights into the digital technology's (DT) characteristics and its possible uses, first the specific functionalities of the DT need to be identified. This also helps in the identification of seemingly dissimilar yet similar earlier assessed DTs as the functionalities of the DTs can be compared. Since the identification of the digital technology's functionalities is rather simple as they can often be found easily on the internet, no requirements are set for the number of people performing this activity and their functional backgrounds.

The second activity to be performed during the exploration phase is the DT similarity check to previously assessed DTs in the organization. This activity is included since time and effort are wasted when a DT is contextualized and evaluated when this has already been done, or when information from previously assessed DTs could have been used. Thus, it is of importance to check whether the DT or a similar one has already been assessed before. No multidisciplinary team is needed to perform this check as only a broad understanding of the DT in question and the previously assessed DTs is needed. There is most likely little room for discussion and interpretation during this activity. Therefore the only requirement for someone performing this activity is to have sufficient understanding of the already assessed and still to be assessed digital technologies and their functionalities.

Given the main objective for the exploration phase is the exploration of additional uses of the DT than initially described in the idea, the third activity to be performed during the exploration phase is the identification of possible value propositions (VPs). In order to make a well informed choice on whether to continue with a specific new digital technology, the possibilities for value creation via this technology throughout different parts of the organization should be known. This way the technologies with a high potential value throughout the organization as a whole can be identified. In order to gain insights regarding the possible value a new digital technology can have for a certain part of the organization,

expertise from these different parts of the organization is desirable. Therefore, a multidisciplinary team of people should execute the VP identification step of the method. Since a group size of three to ten people is recommended when brainstorming [Wilson, 2013], the size of the team performing the VP identification step should be at least three and maximal ten people. However, as it is difficult to represent knowledge from all operational and supporting departments with only three people, a larger team is expected. People composing this team should be roughly the same level in the organizational hierarchy as a difference in hierarchy level can incur status anxiety [Wilson, 2013].

With the identified VP(s) forming the basis for the next phase, it is of importance to evaluate, to some extent, the quality of the identified VP(s). This is being done by evaluating all of the identified VPs. This evaluation is done for each VP separately and is repeated until all of the identified VPs are evaluated. Ranta, Aarikka-Stenroos, and Mäkinen [2018] assess value propositions on two main sub-components, 1) offering, and 2) target customer. The offering refers to a product or service on offer [Ranta et al., 2018], which in our current context refers to the new DT to be used and the value gained from this. In the current context the target customer refers to the main beneficiary—e.g. an organizational department using the digital technology in one or more of their processes.

In order to evaluate these two sub-components and some other criteria, a number of evaluation questions are proposed. The first five questions relate to the VP's structural validity, meaning when an identified VP is not meeting the question's requirement the VP is not complete, the clarity regarding this component is not sufficient, or the identified VP is not unique. The first two questions are proposed in support of evaluating whether the 'offering' is explicitly stated in the identified VP. These questions are formulated as follows: *Is the digital technology explicitly stated in the VP?* (*Q1*) and *Is the main value generated by using the digital technology explicitly stated in the VP?* (*Q2*). The third question evaluates whether the VP's sub-component 'target customer' is explicitly stated, and is formulated as follows: *Is the target customer explicitly stated in the VP?* (*Q3*). With still a lot of uncertainty regarding the context in which the VP is going to be realized, evaluating the feasibility of attaining the value is impractical. The logic to which this value comes about, however, can already be evaluated. Hence the fourth question: *Does value generated realistically follow from the use of the digital technology?* (*Q4*). The fifth, and last question relating to the evaluation of the VP's structural validity, is aimed at making sure the VP is unique in relation to the other identified VP(s) and is formulated as follows: *Is the identified value proposition significantly different from other, already stated, VPs?* (*Q5*).

Aside from the VP's structural validity three additional questions have been proposed. The first question aims to capture the uncertainty with regard to the acceptance of the VP by the target customer as the target customer's interest in the offering may not be guaranteed. Taking a moment to consider the extent to which target customer is expected to be interested in the offering can further strengthen or weaken the VP, aiding in a more informed decision when deciding whether to continue with a VP or not. Therefore the following evaluation question is proposed: *To what extent is the target customer likely to be interested in the offering?* (*Q6*).

The last two evaluation questions are based on the DPII-EC framework's *interference with planned projects* aspect and intent to already evaluate the VP's context to a limited extent. It aims to stimulate positive and prevent negative effects when a VP supports- or conflicts with already planned or ongoing change projects. For example an idea might target a certain process which is already planned to be changed. As a result the VP may not be feasible anymore. If the VP is still possible, one needs to take a perspective from the new situation as the VP's context in which it will be realized is likely to be different from the current situation. As the planned process change is not yet realized, taking a view from this perspective can be difficult since there may still be uncertainties. Additionally, changing a process right after it has been changed already may discomfort process operators as they are still getting used to the new situation and are asked to change their way of working once more. On the other hand, there may also be positive facets in changing a process which is already planned to be changed. If time allows the VP's realization simultaneously to the already planned change, a consolidation into a single change project is achievable. Taking a production process for example, this can bring significant benefits. When an already planned change is requiring the production process to be ceased for a while and this is also required for the realization of the VP, a negative aspect of the latter—namely the requirement for a cease in production—is diminishing. Apart from the possibility of diminishing negative elements for the realization of the VP, it is also thinkable that e.g., consolidating projects can be beneficial to the already planned project. All together, the last two VP evaluation questions have been formulated as follows: *To what extent does the VP contribute to already planned or ongoing projects?* (*Q7*) and *To what extent*

does the VP conflict with already planned or ongoing projects? (*Q8*).

Relatively simple checks are performed to evaluate the value proposition. Therefore it is excessive to have a large multidisciplinary team executing this activity. Yet, as a person's perspective can differ based on their organizational background and a change in perspective may alter a check's outcome, having a single person performing these activities is unwanted. Having the opportunity to discuss the idea of subject is likely to improve decision making during this activity. Additionally a sound understanding of the identified VP and its organizational context is required to limit the risk of inaccurate checks. Therefore the VP evaluation step should be performed by at least two members of the initial multidisciplinary team of people who performed the VP identification activity of the method. One of these should have a functional background regarding the department where the to be changed or implemented process is located. The element of the VP evaluation activity regarding the interference with planned or ongoing projects, however, might prove to be difficult to evaluate if not all organizational departments are represented in the group performing the VP evaluation activity unless there is a central database listing all change projects and the processes they involve is at hand. As desirably all organizational departments are represented in the group performing the VP identification activity, however, a solution would be to have the members of this group check in their own department what change projects are already being performed.

Contextualization

A novel perspective when thinking about business modelling is the consideration of business models as a cognitive concept and entrepreneurial perspective on ideas instead of considering business models merely as an outcome of the innovation process, enhancing management in the front-end of innovation [Schrauder et al., 2018]. The idea's chance of success is actually suggested to be higher when multiple business models have been analyzed [Teece, 2007], which was later backed as evaluating business model alternatives in the front-end of innovation has been found to be closely related to the front-end success [Schrauder et al., 2018]. By examining both value creation and value capture, a comprehensive perception of the idea's logic is emphasized when taking the business model perspective [Schrauder et al., 2018]. Narrow-minded management decisions are potentially prevented because of this, supporting the understanding of causal relationships—underlying an idea—and business model options as well as the description of real-life business phenomena. As the entire value-creation ecosystem is considered, with the core logic behind the value creation holistically described by a business model through "the exploitation of an entrepreneurial opportunity and the connection of firm-internal and firm-external elements" [Schrauder et al., 2018, p. 412], companies are likely to be more realistic about the actual value generated by the idea. Additionally, more strategic decisions can be made as the business model concept has the ability to serve as a cognitive framework. Also, by generating graphical representations of the different ideas and the actors involved in them, a more comprehensive overview, instead of an otherwise complex and tangled textual explanation, can be produced. Business models, being made through a mixture of both graphical representations and informal texts [Turetken et al., 2019], are therefore, aside from the earlier given arguments, an interesting way of representing the ideas.

By incorporating the drafting of business models for each idea as a step of the developed method, the activities typically being performed during the formal idea-study phase of the front-end of innovation—being the anticipation of end-product changes, creation of a preliminary process concept, and the definition of project objectives—are all supported either directly or indirectly. Inherently ideas are further specified, as a draft of the preliminary process concept is made when creating the model. Also, effects of the idea on end-products are incorporated in the business model as this can be either added value or the opposite—i.e. cost. Lastly, by stating the co-created value and benefits for each network-actor, a basis for defining process objectives is laid. Therefore the decision is made that the idea is represented as a business model and a business modelling tool is incorporated in the developed method as a means of idea representation—i.e. the idea description.

Given the service-dominant (SD) context, a service dominant business modeling tool is incorporated in the method, namely the Service-Dominant Business Modeling Radar (SDBM/R). This tool is proposed recently and since it is not an adaptation of an existing tool, it could be developed taking the SD mindset at its center. Therefore the business model is developed taking the SD mindset as its base and it is displayed in a new way compared to traditional business modeling tools. The SDBM/R focuses more on the different actors in the surrounding context—i.e., the network of actors—in relation to

traditional business modelling tools, and in doing so, adopts a network-centric mindset at its core. This way the idea's context is taken into account. Also, how actors co-create value and what the cost/benefit distribution throughout the network is, will be defined when using this tool [Turetken et al., 2019]. The activities defined to comprise the contextualization phase of the developed method are based fully on the design steps for the design of the SDBM/R, as introduced in subsection 2.2.2.

Determining the components of the SDBM/R requires expertise from different disciplines, as well as an accurate understanding of the focal idea. Aside from the disciplines the specific business model is associated with, knowledge and experience of people from other functional departments can provide useful insights or incentive for discussion which may lead to more profound decision making. Also, it can be difficult to define the disciplines linked to a specific VP beforehand as the involved actors are still to be identified. Therefore the same members composing the multidisciplinary, inter-functional team performing the VP identification activity during the exploration phase are desired to perform the contextualization activities of the method.

Evaluation

With the formal idea-study phase's activities mostly supported by drafting business models for the ideas, decision making itself is still in need of further support. By incorporating the method developed by Gilsing et al. [2020], a tool is at hand to support the evaluation of service-dominant business models in a qualitative manner. By evaluating the business models it will be easier to compare them, thus supporting decision making on with which models to continue. As the article written by Gilsing et al. [2020] focuses on the evaluation of service-dominant business models in general and not specifically in the context of evaluating business models generated from digital process innovation ideas in an intra-organizational context, the method stated has been expanded to better capture the lower level of abstraction and to better fit the intra-organizational context. This expansion has been made by changing existing or drafting new evaluation questions based on the more specified criteria presented in the DPII-EC framework—subsection 4.3.1. Argumentation for and the description of the specific changes made is given later this subsection.

The activities defined to comprise the evaluation phase of the developed method are based partially on the activities stated in the service-dominant business model (SD-BM) evaluation method as presented in Gilsing et al. [2020]. As this evaluation method, however, does not include any form of quantification of the evaluation results—e.g., via scoring—the second part of the evaluation phase is aimed at quantifying these results. This way decision making is supported further by reducing the level of subjectivity when interpreting the evaluation results. More information regarding the design of this activity is given later this subsection.

The evaluation activities performed according to the SD-BM evaluation method require expertise from multiple organizational disciplines, but overall they are less complex than the activities in the contextualization phase as predefined questions with predefined answers are to be followed. Therefore not the entire group performing the contextualization activities is required to perform the evaluation phase. However, the group should encompass the knowledge on the main disciplines linked to facets of the designed business model—note, this can differ per business model. Moreover, as the reasoning resulting in certain business model design choices is needed for a solid evaluation, since not all considered aspects may appear explicitly on the radar, the group's composition is required to include people from the group which performed the contextualization activities. Lastly, as the evaluation questions are qualitative of nature, it is desirable to have a fixed part of the team as this will generate more standardized evaluation outcomes due to the consistency in interpretation. All in all, a team of three to four members, composed of the multidisciplinary team which performed the contextualization activities, is advised.

Extension of the SD-BM evaluation method based on the DPII-EC framework

In the coming paragraphs information regarding and argumentation for each change made to the set of evaluation questions, as stated in Gilsing et al. [2020], is given. In general the aim has been to include evaluation questions at a low level of abstraction since feedback on one of the early designs of the artifact stated a lower level of abstraction is desirable as the artifact's complexity is decreased. By specifying the questions on a lower level of abstraction, answering the questions will be easier as less room for interpretation is possible. Therefore the evaluation questions have been translated to a more specified level when possible.

No pre-defined sequence in which the quality attributes should be evaluated is provided in Gilsing et al. [2020]. However, as the structural validity is evaluated to validate whether the service-dominant (SD) logic principles have been followed and whether the general logic is valid in the business model design, the design should be revised when deemed insufficient. When the other quality attributes are evaluated before having revising the model, these attributes would need to be reevaluated after the revision as changes to the model may impact these quality attributes. So in order to safe effort, the structural validity should be evaluated before the other quality attributes.

Structural Validity
The structural validity refers to the logical and structural soundness of the designed business model. In the current context of evaluating SD business models, the adherence to the SD logic's principles is part of the to be evaluated elements. As stated by Al-Debei and Avison [2010], business models in general are composed of four elements, namely 1) value network, 2) value proposition, 3) value architecture, and 4) value finance. For the evaluation of these elements as well as whether the Service-Dominant logic is followed during the business model design, Gilsing et al. [2020] state eleven questions. These questions have been divided according to the business model components to ensure every component is taken into account [Gilsing et al., 2020]. As the structural validity of a business model is general and not specified to different contexts, no translation to the current, more specified, context has been made.

Feasibility
The feasibility of the SD-BMD in the current context refers to the feasibility of the digital process innovation. The extent to which the realization is achievable. As stated in the DPII-EC framework, aspects linked to the feasibility quality attribute are 1) *resource accessibility*, 2) *communication and resource interface availability*, 3) *legal and technological barriers*, and 4) *trust & cooperation between actors*.

The *resource accessibility* aspect refers to the accessibility of the required resources for the internal- and external actors—i.e. actors from the focal organization and actors from external organizations. Based on the DPII-EC framework, the *resource accessibility* has been specified on a lower level of abstraction by subdividing this aspect into two sub-aspects—*resource possession* and *resource availability*. The *resource possession* refers to the extent to which the actor in question has the required capabilities—e.g., knowledge, people, and materials—to realize their part of the SD-BMD. The *resource availability* refers to the extent to which these capabilities are actually available for the realization of the SD-BMD.

Although one of the original evaluation questions, as stated in Gilsing et al. [2020], captures the sub-aspects, the evaluation question related to the resource accessibility aspect has been split into two to specifically address the sub-aspects. The result is the exclusion of the first business model feasibility evaluation question—*To what extent does each actor in the SD-BMD have access to resources needed to conduct its activities?*—and the draft of two new evaluation questions—*To what extent does each actor in the SD-BMD currently possess the resources needed to conduct its activities?* (*Q19*) and *To what extent are these resources available for the realization of the SD-BMD?* (*Q20*).

The *communication and resource interface availability* refers to the interactions and relationships between actors and its structure. Whether they are available or otherwise easily established is to be evaluated. If these are absent and not easily established, the idea's realization might become infeasible. Organizational silos can be a reason for these interfaces to be non or barely existent between actors from the same organization. Therefore this aspect should be evaluated for all actors in need of communicating which each other, independent of whether they are from the same organization or not.

The *legal and technological barriers* aspect refers to the existence of legal or technological barriers making the realization of the idea unattainable. The legal barriers refers to the feasibility of the idea from a regulatory perspective. For example, an idea to set up a 3D printing process for the production of certain parts in need of being replaced before each production batch can be very valuable. However, regulations in the pharmaceutical industry dictate the actual produced product itself is not allowed to come in contact with any 3D printed material. Therefore the idea is not feasible due to a legal barrier.

Lastly, the extent to which *trust or cooperation exists between the different actors* in the SD-BMD is to be evaluated as lacking either or both can have a significant impact on the realization of the SD-BMD itself, as well as the actual collection of the value after the design has been realized. One may expect both trust and cooperation to be high between actors of the same organization, although this does not necessarily have to be the case.

As there is no extra level of detail in the DPII-EC framework regarding the last three aspects, the original evaluation questions addressing these aspects, as stated in Gilsing et al. [2020], have not been changed and no additions have been made.

Viability
The viability in the current context refers to the extent to which the SD-BMD is desirable and its ability to be implemented successfully. Apart from the viability of a Service-Dominant business model being dependent on the bilateral relationship between the customer and the focal organization, it is also dependent on how value is appropriated to all the actors in the model [Turetken et al., 2019]. Taking a more intra-organizational perspective, in the business model, the focal organization may be represented by numerous actors of which one is likely to be the customer. Which is opposed to having the focal organization being represented as a single actor in the business model with an external customer. Therefore, aside from on how value is appropriated to all actors, the viability of a Service-Dominant business model in the current context is dependent on the bilateral relationship between the customer—which can be an internal department—and the organizing party—which can be an internal department as well. As stated in the DPII-EC framework, aspects linked to the viability quality attribute are *costs versus benefits* and *suitability*. The evaluation questions stated in Gilsing et al. [2020] address these aspects to a large extent. However, due to the more detailed levels provided in the DPII-EC framework, changes and additions have been made to the original questions for evaluating the business model's viability. Argumentation for the changes regarding both aspects and their sub-aspects is given in the next paragraphs.

Costs versus Benefits:
The *costs versus benefits* aspect refers to the total costs incurred in relation to the benefits to be obtained and the ratio between them. The sum of these costs and benefits should be positive overall [Turetken et al., 2019]. To a large extent much of these costs and benefits are not likely to be quantifiable yet. Still an overall estimation as to which extent the benefits outweigh the costs should be made as the total costs related to the total benefits is seen among the interviewees as one of the most important aspects when assessing digital process innovations. One of the evaluation questions provided in Gilsing et al. [2020] addresses the balance between them, however this question has been specified to include more emphasis on the extent to which benefits compensate the costs. Therefore the second viability evaluation question provided in Gilsing et al. [2020] has been changed from *To what extent can the costs and benefits per actor in the SD-BMD realistically be balanced?* to *To what extent is the value generated by the benefits per actor compensating for the actor's costs?* (*Q25*).

Based on the DPII-EC framework, the *costs versus benefits* aspect can be further specified into multiple sub-aspects, namely 1) *benefits' link to primary business processes*, 2) *user-friendliness of the digital technology*, 3) *costs due to regulations*, and 4) *implementation complexity*. In order to capture this extra level of detail, a number of sub-evaluation questions have been included. As these sub-questions together comprise the costs versus benefits aspect, which is already captured at a lower level of detail via Q25, these questions are to be answered before answering Q25. By including the sub-questions the method's users are stimulated to consider these sub-aspects explicitly so it is made sure they are taken into account. If there are costs related to any of these sub-aspects, they should already have been included in the SD-BMD. So when this is not the case, the design should be revised. Because of this, one could argue a number of the sub-evaluation questions fit also with the structural validity evaluation questions. However, as they do directly relate to the costs versus benefits aspect and as they relate highly to Q25, they have been placed among the viability questions. These sub-questions are not included in the eventual scoring as the combined responses and the other costs and benefits stated in the SD-BMD should already be included in the response given to Q25.

During the interviews, of which the results are presented in Appendix B, ideas with benefits linked to a need, problem, or opportunity in the organization's core business processes are prone to gain more support from higher management. Therefore they are likely to encounter less resistance from within the organization in comparison to ideas with no benefits linked to the core business—i.e. primary processes. One of the main reasons given for this was stated to be that benefits with a stronger link to the core business are likely to be valued higher as they benefit the organizations core operations, which is seen as a positive point. Therefore the following sub-evaluation question has been added: *To what extent are the benefits gained when realizing the SD-BMD related to primary processes?* (*Q25.1*).

The extent to which the new digital technology is easy to use by the eventual user is referred to as the digital technology's *user-friendliness*. When this is low the end-user is may not like to use the new digital

technology. When changing a particular process, a low user-friendliness can also lead to more required effort when performing an activity compared to the old situation. Which in turn can lead to the end-user not wanting to use the new technology. As the evaluation questions as stated in Gilsing et al. [2020] do not address this aspect, the following sub-evaluation question has been added: *To what extent is extra effort required by actors using the digital technology?* (*Q25.2*).

The extra effort required in order to meet certain regulations—i.e. *costs due to regulations*—can differ significantly per industry as well as the type of processes in question. During the interviews with employees of a pharmaceutical company, this aspect was found to be an important aspect as the organization is operating in the highly regulated pharmaceutical industry. Specifically an important element to include was stated to be whether or not the new or to be changed process is in need of validation, as this can increase the effort needed during the implementation of the idea significantly. The regulatory obligations can range from an important to an almost negligible factor when assessing ideas in an early assessment based on the industry the focal organization is operating in. Still, an evaluation question evaluating this aspect has been added as even in an industry where this aspect normally has little impact, this does not always have to be the case when talking about new digital technologies. The added sub-evaluation question is as follows: *To what extent are extra costs expected in order to comply with regulations?* (*Q25.3*).

The last sub-aspect, *implementation complexity*, refers to the complexity of the implementation itself and therewith extra effort. For example, implementing something in a running organization might prove difficult and may require a lot of effort. For some processes it may be difficult or even impossible to have any downtime at all. Also difficulties may arise using certain technologies in unsuited areas—e.g., poor 4G signal in buildings with a lot of metal in its construction. Elements influencing the implementation complexity, as stated in the DPII-EC framework, are ought to be the 1) *systemic impact*, 2) *system integration*, 3) *scope size*, 4) *technology's adaptation to the organization*, and 5) *organization's adaptation to the technology*.

The first element, the *systemic impact*, refers to the impact the realization of the service-dominant business model design (SD-BMD), and therewith the change to existing- or implementation of new processes, has on other processes in the organization. For this, one can distinguish between ideas which are not or barely affecting other processes, i.e. which are standalone implementable, and ideas which are affecting other processes. If the latter is the case, one needs to take the consequences of the implementation on other processes into account when assessing the realization costs—i.e. the effort required for changes in the other processes. Therefore the sub-evaluation question added to the set of evaluation questions is: *To what extent are there costs expected due to the impact the realization of the SD-BMD has on other processes in the focal organization?* (*Q25.4*).

The second element, the required *system integration*, refers to the integration needed between different systems when realizing the SD-BMD. If the idea involves a certain system, or multiple, to be invoked on for data, there needs to be some integration between these systems. The more systems involved, the more difficult it gets and according to one of the expert interviewees, the effort needed may rise somewhat exponentially. Therefore, the integration between systems needed for the realization of the SD-BMD should be taken into account when evaluating the costs. Therefore the following sub-evaluation question has been added: *To what extent are costs expected due to the need of integration between multiple systems during the realization of the SD-BMD?* (*Q25.5*).

The third element, the *scope size*, refers to the initial size of the idea's scope. Some digital technologies can be used by multiple departments. In a large organization it is easy to include all of these uses in the design because effort can be saved this way as some activities are not performed double. During the interviews, however, it was stated a number times that having too big a scope size can result in having too much people involved, thus creating bureaucracy and slow decision making. This in turn can cause involved people to lose interest. Therefore the scope size of the idea should be evaluated so a change can be made to increase the idea's likeliness of success if needed. Therefore the following sub-evaluation question has been included: *To what extent is decision making made more complicated due to the number of actors involved in the SD-BMD?* (*Q25.6*).

The required *technology's adaptation to the organization* refers to the change or reconfiguration of the new technology to achieve a better fit with the organization. The novelty of the digital technology can play an important role here as effort can be expected for the familiarisation and maybe adaption of the technology when it has not been used by the organization before. When the technology is new to

the industry even more effort needed can be expected since the focal organization is the first to adopt such a technology in the industry. If there are any adaptions needed for the technology to fit the focal industry, they most likely have not been made already. When the technology is new to the world, the effort required to successfully implement a digital process innovation making use of this technology can only be expected to be more. Hence, the addition of the following sub-evaluation question: *To what extent is the digital technology in need of change to fit the organization?* (*Q25.7*).

The required *organization's adaptation to the technology* refers to the change or reconfiguration of the organization to achieve a better fit with the new technology. This element has been divided into two sub-elements in the DPII-EC framework as firstly there can be prerequisites related to the *employees' readiness for change*, e.g., the efforts and costs associated when training is needed. The latter can also be influenced by the demographics of an employee group. When a certain employee group needs to start working with tablets for example, a group consisting of younger employees may require less training than a group consisting of older employees. Secondly there can be prerequisites related to a more organizational perspective—i.e. the *organization's readiness for change*. The infrastructure needed for the smooth operation of the then implemented SD-BMD has been named as one example. For some digital technologies certain infrastructure is needed which may not be present yet. If this is the case, investments are needed to build this infrastructure before the digital technology can be taken into operation. Another point named often during the interviews was the inputs needed for a certain digital process innovation to operate, and more specifically the data needed. When for example an SD-BMD makes use of existing, previously gathered, data to do something new, there can be complications when this data is used for a new goal as the data was not collected with this goal in mind. The quality of the data might be sufficient for its current use but not for the new use. Also there remains the question whether the data is even accessible at all and the effort it costs to make it accessible if this is not the case yet. As all of these named aspects can result in significant costs during the realization of the idea, the readiness for change should be taken into account. All in all, the following two sub-evaluation questions have been added: *To what extent are costs to be expected due to the need to meet unmet prerequisites for the SD-BMD realization?* (*Q25.8*) and *To what extent are there costs to be expected due to employees being unready for the changes occurring when realizing the SD-BMD?* (*Q25.9*).

Suitability:
The *suitability* of a SD-BMD refers to the design's cultural fit with the organization and the extent in which the idea aligns with the direction the organization is planning on going from a more goal oriented and strategical perspective. Two aspects influencing the idea's suitability have been identified, which are the fit with the *organization's strategies & goals* and the *cultural fit*.

The first aspect, namely the fit with the *organization's strategies & goals* concerns the fit the idea has with the organization's strategies and goals. The realization of an idea can contribute to organizational strategies and with this the achievement of organizational goals. The opposite, however, can also be the case as the realization of an idea can also obstruct the achievement of certain organizational goals as the idea may not be in line with organizational strategies. When idea's realization brings forth positive effects with regard to the organization's strategies and goals, acceptance of the idea among organizational members is likely to be greater as the value is directly translatable to the organizational or departmental goals with which everyone is deemed to be familiar with. When the idea's realization has negative effects for the organization's strategies and goals, gaining acceptance for the realization of the idea is likely to be harder. Aside from the acceptance, realizing an idea opposing organizational strategies is a questionable thing to do by itself. Therefore the fit with the *organization's strategies & goals* should be evaluated. The alignment with organizational goals can be evaluated by checking for each goal whether the idea would contribute to or stand in the way of the achievement of this goal, or if it is doing neither.

In order to support this evaluation, an evaluation question has already been stated in Gilsing et al. [2020]. However, in the current research a distinction is made between the satisfaction and hindrance of strategic goals as the first will directly increase the SD-BMD's desirability for realization while the other directly decreases this. Therefore aside from the original evaluation question—*To what extent does the SD-BMD satisfy the strategic goals of each actor?* (*Q26*)—one inverted question has been added as the realization of the SD-BMD can have both positive and negative effects on different strategic goals simultaneously. The added evaluation question is as follows: *To what extent does the SD-BMD conflict with the strategic goals of each actor?* (*Q27).*

The second aspect, namely the *cultural fit* is related to the fit of the SD-BMD with the organizational

culture. Whether the idea is in line with the way employees want to work—i.e. the organization's norms and values. The realization of an idea can bring forth effects not in line with these. During an early version of the artifact design an additional evaluation question was added for the evaluation of this aspect, however, no real value in evaluating this aspect separately was found as feedback on this early version of the artifact stated the aspect was sufficiently captured in Q25. Therefore no additional evaluation question has been added to evaluate this aspect.

Robustness
With the feasibility and viability quality attributes being two distinct attributes focused on whether the model is desirable and achievable, the robustness attribute plays its part alongside those two, relating more to the 'firmness' of the business model and therewith its stability. Three aspects have been linked to the robustness of a SD-BMD, which are 1) *uncertainty*, 2) *applicability*, and 3) *future-proofness*.

As it is important to have an understanding of the uncertainty incurred in the business model design as well as the extent of tolerance for design changes and variations, the first aspect is inherently part of the evaluation questions stated by Gilsing et al. [2020]. The second and third aspect identified are also evaluated when answering the questions stated in Gilsing et al. [2020], although this is done in are more direct way—*Q31* and *Q32* respectively.

With most research regarding the service-dominant (SD) logic being focused on an inter-organizational context, however, the method developed by Gilsing et al. [2020] for the evaluation of SD business models is also more inter-organizational oriented. With the application of the SD Logic on a more internal level of an organization (intra-organizational), the network comprising the business model may include multiple actors from the same, focal, organization. The actors are not likely to be all external to the focal organization, a large part of them may even be more internal of nature. One of the business model evaluation questions provided by Gilsing et al. [2020] seems to be not fully compatible with this change in perspective and therefore the original question—*To what extent can network actors in the SD-BMD be substituted or replaced?*—has been changed to focus on actors having a realistic chance of stopping their participation in the SD-BMD instead of taking all actors into consideration. As most internal actors are, to a high extent, controllable by the focal organization, they are unlikely to stop their participation in the SD-BMD. For example, an IT department ceasing their activities needed for a SD-BMD to be operational when the organization itself has decided to continue, is unrealistic and the chance of it happening negligible. Therefore it is not needed to evaluate whether these can be substituted or replaced, thus saving time and effort. External actors, on the other hand, have a bigger chance of stopping their participation. Thus, the resulting modified question is as follows: *To what extent can network actors, having a realistic chance of stopping their participation in the SD-BMD, be substituted or replaced?* (*Q28*).

Additionally, one of the original evaluation questions—*To what extent are the costs and benefits listed per actor in the SD-BMD subject to risk and uncertainty?*—addresses two aspects—costs and benefits. In order to come to a more detailed evaluation, this evaluation question has been split in two. This way, each question addresses one of the two aspects. This resulted in the substitution of the original question into the following two evaluation questions: *To what extent is the actualization of the expected benefits listed per actor in the BMD subject to risk and uncertainty?* (*Q29*) and *To what extent are the costs listed per actor in the SD-BMD subject to risk and uncertainty?* (*Q30*).

Scoring

Based on the information gained from the evaluation activities, already more information is available when deciding whether to continue with an idea. Further support for this decision making process, however, can still be provided. The decision making process itself, however, can have variations between organizations. Selection can be performed taking a single- or multiple idea's perspective. The former refers to making a decision for a single idea on whether to continue with it, based on some sort of cut-off mechanism taking different aspects into account. When ideas are submitted with a low frequency and resources for realizing ideas being generally sufficient and available, this approach seems valid. This is, however, not always the case and therefore the second possibility is to take a multiple-idea perspective. Ideas can still be let go based on some sort of cut-off mechanism, yet the assumption is made that multiple ideas are deemed desirable after their assessment while not all of them can be realised due to organizational limitations for example—e.g., a limited amount of available resources. In this case a choice has to be made with which to continue at this point in time, i.e. a selection.

To facilitate these different perspectives, the method's main activities are focused on the assessment of individual digital process innovation ideas. This way the organization can already decide whether to continue with an idea or to iterate the assessment activities over other ideas as well before deciding with which ideas to continue. In order to support decision making while still being compliant with both perspectives, the method's activity supporting the eventual selection step is not a selection activity itself but it aims to quantify the evaluation outcome in an understandable manner. By quantifying the evaluation outcome a basis for more objective decision making is provided. The process of quantifying the output of the evaluation activities results in a total score for the business model in question. Therefore the last activity comprising the Evaluation phase is the determination of the business model's 'score'.

As each business model evaluation question is based on a criterion, a Multiple Criteria Decision Analysis (MCDA) can be performed to quantify the summation of responses to these questions. For this analysis two main items are needed for each criterion, namely a rating and a weight. When these two items are known for each criterion the total score can be calculated by taking the summation of each criterion's rating multiplied with its weight.

The first item is gained through the assignment of ratings to each of the business model evaluation question response options. As the business model evaluation question response options are defined in the form of Likert items, adding ratings to these options is very straightforward. Since there are five possible response options, a five point scale is used where the highest number represents the most desirable answer and the lowest number represents the least desirable answer. A scale from zero to four is used for this, which is inverted for the response options of inverted questions.

The second item needed to perform the MCDA is the weight of each criterion. By setting weights for each criterion, a level of importance for these criteria is introduced when calculating the total score. This activity is needed considering organizations are unlikely to deem each criterion equally important to one another. During this thesis, however, no predefined weights are determined as the level of importance of each criterion differs per organization—e.g, based on its goals and culture. Nonetheless, a tool for determining these weights is included—the Analytic Hierarchy Process (AHP) [Saaty, 2008]. In order to determine the the criterion weights, each individual criterion is to be set against all other criteria. With the large number of criteria, however, the number of comparisons to be made becomes unworkable. Therefore the criteria have been grouped based on the quality attributes defined in [Gilsing et al., 2020]. As the questions evaluating the structural validity quality attribute are focused on validating whether the service-dominant (SD) logic principles have been followed in the design and whether the general logic is valid [Gilsing et al., 2020], this quality attribute is, however, not included in the total score calculation. This is because the business model design should be revised when this attribute is insufficient, resulting in no difference between business models with regard to this quality attribute when they enter the scoring activity.

To ensure the possibility of comparing different digital technologies, these weights should not differ per scoring activity. Therefore the weights are to be determined once, when the organization applies the method for the first time. As the organizational goals, culture, and priorities can change over time, the weights should, however, be redetermined periodically—e.g., once every year.

In addition to the aspects incorporated in the idea's score, also the realization time has also been identified as an important aspect to take into account when comparing ideas. Placing a score on this aspect, however, does not make sense as having a relatively long or short realization time can both be experienced positively and negatively dependent on the current portfolio of projects in the pipeline. Having only projects with either a very short or very long realization time in the pipeline may not be desirable. When comparing ideas which are similar in terms of their total score, the decision with which of the two to continue with can depend on their realization time. Therefore, for comparison purposes, a rough estimate of the realization time should be made and included in the decision making process. This decision making process itself, however, is outside of the current research's scope.

Chapter 5

Artifact Demonstration & Evaluation

In this chapter more information regarding the demonstration and evaluation steps of the research process, as stated in chapter 3, is given as well as the results of these steps. First background information concerning the organization in which the demonstration was performed is given. Thereafter the process of demonstrating the developed artifact is described. This is done by describing the execution of the method's activities and their outcomes. Subsequently the artifact evaluation results are stated and the changes made based on these are argued.

As minor improvements were made to the artifact based on the demonstration and evaluation, the demonstrated and evaluated version of the method is not exactly the same as the final method described in the previous chapter. There are three differences: 1) the first activity of the exploration phase has been added as this activity was not explicitly stated before, 2) the business model evaluation question response options have been further elaborated by including Appendix D, and 3) the inclusion of an Excel form which automatically determines the ratings and weights needed to calculate the total score. The demonstrated and evaluated version of the method is from now on referred to as the alpha version of the artifact.

5.1 Organizational Context

MSD Animal Health is a worldwide manufacturer of pharmaceutical products in the animal health industry. In the Netherlands, MSD Animal Health has two sites. One located in Boxmeer and one in De Bilt. In the pharmaceutical industry the site located in Boxmeer is globally the biggest in the development and production of veterinary vaccines and combined with De Bilt, they are home to around 1400 employees. The Dutch sites are part of a global network which is active in more than 150 countries. The global network of both manufacturing and R&D sites are shown in figure 5.1.

MSD Animal Health is currently in the process of setting up a more structured process to handle process innovations leveraging digital technologies. In order to stimulate the realization of profitable projects and try to prevent the realization of unprofitable ones, they are wondering what the selection process of projects should look like. In order to make sure the right projects are selected for further resource investment, the information on which the selection is based must be sound. Therefore, the need for a way of describing and evaluating ideas is existent. As of now, there are people in the organization posting ideas regarding different digital process innovations on a digital platform named 'Idea Hopper', these ideas can be used as input for the innovation process.

Additionally, the organization is facing a problem related to the focus during the process innovation process. It is mainly on the departments of the involved, resulting in little mapping of—and concern for—possible consequences for other departments and the organization as a whole (Silo thinking). A solution which stimulates cross-departmental thinking is desired.

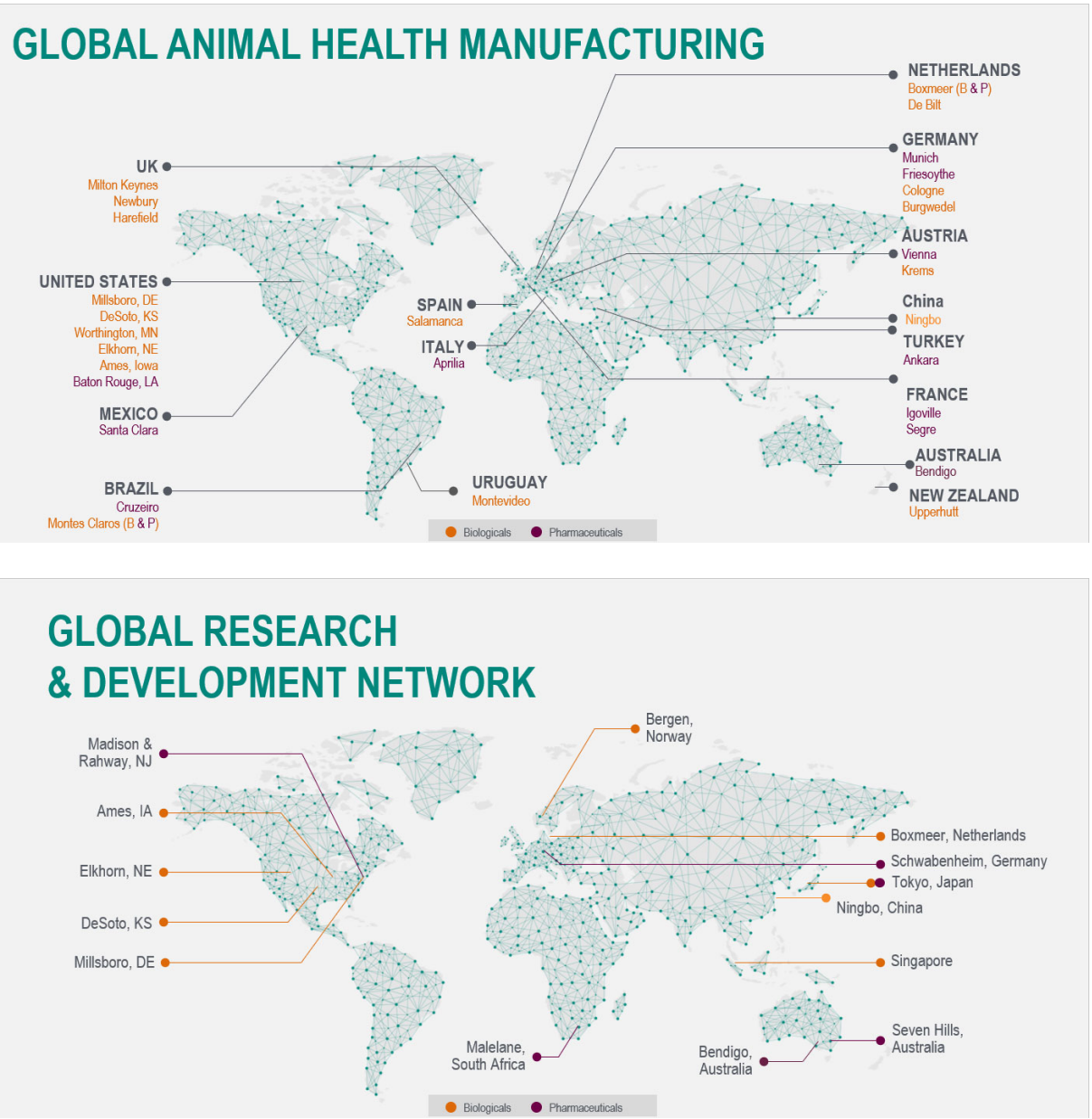

Figure 5.1: MSD Animal Health - Manufacturing and R&D sites

5.2 Application of the Method

For the demonstration of the artifact a real example was used, meaning the the digital technology (DT) as well as the organizational context are not fictitious. The DT used as a starting point was decided to be smart-glasses. As value propositions making use of this DT were already being realized throughout the organization used for the demonstration, and results were promising, a positive evaluation outcome of a value proposition making use of this DT was expected.

Generally a multidisciplinary team comprising of members from different organizational departments is required. This way knowledge is available regarding the departmental processes and possible applications for the DT can be more easily identified. Also during the other activities of the method this specified knowledge is desirable. During the demonstration, however, only a single value proposition (VP) was needed to demonstrate the artifact as a whole. Therefore, it was decided to perform the artifact's demonstration in cooperation with two practitioners. One from an operational department to identify at least one VP and so knowledge is available regarding the context in which that VP is to be realized, and one from the IT department so more specified knowledge is available regarding the implementation of digital technologies. By selecting these two practitioners, both knowledge from a customer's perspective and from an orchestrator's perspective is included. Both of the practitioners had no involvement in the existing smart-glass projects and they were not aware of their progress.

During the demonstration the information required for the execution of the developed method's activities was gained by interviewing these two practitioners twice. These interviews were semi-structured as they were guided by the artifact's activities. During the first interviews information was collected for the execution of the first two phases of the method. Based on the information the Service-Dominant Business Model Radar (SDBM/R) was developed. After this the second interviews were held. During these interviews the required information for the execution of the third phase was collected as the business model evaluation questions were answered. The interview sessions were recorded and listened back to process the activities' results.

The results of the artifact's activities can be found in the next subsections, as well as some initial findings.

5.2.1 Exploration

With the alpha version of the method being demonstrated, the first first activity of the exploration phase was the 'similarity check to already assessed digital technologies (DTs)'. As there are already projects implementing the smart-glasses within the organization, there is a high level of similarity. As the method, however, has not been used in the organization before, only limited information regarding these projects could be used—e.g., how the digital technology was used and in which processes.

The next activity to be performed was the identification of possible value propositions (VPs). This was done by discussing the possible applications of the technology within the Bacto department with an operational manager from this department. During this discussion five VPs were generated. The result is stated in table 5.1.

With the five VPs identified, the next step is to shortly evaluate these to determine whether they are fit for the next phase. For the current demonstration the subsequent phases are performed for a single VP. Together with the operational manager from the Bacto department it was decided the phase three training VP seemed most interesting to further specify at this point, as this was a completely new idea in relation to the smart glasses projects already taking place in the organization. As this single idea was chosen, the VP evaluation activity was performed for with regard to this idea.

The initial value proposition drafted is as follows: '*By having trainees filming their actions via the use of smart glasses during their training (phase 3), trainers can provide better feedback at the end of a long session and the nervousness which trainees experience is lessened*'. Based on this statement the first five value proposition evaluation questions were answered. The result of this is given in table 5.2. As can be seen in this table, the third question was answered negatively as the target customer cannot be easily identified based on this value proposition statement. Therefore the statement was revisited, resulting in the following statement: '*By having trainees filming their actions with smart glasses during their training (phase 3), trainers can provide better feedback to the trainee, at any point in time, and*

Table 5.1: Possible applications for smart glasses in the Bacto department

Application	VP elaboration
Remote Assistance	When something is malfunctioning it is very difficult to explain what and where in the process something is happening. By having operators live-streaming what they see via smart-glasses, the experts asked for assistance are able to ask much more specified questions and can guide the operator through steps to solve the problem as his hands are still free. This way less traveling is required of experts.
Offline instructions	When operators are wearing smart-glasses they can use the display feature to view instructions while their hands remain unoccupied. This way they can check instructional documents—e.g., standard operating procedures—during their activities, saving effort and time.
Process Simulation	During process simulations it is checked whether the process is going according to its validation. During these simulations, at 'filling' for example, two people are constantly watching and recording the process to see if the process executed exactly in alignment with its validation. When using the recording functionality of smart-glasses the operator him/herself can record much to all of the process, thus (partially) removing the need for the other two people. As some simulations can take up to a full day, the time saved is significant.
Incident Investigation	When there is an incident normally a team of four to five persons enter the cleanroom to examine the incident. Enteringthe cleanroom which such a number of people costs a lot of time. By using smart-glasses, part of this team can remain outside and see what the others see inside. Thus, saving time and effort.
Phase three Training	By having trainees filming the actions they perform in an isolator by using smart-glasses during their phase three training in a cleanroom, trainers can provide better feedback at the end of a long session and the nervousness which trainees experience is lessened as the trainer is not standing in their field of view.

the nervousness which trainees experience is lessened. Thus the overall training quality and flexibility of the training schedule goes up, being beneficial to the Bacto department'. The operational manager from the Bacto department stated the department is likely to be highly interested in the idea and there are currently no ongoing or planned changes to the phase three training process. With this information the last three value proposition evaluation questions were answered. The final responses to the value proposition evaluation questions are given in table 5.3.

Table 5.2: Initial response to the value proposition evaluation questions (Q1-Q5)

Label	Evaluation Question	Response
Q1	Is the digital technology explicitly stated in the VP?	Yes
Q3	Is the target customer explicitly stated in the VP?	Yes
Q2	Is the main value generated by using the digital technology explicitly stated in the VP?	No
Q4	Does value generated realistically follow from the use of the digital technology?	Yes
Q5	Is the identified value proposition significantly different from other, already stated, VPs?	Yes

VP stands for Value Proposition

With the target customer likely interested in the phase three training value proposition and no planned or ongoing projects conflicting with the realization of the value proposition, it was decided the value proposition was approved for the contextualization phase of the method.

5.2.2 Contextualization

As stated in the previous subsection, the value proposition used for demonstrating the contextualization phase's activities is the use of smart-glasses during the third training phase of Bacto employees. During the contextualization phase the Service-Dominant Business Model Radar (SDBM/R) is drafted in combination with the 'customer experience'. The result of this phase's activities is a filled radar in combination with a textual description in the form of the 'customer experience'. The radar is stated in figure 5.2. The customer experience is formulated as follows:

The Bacto department needs a new certified employee to perform certain activities in an isolator. In order to achieve this, the Bacto department hires a new employee and enrolls the employee to the training program. In order to become certified, the new employee follows a three-phase training. During the third phase of the training, the trainee is wearing smart glasses when executing the specific tasks, while the

Table 5.3: Final response to the value proposition evaluation questions

Label	Evaluation Question	Response
Q1	Is the digital technology explicitly stated in the VP?	Yes
Q3	Is the target customer explicitly stated in the VP?	Yes
Q2	Is the main value generated by using the digital technology explicitly stated in the VP?	Yes
Q4	Does value generated realistically follow from the use of the digital technology?	Yes
Q5	Is the identified value proposition significantly different from other, already stated, VPs?	Yes
Q6	To what extent is the target customer likely to be interested in the offering?	High
Q7	To what extent does the VP contribute to already planned or ongoing projects?	Very low
Q8*	To what extent does the VP conflict with already planned or ongoing projects?*	Very low

VP stands for Value Proposition
**Inverted Question*

trainer is in a different room. The trainer is watching the trainee's actions closely via the video stream which is recorded from the trainee's point of view. This way the trainer can see all of the trainee's actions clearly as these actions are seen best from this point of view.

After the session is completed, which can take up to 45 minutes, the trainer can provide detailed feedback to the trainee. This is done by showing actual footage of the actions in need of feedback.

The SDBM/R includes seven actors. The targeted customer is the 'Bacto' department, which provides the smart-glasses to the trainees during their phase three training. The orchestrator is the IT department. In the organization this department operates as a sort of contractor which provides the platform with its set-up and contacts the GIO and AMS department regarding the activities they need to perform. The GIO department is responsible for the infrastructure on site and with this, the purchase and installation of both hard- and software. This includes smart-glasses themselves, the platform used, and the wireless network required for operation. AMS is the organizational department responsible for support when problems arise after the smart-glasses have been implemented—i.e. in use. The software and hardware provider is the only external party in the model, and provides the smart-glasses and their software. GIO purchases these components from this actor. The trainer and trainee are the two actors performing the actual training session, where the trainee performs activities and the trainer provides feedback at the end of the session.

5.2.3 Evaluation

With the idea contextualized via the SDBM/R and its corresponding 'customer experience', the last phase of the method was entered. First the model was evaluated based on the evaluation questions. The structural validity evaluation questions were answered first, after which the two earlier mentioned practitioners answered the evaluation questions of the remaining quality attributes—feasibility, viability, and robustness—during two individual meetings. The results are stated in table 5.4, table 5.5, table 5.6, and table 5.7.

Table 5.4: Structural Validity Evaluation Results - Phase 3 Training

Label	Evaluation Question	Response
Q9	Does the SD-BMD consist of at least three actors?	Yes
Q10	Is the customer an explicit actor in the SD-BMD?	Yes
Q11	Does each actor interact with at least one other actor in the SD-BMD?	Yes
Q12	Do all actors in the SD-BMD interact on the same level of hierarchy?	Yes
Q13	Can the value-in-use realistically follow from the set of value propositions?	Yes
Q14	Does the value-in-use address the need of the customer?	Yes
Q15	Does each actor value proposition realistically result from its deployed resources?	Yes
Q16	Does the service enable the value creation process of the customer?	Yes
Q17	Does each actor have at least one cost and one benefit in the SD-BMD?	Yes
Q18	Are all transferred and generated costs and benefits listed in the SD-BMD?	Yes

SD-BMD stands for Service-Dominant Business Model Design

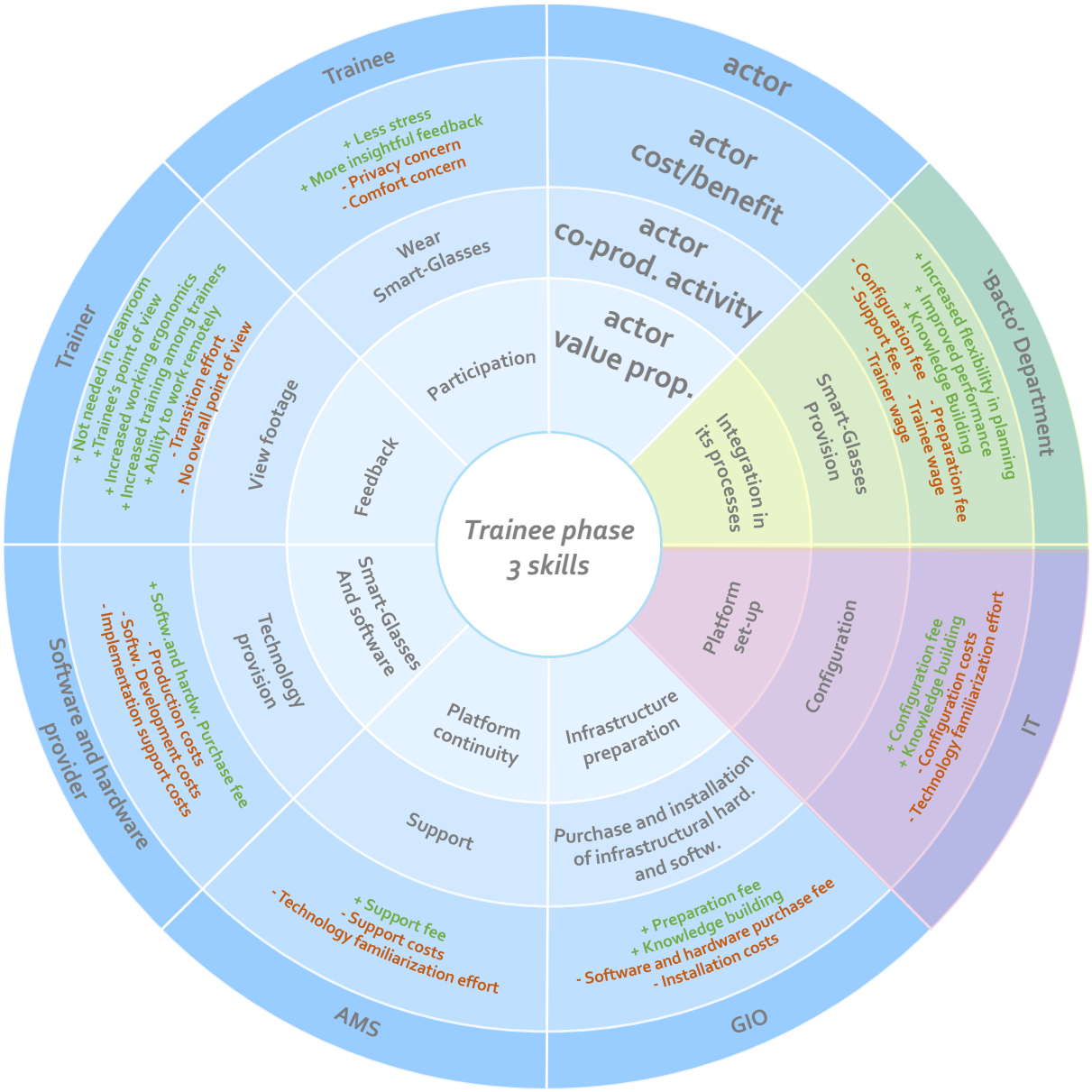

Figure 5.2: SDBM/R - Phase three training at the Bacto department

Table 5.5: Feasibility Evaluation Results - Phase 3 Training

Label	Evaluation Question	Respondent One	Respondent Two
Q19	To what extent does each actor in the SD-BMD currently possess the resources needed to conduct its activities?	High	Very high
Q20	To what extent are these resources available for the realization of the SD-BMD?	Very high	High
Q21	To what extent are communication and resource interfaces present between actors in the SD-BMD?	Moderate	High
Q22*	To what extent do legal and technological barriers exist towards implementation of the SD-BMD?*	Low	Low
Q23	To what extent does trust or cooperation exist between actors in the SD-BMD?	Moderate	High

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Table 5.6: Viability Evaluation Results - Phase 3 Training

Label	Evaluation Question	Respondent One	Respondent Two
Q24	To what extent can the costs and benefits per actor in the SD-BMD be measured or quantified?	Moderate	Moderate
Q25.1	*To what extent are the benefits gained when realizing the SD-BMD related to primary processes?*	*High*	*High*
*Q25.2**	*To what extent is extra effort required by actors using the digital technology?**	*Low*	*Moderate*
*Q25.3**	*To what extent are extra costs expected in order to comply with regulations?**	*Very low*	*Low*
*Q25.4**	*To what extent are there costs expected due to the impact the realization of the SD-BMD has on other processes in the focal organization?**	*Low*	*Low*
*Q25.5**	*To what extent are costs expected due to the need of integration between multiple systems during the realization of the SD-BMD?**	*Low*	*Very Low*
*Q25.6**	*To what extent is decision making made more complicated due to the number of actors involved in the SD-BMD?**	*Moderate*	*Low*
*Q25.7**	*To what extent is the digital technology in need of change to fit the organization?**	*Low*	*Low*
*Q25.8**	*To what extent are costs to be expected due to the need to meet unmet prerequisites for the SD-BMD realization?**	*Very low*	*Low*
*Q25.9**	*To what extent are there costs to be expected due to employees being unready for the changes occurring when realizing the SD-BMD?**	*Very low*	*Low*
Q25	To what extent is the value generated by the benefits per actor compensating for the actor's costs?	High	High
Q26	To what extent does the SD-BMD satisfy the strategic goals of each actor?	High	Moderate
Q27*	To what extent does the SD-BMD conflict with the strategic goals of each actor?*	Low	Low

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Table 5.7: Robustness Evaluation Results - Phase 3 Training

Label	Evaluation Question	Respondent One	Respondent Two
Q28	To what extent can network actors, having a realistic chance of stopping their participation in the SD-BMD, be substituted or replaced?	Low	High
Q29*	To what extent is the actualization of the expected benefits listed per actor in the BMD subject to risk and uncertainty?*	Low	Moderate
Q30*	To what extent are the costs listed per actor in the SD-BMD subject to risk and uncertainty?*	Moderate	Low
Q31	To what extent can the value-in-use of the SD-BMD be offered or catered to different customer segments?	High	Very high
Q32*	To what extent are the actor activities subject to technological or legal developments?*	Low	Low

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Aside from the response to each evaluation question, weights were needed for the calculation of the total score. For the purpose of demonstration the Analytic Hierarchy Process (AHP) was followed once with its required input obtained from the operational manager. As each question is based on a criterion, the AHP's questions are based on these criteria. The questions which the practitioner was asked to answer in order to determine the weights are stated in Appendix F. An overview of the criteria, their corresponding evaluation questions and their calculated weights are given in table 5.8.

Table 5.8: AHP - Criteria and their weights

Evaluation Question	Criterion	Weight
	Feasibility	**0.09**
Q19	Organizational Capabilities	0.21
Q20	Resource Availability	0.11
Q21	Communication and resource interface availability	0.05
Q22	Legal and Technological Barriers	0.57
Q23	Existence of trust or Cooperation between actors	0.05
	Viability	**0.3**
Q24	Quantifiability Costs and Benefits	0.14
Q25	Balance Costs/Benefits	0.08
Q26	Satisfaction of Strategic Goals	0.24
Q27	Conflict with Strategic Goals	0.54
	Robustness	**0.61**
Q28	Replaceability of Actors	0.05
Q29	Risks and Uncertainty related to Benefits	0.09
Q30	Risks and Uncertainty related to Costs	0.16
Q31	Applicability	0.18
Q32	Related Technological or Legal Developments	0.53

Although normally the evaluation questions should be answered once by the team as a whole instead of obtaining separate answers from individual members, for the purpose of demonstration the practitioners were interviewed separately due to the inability to meet given the current corona crisis. Based on the results the total score was calculated by averaging the two practitioner's final score, which resulted in a score of 7.5 on a scale from one to ten.

5.2.4 Findings

During the execution of the developed method's activities no difficulties arose during the first phase. Also no significant difficulties occurred during the design of the service dominant business model design (SD-BMD) and the corresponding 'customer experience', even though the tool used was initially designed for a more inter-organizational context. Also the activities corresponding to the third phase of the developed method, namely evaluation, were performed with no significant problems.

5.3 Evaluation Results

The artifact was evaluated via individual sessions with both experts and practitioners. How this was done and with who is stated in chapter 3, section 3.5. The results of these artifact evaluation interviews are stated in Appendix G.

Taking a look at the artifact evaluation interview results it seems clear each of the participants was rather positive about the method overall. Having analysed the interviews, the main findings are summarized in

the coming subsection, ordered by evaluation criterion. Subsequently the changes made to the artifact based on the findings are argued.

5.3.1 Findings

Efficacy

Overall the interviewees were very positive about the artifact's efficacy. The structure provided stimulates a more fact-based decision process and the traceability is increased as you can always trace back why one idea scores better than the other. It was stated the method "triggers you to take a holistic perspective" [Practitioner 3]. The contextualization phase of the method was stated to be "very valuable" [Practitioner 2] as this ensures the network as a whole is taken into consideration. It was also stated the method "helps to make a lot of intangible things concrete" [Expert 1]. Additionally, the quantified output of the evaluation phase of the method in a familiar form was stated to make decision making "really easy" [Practitioner 1], especially when comparing ideas. All in all, the process being changed or implemented, its context, and the business relevance is clarified so the problem or opportunity being addressed and how this is enabled by the technology becomes evident [Practitioner 4].

On the other hand some concerns were raised. Firstly a type of confirmation bias during the evaluation phase of the method could take form when someone is really convinced of a certain technology, as it was stated that "when you are convinced a certain technology is good, you can work towards a desired evaluation outcome" [Practitioner 3]. Also it was mentioned a couple of times additional demonstrations using different digital technologies are needed to be certain of the method's efficacy.

Clarity & Understandability

The overall clarity and understandability was stated to be ample by most of the respondents. "There is strength in the simplicity of the method" [Practitioner 2]. With regard to the evaluation and scoring phase of the method it was mentioned that the concept of asking questions followed by a scoring is "familiar and therefore easy to understand" [Practitioner 1].

Although it was stated multiple times that the business model evaluation questions can be answered with no problems, it was stated multiple times as well that these questions left a lot of room for individual interpretation. Furthermore, it was stated that additional guidance as to how and when to use the method would be helpful.

Completeness

The method is deemed complete by all interviewees although two of them mentioned additional demonstrations are needed to be certain. One interviewee was wondering, though, whether the user-friendliness of the digital technology is addressed sufficiently. It was stated this would become apparent when the method had been used for a while.

Although the artifact is not seen as incomplete, one interviewee stated that by further specifying the exploration phase of the method by including an activity where the digital technology's functionalities are identified would make it easier to identify the value propositions and compare the technology with already known/existing technologies in the organization [Practitioner 3]. Lastly, one interviewee mentioned it may be interesting to have some sort of reflection at the end of the method where you compare the outcome with what was expected.

Ease of Use & Utility

The ease of use was deemed ample by some, while others had a few remarks. The first remark, stated by three of the interviewees, was that it would be very helpful to have some sort of easy to handle template which automatically calculates the score for the business model evaluation questions. Another remark was that the activities need some understanding at first. Yet as this is a matter of training or practice, which they found normal, this was not seen as a significant concern.

The method is deemed very useful by most interviewees as it supports discussion towards decision making. One interviewee, however, stated the added value of the method is still difficult to determine. It was stated it is difficult to specify the difference with the 'gut' feeling as 'there is not much added value in using the method if the outcome is what is expected every time" [Practitioner 2]. For this difference to become apparent, it was said more demonstrations are needed.

5.3.2 Artifact Changes Based on Findings

During the evaluation of the artifact a number of points of concern or recommendations were stated which have been used for the improvement of the artifact. In the following paragraphs an argumentation is given for each change or addition made to the artifact.

Firstly, an additional activity was defined during the exploration phase. It was decided to explicitly mention an activity for the identification of the specific functionalities of the digital technology (DT). As one needs to know the DT's functionality before possible value propositions can be identified, this activity was already indirectly incorporated in the method. However, by stating it explicitly, it is made sure sufficient attention is paid to this activity. This is important as the outcome of this activity forms the basis on which the value propositions can be identified. Also, insights gained from identifying the functionalities help in identifying seemingly dissimilar yet similar DTs.

Secondly the business model evaluation question response options have been elaborated into more detail—Appendix D—to decrease the complexity of answering them as less room for individual interpretation is available. Also a stronger link between the evaluation questions and the research's context is achieved. The response options, however, have not been quantified. By having quantified response options the respondents are stimulated to think on a higher level of detail which the available information in the early part of the innovation process often does not allow. This would complicate the process of answering the evaluation questions. In addition to this, quantifying the response options removes any room for interpretation, making the method less generalized as the response options would have been catered to the pharmaceutical organization at which this research project was conducted.

The third and last change made based on the artifact evaluation results was the inclusion of a form supporting the evaluation phase of the method. The form has been made in Excel and automatically calculates the ratings and weights needed to calculate the total score, and subsequently calculates this score.

Chapter 6

Discussion & Conclusion

Although a lot of research can be found regarding the front-end of the product innovation process, there is limited research into the front-end activities of the process innovation process. Even less research has been performed into the front-end of the digital process innovation process. With process innovation in general, and the front-end activities of this process more specific, being critical to an organization's competitiveness, a strong need for guidance regarding these activities is present. In order to provide the guidance needed, the level of abstraction should be relatively low. Therefore not the whole front-end of digital process innovation remained in scope and the focus was placed on an initial assessment of digital process innovation ideas. The problem to be addressed was therefore therefore stated to be a lack of guidance regarding the initial assessment of digital process innovation ideas.

In order to provide guidance as to how organizations can assess digital process innovation ideas, a step-wise method is proposed. This method consists of three phases and takes an exploratory approach. The first phase, *exploration*, focuses on further exploring for what additional applications the digital technology stated in the idea can be used. It does so by identifying possible value propositions for the digital technology. This way, during eventual decision making, all of the possible applications of a digital technology can be taken into consideration to come to more optimal decision making from a portfolio perspective. The second phase *contextualization*, focuses on placing the value propositions—i.e. ideas—into their context. By using business models, the ideas are described in a comprehensive manner. The last phase focuses on evaluating the described ideas and presenting the results in a easy to interpret manner. By following the method's activities, the foundation is laid for an informed decision making process on with which ideas to continue.

After having developed the method, it was applied within a pharmaceutical organization by using a real digital technology. The method was then evaluated by interviewing experts and practitioners. As a result of the evaluation, it was found the method provides structure and stimulates a fact-based decision making process in a comprehensive way. Therewith, the method offers, to my knowledge, the first guidance on how digital process innovation ideas can be described and evaluated, based on which an initial selection can be made.

During the artifact evaluation interviews the method was stated to trigger a holistic perspective. Also the contextualization phase in particular was stated to be very valuable as it stimulates the users to think in a more networked perspective. Therefore the method facilitates its users in the consideration of the value network as a whole when the potential value of realizing an idea is determined. Based on prior research, this was stated to be an important objective in chapter 1. By providing a step-wise method of which two phases are dedicated to the description and evaluation of ideas, making use of service-dominant (SD) tools, the main research goal—being the development of a method which supports the process of describing and evaluating digital process innovation ideas while stimulating SD thinking throughout this process—is also achieved. More importantly, however, is what can be achieved when applying this method—i.e. whether the problem stated is actually addressed. By providing a step-wise method for the assessment of digital process innovation ideas, the decision process becomes more fact based as the process being changed or implemented, its context, and the business relevance is clarified. Therefore, the selection of ideas is facilitated to be on a more informed base. Ultimately this is likely to lead to an increase in the success rate of digital process innovation implementations as less unprofitable- and more

profitable projects are realized.

6.1 Implications

With only little known regarding the early phases of the process innovation process making use of digital technologies, this thesis provides a basis for researchers to build upon via further research in the same context or related ones. Researchers can use this thesis to provide further guidance regarding digital process innovation in general as a number of the identified important aspects may not only be important during an initial assessment of ideas but also later in the process. Lastly, by adapting or adopting components of the developed method in their own research, researchers can develop methods, or other forms of guidance, with regard to the early phases of other types of process innovation processes rather than solely in the field of digital process innovation.

Additionally, tools which are not specifically designed for- and have not yet been applied in an intra-organizational context are incorporated in the method. They have also not been applied in the specific context of digital process innovation ideas before. To be more specific, it was decided to use business models to represent ideas, which is a relatively new use of them. The tool incorporated in the method for the design of the business model has not been used to describe process innovation ideas before. During the artifact demonstration and evaluation, however, it was found the service-dominant business model radar can definitely be used in the current research context as the artifact evaluation interviews revealed it provides a holistic perspective which was thought to be very valuable. The descriptive power of business models may therefore also benefit an intra-organizational context. The tool used for the evaluation of the designed business models, however, would not fully fit the current research's context in its original form. Yet, after some additions and adaptations were made, this tool was also found useful in the current context. Therefore, this research provides a basis for other researches who want to use service-dominant business modelling related tools in the context of idea description and evaluation.

Altogether, a comprehensive way of describing and evaluating digital process innovation ideas is provided in this thesis. With digital process innovations being crucial to organizations in their ability to remain, and become even more, competitive, organizations can use these findings to further structure their processes as to how to deal with the incoming flow of these innovative ideas. The findings may be especially beneficial to organizations where the initial selection process of ideas is still very unstructured while many ideas are generated and collected. Here, a more fact-based decision making state is achieved. Therefore organizations have better insights as to which ideas are potentially valuable and which are not. It is likely this will induce financial benefits later on as potentially more valuable ideas can be prioritized.

6.2 Limitations and Future Research

The first limitation concerns the relative newness of the research topic. There is still little to be found in prior research regarding the front-end of the digital process innovation process, let alone a link between this and the service-dominant (SD) logic. Therefore the fields of process and product innovation were further examined at first while trying to dig deeper into the field of process innovation. However, no specific information on how digital process innovation ideas could best be described and evaluated was found and information of how the SD logic would play part in these processes neither. Therefore the design of the artifact was based on prior research considered relevant for to the current context while no indisputable connection was at hand. Although the artifact evaluation results are positive, there is no guarantee the designed artifact is the best way of achieving the research's objective.

Since the demonstration of the artifact was only performed with one idea, the second limitation refers to the number of ideas used for demonstration. It is hard for the experts and practitioners to evaluate these criteria when they have not seen the artifact's use in different settings. Also the interpretation of the eventual score remains questionable as there are more demonstrations required to determine which score range is desirable. Additionally, although the artifact evaluation was performed making use of multiple experts and a number of practitioners, it is hard for them to evaluate the usefulness and completeness when they have not seen the artifact's use in different settings. Thus, more ground for claims made regarding the artifact's usefulness and completeness would be available when it is applied to different

types of process innovation ideas.

The third limitation is also related to the demonstration of the artifact. The demonstration was performed in cooperation with two practitioners, which were contacted individually instead of having the artifact's activities performed by a multidisciplinary team. Therefore it could not be observed whether such a team would easily come to a consensus regarding the business model design decisions and the business model evaluation question responses.

The fourth limitation is that the artifact was designed based on the design objective and input from the pharmaceutical organization by which request this thesis was conducted. Although the artifact was designed to be as generic as possible, the artifact was still formed by a significant amount of the input from this organization. As the demonstration was also performed with employees from this organization, there is no direct evidence the artifact can be used by organizations in different industries.

Although the artifact design is based to large extent on prior research, the last (fifth) limitation refers to the use of qualitative interviews for the extension of certain components. By using qualitative interviews subjectivity is introduced. In addition to this interviewees can differ significantly character-wise as some can respond very outspoken while others tend to be more modest. This could have resulted in a bias when analysing the interviews as more emphasis may have been placed on the aspects mentioned by the more outspoken interviewees. By interviewing a large number of people this bias is reduced and although twelve people have been interviewed for the artifact design, still some level of bias could have occurred.

There are a couple of ways future research could address these limitations. Firstly, when more research is available on the frond-end of digital process innovation as well as on the use of SD logic in the current context, future work could re-validate the design decisions made during this research. This way it can be determined whether the current artifact is still sufficient, whether the artifact should be revised, or whether a new artifact should be developed.

Secondly, by applying the artifact in other organizations and in other industries, future research could address the second, third, and fourth limitation simultaneously as the artifact's design in general as well its usefulness and completeness can then further validated. Also the fifth limitation can then indirectly be addressed as the criteria used for evaluation are also further validated. Another way of addressing the fifth limitation would be to directly validate the criteria addressed by the method by performing a more quantitative form of research on this subject.

Additionally, as many of the additions made to the service-dominant business model evaluation method seem rather general, it is possible that parts of the artifact can be used for other types of process innovation ideas than solely digital ones. By applying the artifact to different types of process innovation ideas it can be confirmed whether the description and evaluation of other types of ideas are also supported. If this is the case, the artifact's usefulness is further increased.

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Appendices

Appendix A

Service Dominant Business Model Evaluation Questions

The evaluation questions as provided by the method stated in Gilsing et al. [2020, p. 8, 9, 10] are given in table A.1, A.2, A.3, and A.4 for the quality attributes *structural validity*, *feasibility*, *viability*, and *robustness* respectively.

Table A.1: Business model structural validity evaluation questions

Evaluation Question	Response	
BM Component - Value Network:		
Does the SD-BMD consist of at least three actors?	No	Yes
Is the customer an explicit actor in the SD-BMD?	No	Yes
Does each actor interact with at least one other actor in the SD-BMD?	No	Yes
Do all actors in the SD-BMD interact on the same level of hierarchy?	No	Yes
BM Component - Value Proposition:		
Can the value-in-use realistically follow from the set of value propositions?	No	Yes
Does the value-in-use address the need of the customer?	No	Yes
BM Component - Value Architecture:		
Does each actor value proposition realistically result from its deployed resources?	No	Yes
Does the service enable the value creation process of the customer?	No	Yes
BM Component - Value Capture:		
Does each actor have at least one cost and one benefit in the SD-BMD?	No	Yes
Are all transferred and generated costs and benefits listed in the SD-BMD?	No	Yes

SD-BMD stands for Service-Dominant Business Model Design

Table A.2: Original Business Model Feasibility Evaluation Questions

Evaluation Question	Response				
To what extent does each actor in the SD-BMD have access to resources needed to conduct its activities?	Very low	Low	Moderate	High	Very high
To what extent are communication and resource interfaces present between actors in the SD-BMD?	Very low	Low	Moderate	High	Very high
To what extent do legal and technological barriers exist towards implementation of the SD-BMD?*	Very low	Low	Moderate	High	Very high
To what extent does trust or cooperation exist between actors in the SD-BMD?	Very low	Low	Moderate	High	Very high

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Table A.3: Original Business Model Viability Evaluation Questions

Evaluation Question	**Response**				
To what extent can the costs and benefits per actor in the SD-BMD be measured or quantified?	Very low	Low	Moderate	High	Very high
To what extent can the costs and benefits per actor in the SD-BMD realistically be balanced?	Very low	Low	Moderate	High	Very high
To what extent does the SD-BMD satisfy the strategic goals of each actor?	Very low	Low	Moderate	High	Very high

SD-BMD stands for Service-Dominant Business Model Design

Table A.4: Original Business Model Robustness Evaluation Questions

Evaluation Question	**Response**				
BM Component - Value Network:					
To what extent can network actors in the SD-BMD be substituted or replaced?	Very low	Low	Moderate	High	Very high
BM Component - Value Capture:					
To what extent are the costs and benefits listed per actor in the BMD subject to risk and uncertainty?*	Very low	Low	Moderate	High	Very high
BM Component - Value Proposition:					
To what extent can value-in-use of the SD-BMD be offered or catered to different customer segments?	Very low	Low	Moderate	High	Very high
BM Component - Value Architecture:					
To what extent are the actor activities subject to technological or legal developments?*	Very low	Low	Moderate	High	Very high

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Appendix B

Interview Results - Challenges, Aspects, and Knowledge Type

As stated in subsection 3.3 there were three main subjects covered during the interviews. These subjects are 1) the main *challenges* of realizing digital process innovation ideas, 2) the *aspects* thought to be most important when assessing digital process innovation ideas, and 3) the *knowledge types* or *organizational roles* thought to be most important to have present when assessing these ideas. The processed interviews are stated in table B.1, B.2, and B.3 for each of these subjects respectively.

Table B.1: Interview Results: Challenges

Code	Description	# of mentions
Knowledge	It can be a challenge to obtain sufficient knowledge regarding new technologies. This may be due to the lack of experience with them. When there is not sufficient knowledge available it is often questionable how well the determinations are made regarding what is needed for the realization of an innovation. Also the acceptance of the idea can be challenged. An example given during the interviews was that the insufficient knowledge on how to validate digital process innovations would result in some initial resistance from the quality department when new ideas are brought up for discussion. Also, generally people underestimate the needed change and therewith effort to fully incorporate a new technology in an organization. As more effort is needed realizing the idea, the costs become higher than expected	7
Mindset	Gaining leadership support and acceptance was also mentioned as a challenge due to the inability to specify with certainty the value gained and costs incurred from investing in a certain digital process innovation. This is stated to be mostly because of the mindset and culture within the organization and is seen as a barrier to innovation.	3
Network of Actors	Also the difficulty in getting the acceptance needed from the required actors in order to achieve a successful realization of an idea was mentioned as a challenge. Having numerous actors throughout the value network, each of them can have different reasons to support or oppose the idea. Gaining support can be challenging when these reasons are not balanced out. These actors might, however, not see the full potential value something can bring and may see potential costs higher than what they are likely to be, resulting in a biased view of the idea, making the challenge to gain support even greater. Challenges can also arise when there are employees specialized in a certain way and the change leads to this specialization to be redundant. As a result of this the change could feel threatening to employees as they are afraid to lose their jobs. Also employees may prefer not implementing the change as they would need to retrain themselves. It was stated that people could bring forth false arguments during the initial stages to oppose the idea in the hope of preventing the change from happening.	3
Benefits	Not having a clear process with guidelines to follow makes it challenging to stop the realization of a 'cool' technology when this is done for the sake of the technology itself—e.g., you have heard of this cool technology/solution and a problem is sought for it without really considering whether this is a problem actually worth solving.	3

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Table B.1 – *Continued from previous page*

Code	Description	# of mentions
Scope Size	Sometimes it can be difficult to prevent the idea's scope from getting to wide in a large organization. If the scope gets too wide—e.g., the digital process innovation is going to be designed for the implementation in multiple parts of the organization—a large number of people get involved with the project, making it harder to move forward and to make adjustments as everybody needs to have their say about it.	2
Knowledge Exchange	In large organizations with multiple sites and offices on different locations, it can be challenging to keep track of all projects being done. As example it was stated that a lot of issues arose when realizing an idea to start the use of digital tier boards instead of doing everything on paper. This while the organization was already having fully functional digital tier meetings at another site. Sharing knowledge regarding these digital tier meetings would probably have prevented issues and therewith saved some effort.	1
Preparation	It can also be challenging to be sufficiently prepared before testing a new technology or digital process innovation. Having prepared proper use cases was mentioned in particular. When problems occur due to insufficient preparation it was stated that support for the idea would often diminish fast as peoples' impression of the new digital technology becomes biased. They are likely to blame the new technology instead of the poor preparation.	1
Organization's Readiness for Change	Sorting out the basis is often something that can be forgotten. If you build on something chaotic, chaos only increases.	1
Resource Availability	As everybody in the organization is always doing something—i.e. is very busy—the first response when asked for the possibility of something is often:"oh, that is going to be difficult".	1

Table B.2: Interview Results: Aspects

Code	Description	# of mentions
Systemic Impact	The impact the realization of the idea has on other processes in the organization apart from the process to be changed or implemented.	9
Organization's Readiness for Change	Are there prerequisites to be met before the idea can be realized? E.g., is the required data available and accessible? Is the required infrastructure in place?	8
Organizational Strategy & Goals	Whether the idea is contributing to or conflicting with the achievement of organizational strategies and goals.	7
Benefits linked to the business	To what extent the benefits are linked to the primary business activities.	6
Implementation effort / costs	The effort and therewith costs it will take to implement the new process or change the existing process.	6
Benefits	The value the realization of the idea is likely to bring.	5
Costs versus Benefits	The total expected costs relative to the total value generated.	5
Novelty	The extent to which the digital process innovation has already been applied elsewhere. Whether it is new to the world, industry or organization.	5
Realization time	The expected time it takes for the idea to be realized.	5
System Integration	The extent to which multiple systems are in need of integration during the realization of the idea.	4
Costs due to regulations	The extra effort needed to realize the idea due to regulatory factors.	3
Feasibility due to regulations	Whether the idea is feasible from a regulatory perspective.	3
Payback Time	The expected time it takes for the financial investment to be earned back.	3
Resource Availability	The extent to which the organizational capabilities are actually available for the realization of the idea.	3

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Table B.2 – *Continued from previous page*

Code	Description	# of mentions
Scope Size	The initial size of the idea's scope. How much use cases are to be incorporated in the design. According to the interviewees this should not be too big.	3
Applicability	The extent to which the new digital technology can be used/deployed in different parts of the organization	2
Future-proofness	The extent to which the change fits in the expected future environment in terms of maintainability and adaptability.	2
Implementation complexity	The complexity of the implementation itself. E.g., if a to be changed process is not allowed to be shut down, or only for a very short time period, it can become very complex to implement the change.	3
Interference with planned projects	The extent to which ideas conflict with or are beneficial to already planned or ongoing projects	2
Likeliness of acceptance	The extent to which resistance is expected.	2
Organizational Capabilities	The extent to which the organization has the knowledge, people, and materials to realize the idea	2
User-Friendliness	The extent to which the new digital technology is easy to use by the eventual user.	2
Cultural Fit	The extent to which the needed change fits with the corporate culture.	1
Employees' readiness for change	The extent to which employees are ready for the change. Are they in need of training? Demographics can play a role as well.	1
Realization Benefits	Benefits linked explicitly to the realization process of the idea.	1
Return on investment	The amount of return on the investment needed for the realization of the idea.	1
Safety	The safety impact incurred.	1
Uncertainty	The extent of uncertainty per assessed aspect	1

Table B.3: Interview Results: Knowledge Types

Code	Description	# of mentions
Multidisciplinary	The team composition of the people performing the assessment should be multidisciplinary. As nowadays IT is very complex it was stated not only knowledge in this field is sufficient anymore. It was stated the assessment of ideas should be performed by multiple people of different organizational backgrounds so knowledge from the different fields involved is at hand.	4
Operations	The insights people from operational departments introduce to the team will help in the identification of applications of the digital technologies. Also they ensure not only wild ideas are chosen which provide no real value to the business. Process owners as well as subject matter experts were named as possible team members.	3
Affinity for innovations	Having someone with general knowledge of and interest in innovation is desirable as others are likely to be very knowledgeable in their specific field but may initially lack the capabilities required for assessing innovations.	2
Mandate	It is of importance that the team has sufficient mandate so they can actually make the decision whether to continue with an idea or not. If the team does not have the freedom to make choices and experiment, decision making will be slow and the innovativeness will decrease. One practitioner stated this decision should not be made by the person who had the initial idea, as he/she might be biased.	2
Not from finance	As the amount of financial uncertainty regarding the ideas is likely to be very high this early in the innovation process, negative effects may arise having someone specifically from the finance department in the team as he/she may want to quantify the costs and benefits too much. Also it was stated once that if someone from finance recently received poor financial numbers he/she may be influenced by this in decision making.	2

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Table B.3 – *Continued from previous page*

Code	Description	# of mentions
Not from the shop-floor	People from the shop-floor could be consulted for different kinds of information as these are the people going to work with the digital process innovation, however they should not be included in the evaluation and decision making process itself.	2
Operational Excellence	As innovations can play an important part in reaching the organization's goals, someone from operational excellence should be included as he/she has the knowledge and means to check whether ideas are in line with the strategy and goals.	2
Quality	Including someone from the quality department will ensure the required knowledge is available for estimating end product changes and other quality related aspects.	1
Value-location dependent	The type of people, and therewith knowledge, which should be included in the assessment of digital process innovation ideas is dependent mostly on the value of the idea. More specifically, based on the location of this value. For example, when the value generated only occurs at a specific process of the focal organization, the people included should be limited to the department where the targeted process is located. When the change or implementation of a process generates value for the focal organization's customer, it can be wise to include the marketing & sales department. When there is a relation to the product itself, it can be wise to involve R&D. And so forth.	1

Appendix C

Method's Trigger Instances

The method's activities can be initiated in numerous ways. This is dependent on the organization itself, as the way the ideation phase of the innovation process, preceding the method's activities, can be organized in different ways. One example could be using a online platform for idea collection. This way a notification can be generated when a defined minimum number of ideas are collected to trigger the start of the the process. Another example could be to have a time-triggered start and having some sort of 'innovation board' coming together periodically, discussing the ideas generated in the time between these sessions. The exact way as to how the process, which is supported by the method, is triggered does not matter for the general line of activities.

Appendix D

BM Evaluation Response Options

In this appendix the business model evaluation questions response options are further elaborated. The response option elaboration for the feasibility, viability, and robustness evaluation questions can be found in table D.1, D.2, and D.3 respectively.

Table D.1: Feasibility Response Options

Evaluation Question	Very low	Low	Moderate	High	Very High
Q19	The actors possess very few to none of the resources required. It is very difficult to obtain the missing resources.	The actors possess some of the resources required. The missing resources are difficult to obtain.	The actors possess most of the resources required and the missing resources are difficult to obtain, or the actors the actors possess some of the resources required and the missing resources are easily obtained.	The actors possess most of the resources required. The missing resources are easily obtained	The actors possess almost all to all of the resources required. The missing resources are very easily obtained.
Q20	Very few to none of the resources required are available for the realization of the SD-BMD. The required ones which are not available are very difficult to relocate to make the realization possible.	Some of the resources required are available for the realization of the SD-BMD. The missing resources are difficult to relocate to make the realization possible.	Most of the resources required are available for the realization of the SD-BMD and the missing resources are difficult to relocate to make the realization possible, or some of the resources required are available for the realization of the SD-BMD and the missing resources are easily relocated to make the realization possible.	Most of the resources required are available for the realization of the SD-BMD. The missing resources are easily relocated to make the realization possible	Almost all to all of the resources required are available for the realization of the SD-BMD. The missing resources are very easily relocated to make the realization possible.
Q21	There are very few to none of the required communication and resource interfaces present between actors in the SD-BMD. The missing interfaces are very difficult to establish.	Some of the required communication and resource interfaces are present. The missing interfaces are difficult to establish.	Most of the required communication and resource interfaces are present and the missing interfaces are difficult to establish, or some of the required resource interfaces are present and the missing ones are easy to establish.	Most of the required communication and resource interfaces are present. The missing interface are easy to establish.	Almost all or all of the required communication and resource interfaces are present. The missing interfaces are very easy to establish.
Q22*	There are very little to none legal and/or technological barriers expected.	There are little legal and/or technological barriers expected.	There is a significant effort expected to be needed in order to overcome legal and/or technological barriers.	There is very much effort expected to be needed in order to overcome legal and/or technological barriers.	The SD-BMD is deemed very difficult or nearly impossible to be realized due to technological or legal barriers.
Q23	There is very little to no trust and cooperation between actors which are required to interact. They have very little to no understanding of each other's operations.	There is little trust and cooperation between actors which are required to interact. Little understanding of each other's operations is present.	There is a significant amount of trust and cooperation between actors which are required to interact and some understanding of each other's operations is present.	There is a lot of trust and cooperation between actors which are required to interact. Some understanding of each other's operations is present.	There is a lot of trust and cooperation between actors which are required to interact. Each other's operations are understood well.

SD-BMD stands for Service-Dominant Business Model Design
**Inverted Question*

Table D.2: Viability Response Options

Evaluation Question	Very low	Low	Moderate	High	Very High
Q24	Nearly none to none of the costs and benefits can be quantified.	Very few of the costs and benefits can be quantified.	A significant number of the costs and benefits can be quantified	Most of the costs and benefits can be quantified.	Almost all to all of the costs and benefits can be quantified.
Q25*	The value generated by the benefits is expected to be similar to the costs to be incurred.	The value generated by the benefits is expected to be slightly more than the costs to be incurred.	The value generated by the benefits is expected to be significantly more than the costs to be incurred.	The value generated by the benefits is expected to be much more than the costs to be incurred.	The value generated by the benefits is expected to be extremely much more than the costs incurred.
Q26*	There are no strategic goals of which the achievement is being supported by realizing the SD-BMD.	There are very few strategic goals of which the achievement is being supported by realizing the SD-BMD.	There is a significant number of strategic goals of which the achievement is being supported by realizing the SD-BMD.	Most of the strategic goals are supported in their achievement by realizing the SD-BMD.	Almost all to all of the strategic goals are supported in their achievement by realizing the SD-BMD.
Q27*	There are no strategic goals obstructed in their achievement by realizing the SD-BMD.	There are very few strategic goals obstructed in their achievement by realizing the SD-BMD.	There is a significant number of strategic goals obstructed in their achievement by realizing the SD-BMD.	Most of the strategic goals are obstructed in their achievement by realizing the SD-BMD.	Almost all to all of the strategic goals are obstructed in their achievement by realizing the SD-BMD.

Table D.3: Robustness Response Options

Evaluation Question	Very low	Low	Moderate	High	Very High
Q28	Most of the actors can stop their involvement and are all very difficult to replace.	Most of the actors can stop their involvement and most of them are difficult to replace	Most of the actors can stop their involvement and most of them are easy to replace, or few actors can stop their involvement yet most of them are difficult to replace.	Few of the actors can stop their involvement and most of them are easy to replace.	There are no actors realistically stopping their involvement or all of them are very easy to replace.
Q29*	Almost all to All of the benefits are likely to be realized.	Most of the benefits are likely to be realized.	A significant number of benefits are likely to be realized.	Most of the benefits are unlikely to be realized.	Most to all of the benefits are very unlikely to be realized.
Q30*	It is certain the estimated cost turn out to be the eventual costs.	It is almost certain the estimated cost turn out to be the eventual costs. quite difficult to say whether the estimated cost turn out to be the eventual costs.	It is difficult to say whether the estimated cost turn out to be the eventual costs.	It is very difficult to say whether the estimated cost turn out to be the eventual costs.	It is impossible to say whether the estimated cost turn out to be the eventual costs.
Q31	It is not possible to implement the model in other parts of the organization as it is very specialized.	It is difficult to apply the model in other parts of the organization as there simply are not many possibilities or it will require significant changes to the model.	It is doable to apply the model in other parts of the organization as there are some possibilities and the changes required to the model are not to great.	There is a significant number of possibilities to apply the model without having to change the model significantly.	It is very easy to apply the model elsewhere as there are many possibilities and very little change to the model is required.
Q32*	There are no legal or technological developments endangering the actor activities.	There are a few activities subject to technological or legal developments, bringing some risks to the continuity of these activities.	There is a significant number of activities subject to technological or legal developments, bringing some risks to the continuity of these activities.	There are a lot of activities subject to technological or legal developments, bringing risks to the continuity of these activities.	Most of the activities are subject to technological or legal developments, bringing high risks to the continuity of these activities.

Appendix E

Evaluation Questions Response Scores

Evaluation Question	Response				
	Feasibility:				
Q19	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q20	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q21	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q22*	Very low *5*	Low *4*	Moderate *3*	High *2*	Very high *1*
Q23	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
	Viability:				
Q24	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q25	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q26	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q27*	Very low *5*	Low *4*	Moderate *3*	High *2*	Very high *1*
	Robustness:				
Q28	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q29*	Very low *5*	Low *4*	Moderate *3*	High *2*	Very high *1*
Q30*	Very low *5*	Low *4*	Moderate *3*	High *2*	Very high *1*
Q31	Very low *1*	Low *2*	Moderate *3*	High *4*	Very high *5*
Q32*	Very low *5*	Low *4*	Moderate *3*	High *2*	Very high *1*

**Inverted Question*

Appendix F

Analytic Hierarchy Process Questions

In this appendix first the Analytic Hierarchy Process (AHP) questions are stated after which each criterion is elaborated as well as the response options.

F.1 Feasibility

Resource Possession									Resource Availability							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Resource Possession									Communication and Resource interface availability							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Resource Possession									Legal and Technological Barriers							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Resource Possession									Existence of trust or Cooperation between actors							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Resource Availability									Communication and Resource interface availability							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Resource Availability									Legal and Technological Barriers							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Resource Availability									Existence of trust or Cooperation between actors							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Communication and Resource interface availability									Legal and Technological Barriers							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Communication and Resource interface availability									Existence of trust or Cooperation between actors							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Legal and Technological Barriers									Existence of trust or Cooperation between actors							
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9

F.2 Viability

Quantifiability Costs and Benefits											Balance Costs/Benefits					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Quantifiability Costs and Benefits											Satisfaction of Strategic Goals					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Quantifiability Costs and Benefits											Conflict with Strategic Goals					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Balance Costs/Benefits											Satisfaction of Strategic Goals					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Balance Costs/Benefits											Conflict with Strategic Goals					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Satisfaction of Strategic Goals											Conflict with Strategic Goals					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9

F.3 Robustness

Replaceability of Actors											Risk and Uncertainty related to Benefits					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Replaceability of Actors											Risk and Uncertainty related to Costs					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Replaceability of Actors											Applicability					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Replaceability of Actors											Related Technological or Legal Developments					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Risk and Uncertainty related to Benefits											Risk and Uncertainty related to Costs					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Risk and Uncertainty related to Benefits											Applicability					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Risk and Uncertainty related to Benefits											Related Technological or Legal Developments					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Risk and Uncertainty related to Costs											Applicability					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Risk and Uncertainty related to Costs											Related Technological or Legal Developments					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
Applicability											Related Technological or Legal Developments					
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9

F.4 Feasibility vs Viability vs Robustness

			Feasibility										Viability			
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
			Feasibility										Robustness			
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9
			Viability										Robustness			
9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9

F.5 Criterion Explanation

Criterion	**Explanation**
Feasibility	The feasibility of the digital process innovation. Whether the realization is regarded as attainable.
Resource Possession	The extent to which the actor in question has the required knowledge, people, and materials to realize their part of the SD-BMD.
Resource Availability	The extent to which the above-mentioned capabilities are actually available for the realization of the SD-BMD.
Communication and Resource Interface Availability	The extent to which interactions and relationships between actors in the SD- BMD are already available or otherwise easily established.
Legal and Technological Barriers	The extent to which legal or technological barriers to realization exist.
Existence of Trust and Cooperation between Actors	The extent to which trust or cooperation exists between different actors.
Viability	The extent to which the SD-BMD is desirable and its ability to be implemented correctly.
Quantifiability Costs and Benefits	The extent to which the costs and benefits are quantifiable.
Balacne Costs/Benefits	The extent to which the costs and benefits can be balanced and are not negative.
Satisfaction of Strategic Goals	The extent to which the realization of the SD-BMD will contribute to strategic goals.
Conflict with Strategic Goals	The extent to which the realization of the SD-BMD will conflict with strategic goals.
Robustness	The 'firmness' and stability of the SD-BMD.
Replaceability of Actors	The extent to which actors, having a realistic chance of stopping their participation, can easily be replaced or substituted.
Risk and Uncertainty related to Benefits	The extent to which the expected benefits are subject to risk and uncertainty.
Risk and Uncertain related to Costs	The extent to which the expected costs are subject to risk and uncertainty.
Applicability	The extent to which the idea is applicable in other parts of the organization.
Related Technological or Legal Developments	The extent to which the activities performed by the actors are subject to technological or legal developments.

SD-BMD stands for Service-Dominant Business Model Design

F.6 Response Option Explanation

Intensity of Imortance	Definition	Explanation
1	Equal Importance	The criterion is equally important
3	Moderate Importance	The criterion is slightly more important than the other.
5	Strong Importance	The criterion is significantly more important than the other.
7	Very Strong Importance	The criterion is much more important than the other.
9	Extreme Importance	The criterion is extremely more important than the other.

Saaty [2008]

Appendix G

Artifact Evaluation Interview Results

In this appendix the evaluation results regarging efficacy, clarity & understandability, completeness, and usefulness & ease of use are stated in table G.1, G.2, G.3, and G.4 respectively.

Table G.1: Evaluation Results related to Efficacy

Respondent	Statement
Practitioner 1	Nice to have a quantified output on a familiar scale instead of terms like 'potential' and 'probably'. Because of this the method certainly succeeds in supporting decision making.
Practitioner 1	When comparing ideas, decision making is made really easy. Especially when a group of people need to decide. The scoring makes it easier to take the next step.
Practitioner 2	I think the efficacy is good because the method is structured. You can always trace back why one idea scores better than the other.
Practitioner 2	Because the decision process becomes more fact based I think it is very effective.
Practitioner 2	The contextualization phase ofthe method is very valuable as you are looking at the network as a whole.
Practitioner 3	The method triggers you to take a holistic perspective. Not just solely from the benefits or the eventual user but an integral perspective from multiple aspects. You also work towards a decision in a structured way. Therefore I think the method can definitely be effective.
Practitioner 3	There can be a form of confirmation bias. When you are convinced a certain technology is good, you can work towards a desired evaluation outcome.
Practitioner 4	The structure provided by the method can help very well in clarifying the process and its context, as well as the business relevance so you know which problem is being solved and how the technology helps in solving this problem. Therefore I think it will most certainly help.
Expert 1	With this method you can come to something reasonably concrete from a fairly general starting point.
Expert 1	It helps to make a lot of intangible things concrete. In that sense I think it is an interesting method.
Expert 1	The value of the score is more apparent when multiple ideas are set aside each other for comparison purposes.
Expert 2	I think the efficacy is good, however you really know this when you have gone through the method a couple of times.
Expert 3	I think the method works. This is also illustrated via the example.
Expert 3	It would be nice to have some more examples to see if it works with more cases.

Table G.2: Evaluation Results related to Clarity and Understandability

Respondent	Statement
Practitioner 1	The concept of asking questions followed by a scoring is familiar to people and therefore easy to understand.
Practitioner 1	Some evaluation questions are difficult to answer. Having some additional explanation accompanying the evaluation questions will do wonders.
Practitioner 2	There is strength in the simplicity of the method. This makes the method easy to understand.
Practitioner 2	The evaluation questions are clear. Everybody can answer them.
Practitioner 3	The method is clear, the clarity and understandability in general are fine.
Practitioner 3	Some of the evaluation questions are quite generic, which can make it difficult for some people to properly understand what is asked of them.
Practitioner 4	The evaluation questions and their response options could be more clear so less freedom of interpretation is left to the individual.
Expert 1	The evaluation questions provide quite a clear guidance to its users.
Expert 1	The one applying the method in the organization could need some guidance as to how and when to use it.
Expert 2	The clarity and understandability is good as well. I expect everybody being part of the multidisciplinary team to be able to answer the evaluation questions without problems. Also the activities before the evaluation phase are clear.
Expert 3	I think I understand the method. So for me it is clear and understandable. I think the clarity and understandability is sufficient.

Table G.3: Evaluation Results related to Completeness

Respondent	Statement
Practitioner 1	You should not underestimate the user friendliness of the technology in a manufacturing environment. Aspects related to the user friendliness are represented in the method but I cannot judge whether it is sufficient. Time will have to tell.
Practitioner 1	The rest is mostly captured.
Practitioner 2	A step where you reflect on the outcome may be beneficial to have.
Practitioner 2	I cannot think of any steps that are currently missing, however the method needs to be tested with more ideas be able to state with certainty that it is complete.
Practitioner 3	I think it the method is complete.
Practitioner 3	Maybe it would be good to introduce an extra activity before the value proposition identification in which you specify what are the specific functionalities of the digital technology.
Practitioner 4	I think you have addressed all facets well. I would not know what else you would like to consider.
Expert 1	The completeness is more than sufficient.
Expert 1	In these cases there is no need to be overly complete in the sense of adding to much detail. This will not bring much in the end.
Expert 2	I think the method is complete. When you finish the last step of the method you will have a well-based line of reasoning.
Expert 3	You demonstrated it works so in that case I think it is complete. In order to be certain this is the case for all ideas, more cases are required to be performed.

Table G.4: Evaluation Results related to Usefulness and Ease of Use

Respondent	Statement
	Ease of Use
Practitioner 1	Some experience is needed when designing the radar. The first couple of times are likely to be difficult but like with other tools, when you have done it a couple of times it becomes a lot easier. When an example is provided I think people can start designing the business model relatively easy.
Practitioner 2	Everybody can use the method
Practitioner 3	Executing the method's activities takes some effort. If we want to start using it, it would be good to have some sort of templates which are easy to handle.
Practitioner 4	The ease of use is still difficult to say. It will depend on the earlier stated clarity of the evaluation questions. Some extra information making the response options more concrete will help a lot I think.
Practitioner 4	Maybe you can automate things. For example you fill out a form and the score rolls out.
Expert 1	In order to follow the method you need some understanding of what you are about to do. This, however, is a matter of training.
Expert 3	I don't think the ease of use is very high as of now. It would be a lot more user friendly if you have some excel file where the score is automatically calculated based on the evaluation question responses.
	Usefulness
Practitioner 1	It definitely helps you progressing. So whether something like this is useful? Yes, most certainly.
Practitioner 2	It is still not very clear what the score contributes to the gut feeling. If the outcome is what is expected every time, there is not much added value in using the method. If it is different, there is. More cases are needed to determine this.
Practitioner 3	I think it is very useful.
Practitioner 4	I think the way you put things together is good.
Expert 1	The method is perfectly usable to support discussion towards decision making.
Expert 2	Based on what I've seen I think the usefulness and ease of use are good. It seems very suitable to specify and evaluate an idea in this manner. Although I should participate as a member of the multidisciplinary team once to be sure.