Eindhoven University of Technology

MASTER

A Goal-Oriented Method for Eliciting and Assessing Digital Platform Requirements

a Service System Engineering Perspective

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Award date:
2023

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11-07-2023

DEPARTMENT OF INDUSTRIAL ENGINEERING
Master Operations, Management & Logistics
Information Systems

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

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INFORMATION SYSTEMS GROUP

MASTER THESIS

A Goal-Oriented Method for Eliciting and Assessing Digital Platform Requirements: a Service System Engineering Perspective

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Final report
Eindhoven, July 11, 2023

Abstract

Digital platforms have transformed industries by enabling value co-creation and strategic advantages for businesses. These platforms facilitate collaborative interactions, resource exchange, and knowledge sharing among actors. To effectively develop a digital platform, it is necessary to first analyse its deployment context and then gradually elicit platform requirements for desired value co-creation that align with this context. Given the ever-changing configuration of value propositions and resource allocation among service system entities, assessing the feasibility of these requirements is critical. A systematic literature review revealed that methodological guidance from taking the service system as a unit of analysis for value co-creation until the elicitation and assessment of digital platform requirements lack. A study that built a theoretically strong meta-model of service systems and provided a profile of the goal-oriented language to model the service system requirements was selected as a base method and extended using situational method engineering. This master's thesis presents a method for eliciting and assessing digital platform requirements from a service system perspective, called GEA-DPR. The GEA-DPR method is developed following the design science research methodology and is demonstrated through the elicitation and assessment of requirements for a digital platform developed for smallholder farmers in Cambodia. An exploratory focus group was held to improve the efficacy and ease of use of the GEA-DPR method, followed by a confirmatory focus group to assess its achievement of solution objectives and its fit with the application environment. The study's evaluations provided positive evidence, supporting the efficacy, utility, usefulness, and alignment with the business of the GEA-DPR method. The contribution of this research is a method that provides guidance in the complete process of the elicitation and assessment of digital platform requirements for the development of a digital platform considering the service system context enabling value co-creation.

Keywords: digital platform, value co-creation, requirements engineering, goal modelling, service system engineering.

Executive Summary

The emergence of digital platforms has changed the way businesses generate strategic advantages (Breidbach et al., 2014; Breidbach & Maglio, 2016). These platforms have improved the efficiency of service exchange and resource integration by allowing actors to interact across geographical boundaries. As a result, digital platforms are recognised as value co-creation facilitators, facilitating resource exchange and collaboration to create value propositions and deliver services (Lusch & Nambisan, 2015; Vargo et al., 2008). To ensure effective value co-creation, the functionalities of a digital platform should align with actor capabilities, requiring requirements that encompass the needs of all actors (Adali et al., 2021; Lessard et al., 2020). As a result, designing digital platforms that enable value co-creation requires a thorough understanding of the underlying dynamics of value co-creation (Haki et al., 2019).

The analysis of service systems is a valuable approach for understanding value co-creation (Maglio et al., 2009; Vargo & Lusch, 2008). By using the service system as the unit of analysis, this study adopts a perspective that recognises the critical role of service systems in shaping the development context of digital platforms and influencing their requirements. Within a service system, the value propositions of each actor play a crucial role in shaping the configuration of actors, resources, and value co-creation activities (Böhmann et al., 2014; Alter, 2011). These value propositions shape the requirements of the digital platform. However, eliciting digital platform requirements based on value propositions is a complex task due to the dynamic nature of the service system (Adali et al., 2021). This dynamic nature of service systems also emphasises the need to assess the feasibility of the requirements in order to identify any gaps between the elicited requirements and the value co-creation activities and resource availability at the time.

Although several studies have looked into the role of requirements engineering in conjunction with service system design, comprehensive and empirically validated methods or approaches for eliciting and assessing digital platform requirements within a service system context are lacking. Lessard et al. (2020) proposed heuristics and a lightweight GRL profile to elicit and model service system requirements. While these provided a starting point, the resulting requirements were too high-level for assessing digital platform requirements. Therefore, the objective of this research is to develop an empirically validated goal-oriented requirements engineering method that assists practitioners in eliciting and assessing digital platform requirements, taking into account the service system context. The remainder of this section elaborates on the research methodology used to design, develop, demonstrate, and evaluate the proposed method, as well as the conclusions of this research.

The research design used for the proposed Goal-Oriented Elicitation and Assessment of Digital Platform Requirements (GEA-DPR) method adopted the Design Science Research Methodology (DSRM) proposed by Peffers et al. (2007). The DSRM encompasses six activities: identification of the research problem and motivation, definition of solution objectives, design and development, demonstration, evaluation, and communication. The activities "design and development" and "demonstration and evaluation" were executed twice.

Design and Development
The GEA-DPR method is developed using Situational Method Engineering (SME) in addition to the DSRM. First, a systematic literature review (SLR) with a snowballing approach was conducted to identify and motivate the problem. The SLR helped to identify the limitations of existing GORE methods or approaches in eliciting and assessing digital platform requirements while capturing the S-D Logic principles. An objective-centered approach was adopted to design a GORE method that addresses this gap. Solution objectives for the GEA-DPR method were formulated and used to guide design and development as well as the evaluation of the GEA-DPR method.

In the first phase, the method is created based on the solution objectives. The selected base method of Lessard et al. (2020) was modified to provide better guidance in eliciting service system requirements.

This modification involved the integration of the heuristics proposed by Lessard et al. (2020) supplemented or replaced with the SDBM-r elements proposed by Turetken et al. (2019) as sources of identification for service system constructs. This modification was validated by the first author of Lessard et al. (2020). Consequently, as a preliminary step, the organization of a service-dominant business modeling workshop utilizing the SDBM-r framework developed by Turetken et al. (2019) was included. Next, the extension-based strategy as proposed by Ralyté et al. (2003) was used to select meta-patterns to carry out the required extensions to transition from service system requirements to digital platform requirements. The base method was extended by incorporating five meta-patterns from Ohshiro et al. (2005), Letier & van Lamsweerde (2002), Amyot et al. (2009), and Amyot et al. (2010).

In the second phase, the exploratory focus group (EFG) results were used to improve the GEA-DPR method. The GEA-DPR method was simplified based on the feedback from the EFG session, which indicated a low "ease of use" score. To address this, a simplified documentation structure was adopted instead of the formal refinement patterns introduced by Darimont & van Lamsweerde (1996), which were part of the selected meta pattern from Letier & van Lamsweerde (2002) for goal model elaboration. Furthermore, a consistency control checklist was introduced to help users determine successful completion and understand each activity's purpose. The method's roles were also clarified, emphasising that one person doesn't need strategic, operational, modelling, engineering, and social skills. The resulting GEA-DPR method consists of six steps, of which three steps are focused on eliciting and assessing requirements, carried out by the business analyst, while the remaining three steps are centered on goal modeling and analysis, conducted by the modeller.

GEA-DPR steps 1 and 2 elicit and model service system requirements to enable co-created value-in-use. This process uses the service system element identification sources and the GRL profile introduced by Lessard et al. (2020) to visually represent these elements in a model. GEA-DPR steps 3 and 4 elicit and model digital platform requirements. The goal-oriented brainstorming method of Ohshiro et al. (2005) and the goal model elaboration strategy of Letier & van Lamsweerde (2002) are used to refine the value propositions from the GRL model directly related to the digital platform. Each value proposition has a goal refinement tree (GRT), leaf nodes showing digital platform tasks. This research's informal operationalization pattern eleborates on and operationalizes these tasks. The modeller creates an SR model from these operationalized tasks. Steps 5 and 6 of the GEA-DPR method assess and model digital platform requirements to identify gaps and bottlenecks. The business analysts present the SR model and discuss task execution status and resource availability for each service system entity in a workshop. The modeller then creates the assessed SR model using the goal model evaluation strategy from Amyot et al. (2010).

Demonstration

The GEA-DPR method was demonstrated at Agros, an agricultural company operating in Singapore, Myanmar, and Cambodia. Agros aims to enhance smallholder farmers' income and climate resilience by offering a comprehensive solution comprising technologies, inputs, advice, and financing. However, they need assistance in eliciting digital platform requirements, considering service system elements, and assessing feasibility in order to develop a digital platform that facilitates value co-creation.

During the workshop, it was determined that the digital platform should serve as a one-stop shop for sustainable farming solutions, enabling access to financial resources, farming solutions, and improved insights. These value propositions were further refined into 12 tasks dependent on the execution status and resource availability of farmers, agronomists, and Agros' M&E and S&O departments. Feasibility assessment revealed the need for training farmers and Agros S&O employees in transitioning to online and automated processes. Existing processes, predominantly executed manually through Telegram, will require education, process automation, and data enhancement. Initially, the Agros S&O department will be the primary users, allowing farmers to observe and gradually adopt the platform, gaining a deeper understanding of its benefits over time.

Evaluation

The GEA-DPR method was evaluated using exploratory and confirmatory focus groups (EFG and CFG) as well as an online questionnaire with the intended users. The focus groups were held to assess the extent to which the predefined solution objectives were met as well as the fit with the environment. The GEA-DPR

method was evaluated based on five criteria: efficacy, utility, ease of use, perceived usefulness, and alignment with business. These evaluation criteria were selected based on the taxonomy of evaluation methods for IS artifacts presented by Prat et al. (2015).

The GEA-DPR method was found effective and usefull in eliciting and assessing digital platform requirements within the context of a service system. Furthermore, participants liked the holistic, user-centric, and goal-oriented approach of the method fostering communication, stakeholder involvement, and collaboration. Especially the SDBM-r and the two models displaying the dependencies and rationale behind the requirements as well as the colours indicating potential gaps and bottlenecks were found useful. However, based on the evaluation results also several points of improvement were identified. The GEA-DPR method can be improved by addressing the concerns raised by participants regarding the size and complexity of the models and the activities involved in creating the final output.

Conclusion

The study aimed to develop a method for eliciting and assessing digital platform requirements within the context of a service system. The evaluation results show that the GEA-DPR method was effective in eliciting and assessing digital platform requirements within the context of a service system, but there is room for improvement in terms of ease of use.

The study contributes to the existing literature by integrating and modifying various methods to address solution objectives. The GEA-DPR method offers practical implications by enabling the elicitation and assessment of digital platform requirements, facilitating stakeholder involvement and alignment, and improving communication between business and IT employees. However, the method has limitations in terms of scope, complexity, and expertise required. Furthermore, the development process of this research also had limitations as multiple design iterations as well ass focus groups to evaluate the method were preferred and the context in which the GEA-DPR method was deployed was not optimal due to language barriers.

Future research opportunities for the GEA-DPR method encompass two main areas. Firstly, there is a need to address the identified improvements suggested by focus group participants, such as linking the method to project management tools, automating steps and modeling, simplifying the method, and integrating it with execution-focused methods like agile backlogs. These enhancements aim to enhance the method's usability, practicality, and integration with other agile tools, thereby improving service system analysis and digital platform design. Secondly, conducting additional research cycles is crucial to refine the method's practical applicability and validate the combination of the base method with selected meta patterns. Longitudinal studies can assess the feasibility of elicited requirements and evaluate the effectiveness of the developed digital platform in facilitating value co-creation.

Preface

This Master's thesis is submitted as part of the Master program in Operations Management Logistics at the Eindhoven University of Technology (TU/e) and conducted for the Information Systems Group within the faculty of Industrial Engineering & Innovation Sciences. The primary objective of this study was to develop a method to elicit and assess digital platform requirements from a service system perspective.

I would like to take this opportunity to express my gratitude to the individuals who provided guidance, support, and valuable insights throughout this final project. First and foremost, I would like to express my gratitude to Dr. B. Ozkan, my first supervisor and mentor. His support and availability at any time throughout my Master's degree really helped in the successful completion of this thesis. His valuable input and guidance steered me in the right direction, enabling me to refine my research and make significant contributions to the field. Furthermore, I'd like to thank my supervisor for allowing me to conduct my research in another country, as well as his flexibility and willingness to adapt to the demanding schedule during critical project phases, which was critical to the project's success.

I would also like to express my gratitude to Dr. B. Aysolmaz, my second supervisor, for her invaluable support and detailed feedback on my intermediate deliverables. Her guidance and expertise have been instrumental in shaping the methodology and enhancing the quality of this research.

Furthermore, I would like to thank my company supervisor, Sandra Bos, for providing me with the opportunity to engage in such an impactful project. Her passion for sustainability and the agricultural sector has been truly inspiring. I am grateful for her time, support, and valuable input throughout the duration of this research. Furthermore, I am very grateful for the opportunity she gave me to come to Cambodia and especially that she made me feel welcome and that I could visit her for one week in Siem Reap, it was an amazing time and I learned a lot from her.

Additionally, I would like to extend my thanks to everyone at Agros who welcomed me to Cambodia and actively participated in the workshops. The experience and knowledge shared during my time there were invaluable, and I am incredibly grateful for the opportunity to learn and grow from this enriching experience.

Finally, I would like to express my gratitude to all the participants of the focus group. Their valuable contributions were instrumental in shaping and evaluating the GEA-DPP method. Despite not having a deep personal connection with everyone, their willingness to assist and provide feedback is truly appreciated. I am grateful for their support and involvement in this research.

It is my hope that this thesis contributes to the existing body of knowledge in the field of goal-oriented requirements engineering, specifically in the domain of digital platform requirements elicitation and assessment from a service system perspective. May it serve as a stepping stone for further research and innovation in this area.

Thank you, I hope you enjoy your reading.

Julia Geschiere
Eindhoven, July 11, 2023

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List of Abbreviations

AF	Artificial and Formative
AS	Artificial and Summative
BPM	Business Process Management
CFG	Confirmatory Focus Group
CSS	Customer Service Scenario
DSR	Design Science Research
DSRM	Design Science Research Methodology
EA	Ex Ante
EFG	Exploratory Focus Group
EP	Ex Post
GEA-DPR	Goal-Oriented Elicitation and Assessment of Digital Platform Requirements
GORE	Goal-Oriented Requirements Engineering
GRL	Goal-Oriented Requirement Language
GRT	Goal Refinement Tree
IA	Institutional Arrangements
IE	Industrial Engineering
IS	Information Systems
MFIs	Microfinance institutions
NA	Nature of Actors
NF	Natural and Formative
NS	Natural and Summative
OCL	Object Constraint Language
OD	Operand resources
OR	Operant resources
RE	Requirements Engineering
REP	Requirements Engineering Phase
RES	Resources
SDBM-r	Service-Dominant Business Model Radar
SE	Service Exchange
SLR	Systematic Literature Review
SME	Situational Method Engineering
SR	Strategic Rational
SS	Service Systems
SSE	Service System Engineering
TE	Type of Evaluation
TEE	Timing of Evaluation Episode
UII	Universitas Islam Indonesia
UX	User Experience
VIC	Value in Context
VP	Value propositions
WOS	Web of Science

Chapter 1

Introduction

In recent years, digital platforms have gained significant attention and research interest across various fields, driven by the success of major platform companies like Apple, Microsoft, Alphabet-Google, Amazon, Facebook, Tencent, and Alibaba (Cusumano et al., 2020). While digital platforms were initially seen as a disruptive wave only affecting specific industries, now they are seen as a key driver of global economic growth (Ács et al., 2022; Cutolo & Kenney, 2021; Goldfarb & Tucker, 2019). These platforms have enabled the large-scale development and adoption of digital technologies (Lafuente et al., 2022; Veile et al., 2022; Van Alstyne et al., 2016). Platforms like Uber and Airbnb have completely changed the status quo in many sectors (De Reuver et al., 2018). Gawer (2021) reported that seven of the world's eight largest companies by market capitalisation in 2019 were digital platform companies. This is reflected in the increasing use of digital platforms to generate strategic advantages (Breidbach et al., 2014; Breidbach & Maglio, 2016).

Digital platforms have changed the way businesses create strategic benefits and enabled an economy-wide redesign of processes to create, capture, and deliver value (Autio et al., 2018). Digital platforms are used to extend an organization's activities beyond its organizational boundaries (Blaschke et al., 2018). Innovation now stems from collaborative networks of actors, rather than being limited to within the boundaries of individual businesses (Hein et al., 2020; Lusch & Nambisan, 2015). Digital platforms facilitate the exchange and integration of dispersed digital resources, exploiting their potential while enabling connections between parties to generate mutual network effects (Yoo et al., 2010; Gawer, 2021). These interactions enhance the efficiency and effectiveness of service exchange and value co-creation among system actors (Lusch & Nambisan, 2015). Consequently, digital platforms are increasingly recognized as facilitators of value co-creation, where a network of actors exchange and combine their diverse resources to create value propositions and deliver services (Lusch & Nambisan, 2015). These actors organize both operand resources, such as physical space, and operant resources, including knowledge and skills (Lessard, 2015).

Digital platforms play a central role in value co-creation within the information technology domain, situated at the intersection of value creators in the ecosystem (Gawer, 2021; Adali et al., 2021). A key consideration during the design of a digital platform is the emphasis on value co-creation, which enables ecosystem actors to collaboratively generate value on the platform (Hein et al., 2020; Lusch & Nambisan, 2015). In this regard, organizations should adopt a holistic approach when designing a digital platform, taking into account the entire platform service delivery system. This perspective includes considering external environments, customers, and partners as operant resources, as well as information technology as both operand and operant resources (Lusch et al., 2007; Lusch & Nambisan, 2015). Furthermore, this perspective involves understanding and aligning the diverse and subjective needs of all actors involved in the service system, including the platform users (De Reuver et al., 2018; Saarikko, 2015). This makes software development a complex social activity.

Goal-oriented Requirements Engineering (GORE) approach recognizes that software development is a complex social activity (Liu & Yu, 2004). It takes into account the strategic interests of different stakeholders and their limited knowledge and control over each other (Amyot et al., 2022). It enables the exploration and evaluation of alternative approaches to achieve these goals, leading to effective software solutions aligned with stakeholder objectives(Yu, 2009). Goal modelling is a technique used in GORE to represent and analyze goals and their dependencies which is essential for understanding and modelling the problem space, focusing on goals rather than prescribing solutions (Yu, 2009). Goal-oriented modelling has proven to be a suitable method for designing and developing service systems aligned with S-D Logic principles (Lessard et al., 2020).

The high connectivity and interdependence of ecosystem actors have increased service systems' complexity (Thomson et al., 2022). For example, the creation and exchange of value within a service system are triggered and influenced by the goals and motivations of all relevant stakeholders (Samavi et al., 2009). The complexity of a service system presents numerous challenges in designing a digital platform. According

to Lusch & Nambisan (2015), information technology should be viewed as an active agent in the service ecosystem, capable of initiating or triggering service innovation as well as influencing other actors and their decisions. However, currently, there is a lack of methods for considering the elements of the digital service ecosystem in service engineering (Immonen et al., 2016). According to Vargo et al. (2008), the service system is the proper unit of analysis for value co-creation. By adopting a service system perspective while designing a digital platform, one can gain a comprehensive understanding of the dynamics involved in value co-creation.

1.1 Problem Definition and Research Goal

The concept of platform design is gaining increased attention in academic literature (De Reuver et al., 2018). Digital platforms are being used to produce strategic benefits and to facilitate value co-creation (Lusch & Nambisan, 2015; Autio et al., 2018). Digital platforms can be conceptualized from a value co-creation and therefore from a service system perspective (as a unit of analysis for value co-creation) (Lusch & Nambisan, 2015; Vargo et al., 2008). In order to understand the requirements necessary to facilitate effective collaboration and value co-creation among the ecosystem actors, platform designers must comprehend the underlying dynamics of the value co-creation (Haki et al., 2019). A comprehensive analysis of the service system surrounding the platform is essential before engineering the digital platform. However, the complexity of the service system makes eliciting platform requirements a difficult task (Adali et al., 2021). The elicitation and assessment techniques for digital platform requirements in a service system context are scarce.

There are several studies that explored and proposed approaches for eliciting digital platform requirements (Adali et al., 2021; Jungerius et al., 2022) or for eliciting service system requirements (Immonen et al., 2016; Lessard et al., 2020). However, these approaches do not provide adequate guidance for the initial analysis of the service system and the subsequent gradual elicitation of requirements specific to the digital platform under design. While platform owners are responsible for providing the platform infrastructure, the survival and success of the platform ultimately rely on the quality of value co-creation among all actors (Haki et al., 2019). Therefore, the requirements of the digital platform should encompass the needs of all actors and enable value co-creation by aligning platform functionalities with actor capabilities (Lessard et al., 2020; Adali et al., 2021). However, there is a need for better understanding and tools to facilitate co-creation in knowledge-intensive sectors (Jayashankar et al., 2020; Haki et al., 2019). Misunderstanding the deployment service system can result in challenges like resource misconfigurations, misuse, failed integrations, and value imbalances among actors, impacting ecosystem well-being (Li et al., 2022).

Furthermore, the requirements of a digital platform continuously emerge and evolve over time, driven by changes in value propositions, actor-resource configurations, and the dynamics of the platform ecosystem (Hein et al., 2020; Maglio & Spohrer, 2013). Therefore, iterative platform design approaches are necessary to address the diverse and evolving needs of multiple actors involved in value co-creation (De Reuver et al., 2018; Blaschke et al., 2018; Haki et al., 2019). While the method proposed by Jungerius et al. (2022) discusses the assessment of digital platform requirements from a value co-creation perspective, it primarily focuses on already deployed platforms. Within this research, the focus is on eliciting and assessing digital platform requirements from a blank slate which is a typical situation for networks to develop digital platforms. Furthermore, the assessment should ensure the feasibility of elicited requirements and their alignment with the value propositions of each stakeholder at a given time. Currently, there is, to my best knowledge, no method guiding practitioners through the process of eliciting and assessing requirements for a digital platform within a service system context.

All in all, conventional requirements engineering methods fail to guide practitioners in eliciting and assessing digital platform requirements from scratch, lacking a value co-creation perspective. Therefore, there is a need for a method that guides practitioners in eliciting and assessing digital platform requirements, with a focus on the service system as the unit of analysis for value co-creation. This holistic approach can help organizations effectively design and deliver their digital platform within a service system context. As a result, the following main research question is formulated:

How to elicit and assess digital platform requirements within a service systems context?

Currently, there is limited guidance in the process of eliciting and assessing digital platform requirements within a service system context. Due to the unique networked structure of a service system and distinct value propositions of service system entities, developing the digital platform from scratch is often necessary to ensure alignment with their specific needs and expectations to enable value co-creation. Therefore, the aim of this research is to propose a method for eliciting and assessing digital platform requirements from a blank slate, taking into account the service system context. By starting from scratch, this method will enable users to effectively capture and evaluate the necessary requirements for the development of a digital platform, facilitating value co-creation and ensuring alignment with stakeholders' needs and expectations. As a result, the following research objective will be pursued in this study:

To create a method that assists practitioners in eliciting and assessing digital platform requirements, while considering the service system context, with the aim of facilitating value co-creation on the digital platform.

There are several methods that can be used to carry out part of this process. Lessard et al. (2020) developed a meta-model for service systems based on S-D logic principles, and then used this meta-model to derive a domain-specific profile of the goal-oriented Requirement Language (GRL), as well as a set of heuristics for drafting service system requirements. These heuristics and the GRL profile were selected as starting points to develop the method to elicit and assess digital platform requirements while considering the service system context and will be explained in Chapter 3 in more detail.

For this master thesis research, the design science research methodology (DSRM) proposed by Peffers et al. (2007) was adopted. Initially, a systematic literature review (SLR) was conducted to examine the existing body of research on RE methods for eliciting and assessing digital platform requirements in the context of service systems. The SLR revealed a limited availability of methods in this specific research area, emphasizing the need for the present design science research (DSR). Subsequently, an objective-centered solution approach was pursued, leading to the selection of the GRL profile and heuristics proposed by Lessard et al. (2020) as the base method. To align with the objectives of the study, the GRL profile and heuristics were extended and modified through a situational method engineering (SME) approach. The extended method, named GEA-DPR (Goal-oriented Elicitation and Assessment of Digital Platform Requirements), was then developed and applied at a case company to demonstrate its practical application in eliciting and assessing digital platform requirements within the context of the service system. Finally, the following criteria: efficacy, utility, ease of use, perceived usefulness and alignment with business of the GEA-DPR method were evaluated through an exploratory focus group (EFG) and confirmatory focus group (CFG) methodology, which further substantiated its ability in achieving the intended outcomes of eliciting and assessing digital platform requirements within the service system context.

1.2 Report Structure

The research structure of this thesis is as follows: In Section 2, the related literature in the field is reviewed to provide background information, to introduce the theories and methods that are relevant to the research objective, and to present the state-of-the-art research on GORE methods taking the service systems as a unit of analysis for value co-creation. The research design and objectives are discussed in more detail in Section 3. The design and development decisions of the method will be explained in Section 4. In Section 5, the proposed method is introduced and explained in detail. The proposed method will be demonstrated in a business case, with a focus on service delivery to smallholder farmers, in Section 6. The evaluation of the method is done using a focus group methodology with actors from the case context and experts in the field of RE, which is presented in Section 6. Finally, in Section 7, the conclusion of the research is presented, including a discussion of the limitations of the approach and opportunities for future work.

Chapter 2

Literature Review

This study aims to develop a method that guides users in the process of eliciting and assessing requirements for a digital platform in a service system context. This study is drawn on existing theories related to the context in which the digital platform will be deployed, service systems, and goal-oriented requirements engineering (GORE). The findings of this review helped to shape the design of the proposed method. The literature review begins by providing an overview of the concepts of service systems, digital platforms, GORE, and goal models to provide background information. Following the overview, a SLR was conducted to analyze the existing research on GORE within the context of service systems. The purpose of this SLR is to provide a comprehensive understanding of the current state of research and challenges in this area.

2.1   Service Systems

The services sector is the largest contributor to the global economy, yet it is the least studied (Spohrer et al., 2007). Current service system research methods are adapted from the principles of business and digital service systems, which do not fully account for the unique characteristics of "service" (Pingfeng & Guihua, 2009). To address the limitations of current service system research methods, this study adopts the service-dominant logic (S-D Logic) perspective. S-D Logic is a widely accepted worldview that emphasizes the primacy of service in economic exchange (Pingfeng & Guihua, 2009). The S-D Logic perspective enables a more holistic approach to understanding the requirements of digital platforms and their service delivery systems.

Building on the S-D Logic, Maglio et al. (2009) proposed a new basic abstraction called a "service system" defined as a dynamic value co-creation configuration of resources such as people, organizations, shared information (language, laws, measures, methods), and technology, all of which are linked internally and externally by value propositions to other service systems. The research discipline that focuses on the systematic design and development of such service systems is called service system engineering (SSE) (Böhmann et al., 2014). Based on the S-D Logic and SSE perspective, a service system can be defined as a complex socio-technical system that enables collaborative value creation through value propositions, service exchange, and resource integration processes (Spohrer et al., 2007; Vargo et al., 2008; Böhmann et al., 2014). Evidence-based design knowledge plays a critical role in the design of these pervasive systems in our society, and further research in this area is strongly encouraged, as highlighted by Böhmann et al. (2014).

Service systems are critical in co-creating value as they enable interactions between various components to generate outcomes that are greater than the sum of their parts. They are complex, dynamic, and adaptive systems with emergent properties, encompassing data, physical components, layers of knowledge, communication channels, and networked actors (Böhmann et al., 2014; Maglio et al., 2009). To effectively function, the complexity and dynamic nature of these systems must be taken into account. According to Maglio et al. (2009), each service system participates in three key service interaction activities: proposing a value co-creation interaction to another service system (proposal), agreeing to a proposal (agreement), and realizing the proposal (realization). These are typical activities for open systems that improve the state of another system by sharing or applying its resources while also improving their own state by acquiring external resources (Maglio et al., 2009).

At least two entities are involved in these service interactions, one applying competencies and the other integrating applied competencies with resources and determining benefit (value co-creation) (Poels, 2010). A service system entity's granularity can range from an individual (with their resources) to an organization, a city, or the global economy (Lessard et al., 2020). Spohrer et al. (2007) defined a service system entity as a system composed of people and technology that adapts to the changing value of knowledge. According to Maglio et al. (2009) and Spohrer et al. (2007) any entity capable of intentional interactions aiming to

co-create value and apply resources can be viewed as a service system entity. Finally, the operand resources that operant resources are able to acquire define the boundaries of service systems (Lessard et al., 2020).

There are multiple types of service systems and corresponding perspectives. This study focuses on the concept of a service system as a fundamental unit of analysis for value co-creation, wherein a service system consists of a minimum of two entities that interact with each other to achieve specific objectives (Lessard et al., 2020; Poels, 2010). Within service systems, digital platforms have emerged as a novel and innovative approach for organizing resources in a self-organizing environment, fostering member collaboration, and facilitating value co-creation (Immonen et al., 2016). Digital platforms facilitate service systems by acting as a hub for the integration and configuration of various actors and resources, allowing for the creation of comprehensive value propositions (Adali et al., 2021). The digital platform, as both a technology and a complex resource, enables the operation of one or more service systems while addressing key challenges of openness and dynamicity (Blaschke et al., 2018). Because of these distinguishing characteristics, the digital platform is an important component of SSE. There are only a few studies in SSE that consider digital services, such as Immonen et al. (2016) and Lessard et al. (2020). The following section will go over the design considerations for digital platforms in the context of service systems, as well as how these can be addressed through GORE.

2.2 Digital platforms and requirements engineering

Digital platforms are being implemented by an increasing number of companies in order to generate strategic benefits. As mentioned in Chapter 1, this research focuses on GORE of digital platforms and adopts a service system lens. Digital platforms are thus deployed in the context of a service system aiming to co-create value. Zolnowski & Warg (2018) investigated the role that service platforms play in facilitating service systems based on four meta-theoretical foundations of S-D logic. The authors conducted a systematic analysis of the role of digital platforms in resource management, highlighting the key mechanisms by which these platforms enable resource liquefaction, integration, density, and orchestration in actor-to-actor networks. The study provides useful insights into how digital platforms can aid in the delivery of efficient and effective services. One of the primary reasons that service platforms enable value co-creation is that they enable multiple actors to integrate and configure their competent resources in service systems, allowing them to design compelling and complete value propositions (Adali et al., 2021).

Digital platforms are complex socio-technical artifacts that connect different user groups and facilitate transactions within a service system context, presenting conceptual and methodological challenges (Gawer, 2021). From a socio-technical view, digital platforms are technical elements (of software and hardware) and associated organizational processes and standards that facilitate these transactions (De Reuver et al., 2018). A platform owner implements governance mechanisms to facilitate value-creating mechanisms on a digital platform between the platform owner and a service system of autonomous complementors and consumers (Hein et al., 2020). The multi-actor setting makes the design of a digital platform complex as multiple distributed actors with divergent goals iteratively shape and redefine what the platform is and how it functions (De Reuver et al., 2018). This creates a complex design challenge that involves managing interactions and relationships between different actors within the service system.

The conventional requirements engineering (RE) approaches exhibit limitations when it comes to supporting the design of digital platforms within the context of service systems. Typically, most RE methods are tailored to handle either service system requirements or software requirements separately. However, from a value creation perspective, it becomes clear that the platform development company cannot determine the software requirements entirely on its own. Instead, it relies on the collective value propositions put forth by each stakeholder involved in the co-creation of value on the digital platform (Lessard et al., 2020; Haki et al., 2019). Therefore, the elicitation and assessment of digital platform requirements requires an understanding of the service system context. Despite numerous RE approaches for platform design being used in various contexts, few explicitly account for the service system context when designing a digital platform. Current RE methods often neglect the perspective of service-oriented development and service engineering (Ralyté, 2012) and do not adequately consider the service system context (Immonen et al., 2016). There are only a few studies that explicitly address the consideration of the context in the requirements identification of a

digital platform with a service system, such as Adali et al. (2021), Lessard et al. (2020) and Jungerius et al. (2022).

2.3 Goal models

The increasing interaction between IS with the social world has led to the emergence of social modelling as a new area for conceptual modelling (Yu, 2009). While requirements have traditionally focused on stating what a system should do rather than how it should do it, understanding the organizational context and rationales behind system requirements can be critical to the system's long-term success. Therefore, considering the "whys" that led to the requirements is an important RE activity (Yu, 2009). Early requirements define the purpose, goals, and objectives of a software system by answering the "why" questions. Prescriptive requirements, on the other hand, describe the system-to-be's specific features, capabilities, and behaviors, answering the "what" and "how" questions (Giorgini et al., 2006). In this research goal modelling is used to understand the "why" of the system and to elicit the "what" and "how" of the intended platform solution.

GORE is a field that uses goals to elicit requirements (Van Lamsweerde, 2001). Goal-oriented modelling, incorporating an agent-oriented perspective, has been widely adopted for service engineering, particularly in the design and development of service systems from the perspective of S-D Logic (Lessard et al., 2020). By establishing traceability links from enterprise goals to system requirements, GORE methods enable effective goal identification, refinement, and elaboration into requirements while ensuring completeness and considering alternative solutions (Regev & Wegmann, 2005). In software engineering, goals are prescriptive statements that express intentions and necessitate cooperation between software agents and their environments. Actor interactions are crucial for achieving goals, performing tasks, and providing resources in software systems (Yu, 2009), especially for agent-oriented software like digital platforms, which rely on the cooperation of multiple actors to provide services and achieve their objectives. These goals and interactions are organized in AND/OR structures that form goal models, ranging from high-level strategic goals to software requirements (Van Lamsweerde, 2004). Properly organized goal models have been shown to be an effective communication channel between software engineers and business managers (Van Lamsweerde, 2004), and can prevent system failures caused by implementing incorrect requirements or neglecting the needs of certain stakeholders (Horkoff & Yu, 2013).

This research utilizes the Goal-oriented Requirements Language (GRL) as a technique for capturing and analyzing the intended platform's goals and requirements. GRL is a visual modelling language that offers a structured approach to representing and examining goals and their interdependencies (Amyot et al., 2009). In GRL, goals are used to depict business objectives and system requirements, both functional and non-functional (Liu & Yu, 2004). A key benefit of GRL is that it allows for the analysis of system requirements based on actors' intentions within the context of the given system (Amyot et al., 2009; Liu & Yu, 2004). It uses goal-oriented elements such as goals, soft goals, tasks, resources, and indicators, as well as various types of relationships between these elements. The intentional elements in GRL are divided into parts or alternative means through the Decomposition link. The Dependency link shows how one actor relies on another, while the Contribution link demonstrates how an intentional element or indicator contributes to the satisfaction of another. Actors have intentions and perform actions to accomplish goals, while goals are desired states or conditions. Soft goals are similar to goals in that they do not have clear criteria for achievement. Tasks are specific methods of achieving goals, and resources are physical or informational entities. Indicators are measurements used to assess whether a value expectation has been met.

2.4 SLR on GORE and Service Systems

This section presents a SLR that provides an overview of the current state-of-the-art research on GORE methods or approaches, with a focus on capturing service system elements aligned with the SDL principles. First, the methodology employed in the SLR will be explained, next the SLR results and conclusions will be presented.

2.4.1 Systematic Literature Review Methodology

For this master thesis research, the guidelines of B. A. Kitchenham (1996) for performing SLRs in software engineering and the guidelines of Wohlin (2014) for snowballing were used. Figure 2.1 provides an overview of the SLR process, displaying the activities recommended by B. A. Kitchenham (1996) and Wohlin (2014) as well as the number of studies resulting from each stage.
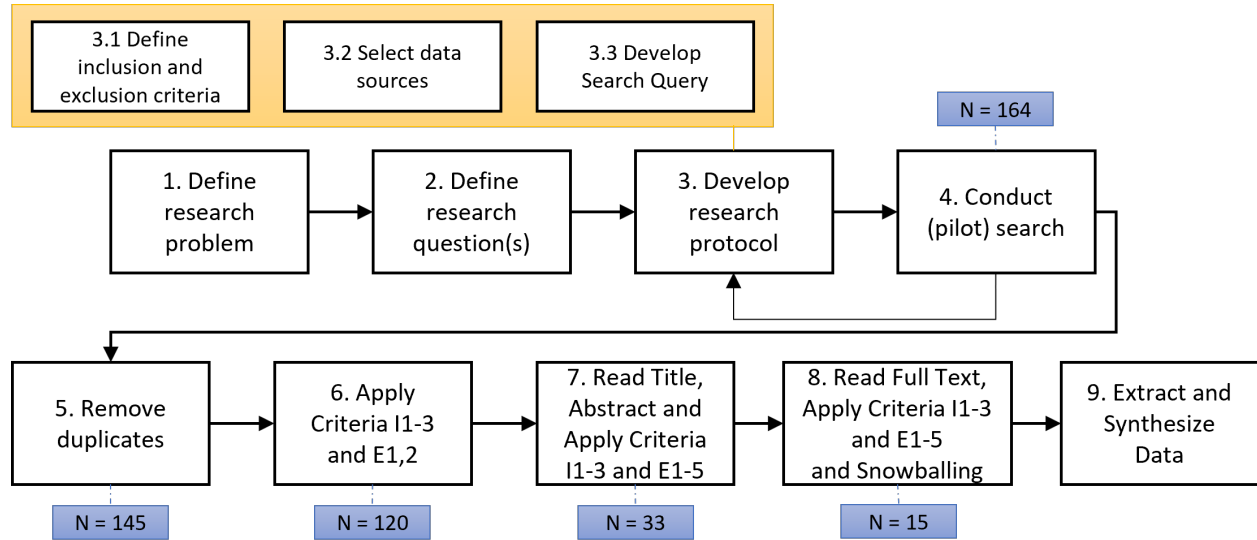
Figure 2.1: Systematic Literature Review Protocol

Steps 1 and 2 of the SLR process were to define the research problem and the research question(s). The research problem addressed in this SLR is the lack of methods that guide practitioners in the elicitation and assessment of digital platform requirements within a service system context.

In order to capture value co-creation, organizations should embrace the principles of Service-Dominant (S-D) logic in the design of their information systems (IS) (Haki et al., 2019). By doing so, organizations can better align their systems and processes with collaborative and customer-centric approaches to value creation (Haki et al., 2019). However, conventional RE techniques are not well-suited for this purpose, since they do not capture value co-creation well (Haki et al., 2019; De Reuver et al., 2018). While GORE methods can be effective in representing service system requirements, there is to my best knowledge no GORE method to elicit and assess digital platform requirements while capturing value co-creation. This lack of dedicated methods leaves practitioners without adequate guidance, as there are no clear steps or activities available in this domain.

A SLR is conducted to present the state of the art on GORE methods within a service system context and to demonstrate the need for the proposed method, GEA-DPR (Goal-oriented Elicitation and Assessment of Digital Platform Requirements). Based on this objective, the following research question is being formulated:

What is the current state of the art in GORE methods or appraoches that capture value co-creation while eliciting and assessing digital platform requirements?

According to the guidelines of B. Kitchenham et al. (1995), it is essential to confirm the need for a SLR. While there have been several reviews in the field of RE or GORE, none of them have specifically focused on the service system as the unit of analysis for value co-creation and digital platform requirements. For instance, Horkoff et al. (2019) conducted a systematic mapping study in the field of GORE, analyzing and categorizing various aspects of GORE research. While their study provided valuable insights into the broader landscape of GORE research, it did not specifically focus on value co-creation in service systems. Their work primarily focused on analyzing various aspects such as paper types, evaluation presence, covered

topics, frameworks used, venues, citations, author networks, and publication numbers in the field of GORE. The objective was to identify trends and offer recommendations for future research in GORE. Notably, the covered topics did not explicitly mention service systems. Among the 248 selected studies, 28 of them were found to discuss the topic of "Architecture," which encompasses papers focusing on various types of architecture, including software, systems, or business architecture. However, it was observed that these studies primarily focused on the development of software systems based on goals, rather than explicitly addressing service systems and the principles of the SDL. This finding suggests that the GORE research domain currently lacks sufficient representation of service systems and the SDL principles.

Additionally, Fragidis & Tarabanis (2011) conducted a study that explored a similar research question and provided complementary insights to this study. Fragidis & Tarabanis (2011) defined a set of concepts for analyzing the requirements of service systems as value co-creation systems based on the S-D Logic. They examined various GORE methodologies, such as KAOS, I*, Tropos, NFR, AGORA, and GBRAM, in relation to these concepts. Their study looked into the ability of GORE methodologies to capture specific service system elements and model value co-creation using goal diagrams. They concluded that GORE methods offer a promising foundation for analyzing value co-creation in service systems.

The findings highlight the suitability of the I* and Tropos methodologies for most aspects of the analysis of value co-creation, as they provide a broader systems perspective and consider agents as social entities with strategic intentions and dependencies. The study also emphasises the importance of AND/OR goal diagrams in modelling value co-creation. The abstract goal of value co-creation can be put at the top of the AND/OR goal tree, with subgoals contributing to its realisation. These valuable insights were utilized in the development of the GEA-DPR method, which incorporates the capabilities of I* and utilizes AND/OR goal diagrams to model value co-creation. However, Fragidis & Tarabanis (2011) did not specifically focus on providing an overview of GORE methods for eliciting or assessing digital platform requirements within a service system context.

The literature reviews conducted by Fragidis & Tarabanis (2011) and Horkoff et al. (2019) had distinct focuses that did not encompass the topic of value co-creation in service systems or provide a comprehensive overview of methods for eliciting and assessing digital platform requirements. Based on my current understanding, there is no existing SLR that specifically addresses this particular field of research. Hence, it was determined that conducting an SLR is necessary to fill this research gap and provide a comprehensive synthesis of relevant literature in this area. By doing so, an overview of the state of the art in research methods and approaches to accurately capture value co-creation on digital platforms within a service system context while eliciting and/or assessing digital platform requirements is provided.

Step 3 of the SLR process involved developing a research protocol, which included selecting data sources, defining a search strategy, establishing study selection criteria, and creating a data extraction form. It was chosen to use the Scopus and Web of Science (WOS) databases, as they are highly suitable for conducting the required SLR, given their high precision, reproducibility, and comprehensive coverage of leading IS journals (Gusenbauer & Haddaway, 2020; Palvia et al., 2015). Further, multiple search strings were tested, as displayed in Table 2.1 below.

Scopus	WOS	Query
8	5	(("service ecosystem*" OR "service system*") AND ("goal-oriented" OR "goal model*" OR "GORE") AND ("requirements engineering") AND ("method" OR "approach"))
12	8	(("service ecosystem*" OR "service system*") AND ("goal-oriented" OR "goal model*" OR "GORE") AND ("requirements engineering"))
72	21	(("service ecosystem*" OR "service system*") AND ("goal-oriented" OR "goal model*" OR "GORE" OR "requirements engineering") AND ("method" OR "approach"))
117	47	(("service ecosystem*" OR "service system*") AND ("goal-oriented" OR "goal model*" OR "GORE" OR "requirements engineering"))

Table 2.1: Search Query

During step 4, several pilot searches were conducted; however, when the AND operator was not used for "requirements engineering" and "method or approach," the initial pilot search yielded only 13 studies. Furthermore, when "method or approach" was excluded, the search yielded only 20 studies. To ensure a comprehensive review, the scope of the SLR was expanded beyond GORE methods. As a result, relevant studies that focused on both requirements engineering (RE) and service systems (SS) were also included. The search strategy employed the OR operator with the search term "requirements engineering" to capture a wide range of relevant literature. Additionally, to avoid excluding publications that could be useful for requirements elicitation and assessment in the context of service systems, the AND operator before "method or approach" had to be removed. As a result, the following search query was generated: (("service ecosystem*" OR "service system*") AND ("goal-oriented" OR "goal model*" OR "GORE" OR "requirements engineering")). After defining the search query and executing pilot searches, the study selection criteria were defined. The inclusion and exclusion criteria used in this SLR are presented in Table 2.2 below.

Inclusion Criteria	Exclusion Criteria
I1. The study discusses a method or approach that is relevant to elicit the requirements of a digital platform in a service system context.	E1. The study is written in languages other than English.
	E2. The study is not publicly available.
I2. The study discusses a method or approach that is relevant to assess the requirements of a digital platform in a service system context.	E3. The study is out of context (e.g., big data, IoT, smart PSS, smart manufacturing, etc).
I3. The study discusses a method or approach that is goal-oriented.	E4. The study does not discuss or explain a RE method or approach.
	E5. The study is referring to a method or approach originally published in another study.

Table 2.2: Inclusion and Exclusion Criteria

A classification scheme was formulated for the data extraction form to align with the research question of the SLR and to evaluate the quality of the methods and/or approaches outlined in the included studies. The form captures essential details about GORE methods, including author metadata, publication year, publication type, and a brief method description. Furthermore, the form evaluates the degree to which the methods or approaches described in the studies capture value creation, as delineated in the S-D Logic (Vargo & Lusch, 2016). Additionally, the form evaluates the requirements engineering phase and what timing and

type of evaluation was used, as delineated in the FEDS framework (Venable et al., 2016). These evaluations enhance the comprehensiveness of the analysis by examining the methods and approaches presented in the studies regarding their coverage of value co-creation aspects, requirements elicitation and/or assessment, and quality considerations.

The S-D Logic, as outlined by Vargo & Lusch (2016), is underpinned by five fundamental axioms encompassing elements such as service exchange, actors, resources, value, and institutions and institutional arrangements. In line with the S-D Logic perspective adopted in this study, which views service systems as arrangements of resources, information, and technology interconnected through value propositions, the evaluations of the studies focus on the incorporation of several key elements. These elements include service exchange, actor typology, operant and operand resources, value propositions, value in context, and institutional arrangements.

Within the S-D Logic framework, service exchange and multi-actor settings are fundamental elements of service systems and are therefore expected to be addressed in all included studies. However, it is worth noting that different definitions and interpretations of service systems exist, and not all studies explicitly discuss the key elements outlined in the S-D Logic. In order to provide a comprehensive analysis, each of the fundamental elements of the S-D Logic framework was considered in the data extraction process. This allows for an evaluation of the extent to which the methods or approaches presented in the studies capture digital requirements elicitation or assessment, with the service system serving as the primary unit of analysis for value co-creation (Maglio et al., 2009; Spohrer et al., 2007; Vargo & Lusch, 2008).

The final search query was implemented during step 5, and a total of 19 duplicate studies were identified and removed. As a result, the final set of studies for analysis included 145 different studies. During Step 6, an initial screening of studies was conducted using all the predefined inclusion criteria and exclusion criteria 1 and 2. This screening was performed based on the evaluation of titles and keywords. As a result, a preliminary set of 120 articles was identified for further assessment and analysis. Following that, in step 7, a second screening encompassing title, keywords, and abstract resulted in a refined set of 33 articles after all inclusion and exclusion criteria were applied. To expand the coverage, a snowballing approach was used on the articles in the refined set in step 8, resulting in the identification of 9 additional relevant studies. However, after a thorough review of the full text and consideration of all inclusion and exclusion criteria, 27 articles were eliminated, leaving a total of 15 studies for the data extraction process of step 9 using the designated data extraction form shown in Table 2.5.

The abbreviations listed in Table 2.3 will be employed in the following tables: Table 2.4, Table 2.5, and Table B.1.

Abbreviation	Explanation
SE:	Service Exchange
NA:	Nature of Actors
RES:	Resources
VP:	Value Propositions
VIC:	Value In Context
IA:	Institutional Arrangements
REP:	Requirements Engineering Phase
TEE:	Timing of Evaluation Episode
TE:	Type of Evaluation

Table 2.3: List of Abbreviations used in SLR

The data extraction form employed specific criteria that were assigned labels based on the data extraction coding keys presented in Table 2.4 below.

Topic	Values	Description
Publication Type	Conference publication (C) or Journal publication (J)	The publication can be classified as either a conference paper or a journal paper, depending on the specific venue where it was published.
Nature of Actor	Single Actor (s) / Multiple Actors (M)	The study focuses on the activities or perspectives of a single actor or multiple actors.
Resources	Operant resources (OR) and/or Operand resources (OD)	The study takes into account operand resources and or operant resources
Requirements engineering activities	Elicitation (E), Assessment (A)	The study discusses a requirements elicitation and/or assessment method or approach.
Timing of evaluation episode	Ex Ante (EA), Ex Post (EP)	Evaluation is performed before and/or after the artifact has been implemented.
Type of evaluation	Artificial and Summative (AS), Artificial and Formative (AF), Natural and Summative (NS) or Natural and Formative (NF)	The evaluation is conducted in an artificial or natural setting and the evaluation assesses overall effectiveness or focuses on identifying and correcting problems.
Specific variables: SE, VP, VIC, IA	Yes (Considered), No (Neglected)	The study does or does not take into account the specific variable.

Table 2.4: Data Extraction Coding Keys

These labels were used to assess each study in terms of the S-D Logic principles, requirements engineering phase(s), and evaluation timing, type, and method. The data extraction form provided a structured framework for systematically analyzing and capturing relevant information from the included studies. Table 2.5 and Table B.1 were created to organize the included studies based on their focus. Table 2.5 was dedicated to studies discussing GORE methods or approaches, while Table B.1 included studies discussing RE methods or approaches without explicitly considering the intentions or goals of the actors involved.

2.4.2 Results Systematic Literature Review

The results of the SLR encompass conference papers and journal articles published from 2006 to 2022 that address (GO)RE approaches or methods. First, an overview of the studies focusing on GORE methods will be presented. Subsequently, the studies that utilized RE techniques but did not explicitly adopt a goal-oriented perspective will be discussed.

Goal-Oriented Requirements Engineering and Service Systems

Figure 2.2 below presents a summary of the evaluation results regarding whether the presented methods or approaches discuss the value co-creation aspects.

As expected, all 12 included studies address service exchange and multi-actor settings. Additionally, the majority of studies consider value propositions. However, there is limited explicit discussion of operand and operant resources, value in context as well as institutional arrangements, across most of the studies. Furthermore, according to the information provided in Table 2.5 below, it is evident that only 3 out of the 11 studies were journal papers, and only 6 out of the 11 studies were relevant for assessing requirements. Moreover, most of the studies presented their method or approach without explicitly validating its quality, utility, or effectiveness. The studies employed various evaluation approaches, including demonstration, prototyping, artificial illustration, or no evaluation at all. Notably, the study conducted by Jungerius et al.
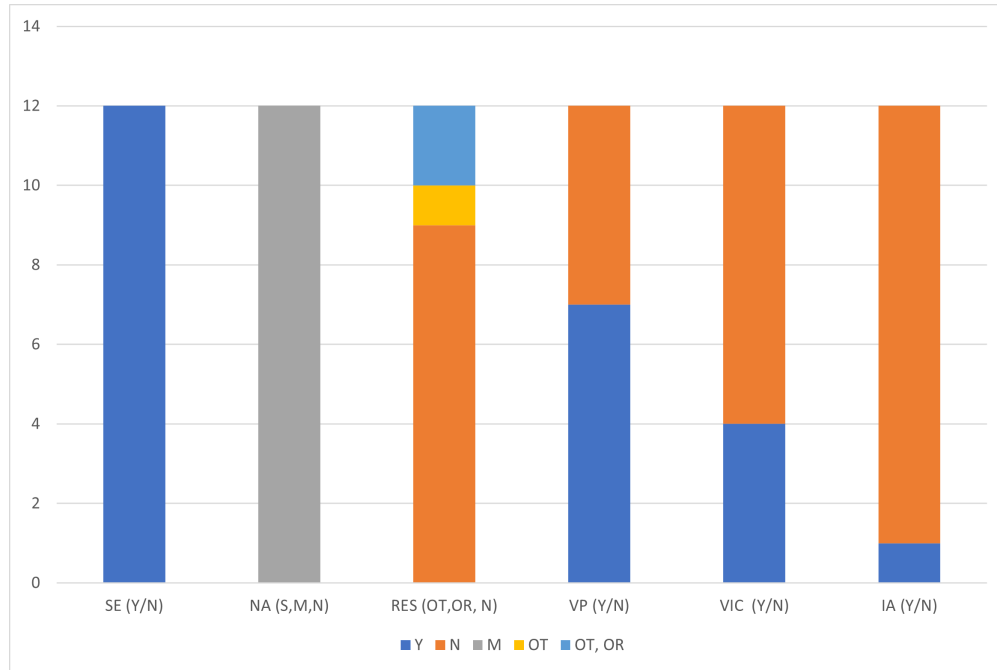
Figure 2.2: Evaluation of S-D Logic elements captured by GORE methods

(2022) stands out as the only study that demonstrated their method in a naturalistic setting and evaluated the method using a focus group methodology.

The data extraction of the identified GORE methods reveals a lack of comprehensive guidance in eliciting and assessing digital platform requirements while addressing value co-creation. This highlights the existing gap in effective digital platform requirements engineering methods that fully capture value co-creation. However, certain aspects of the identified studies provide valuable insights. To further evaluate these studies, the focus was on those that demonstrated the greatest potential for eliciting and assessing digital platform requirements while incorporating value co-creation. The selected studies employed GORE methods to capture value co-creation in service systems and focused on requirements elicitation or assessment methods or approaches at the service system, digital platform, or business services level.

The study of Lessard et al. (2020) captures value co-creation and can be used to elicit (digital) service system requirement. Lessard et al. (2020) adopted a service-oriented approach that emphasizes the value-creating relationships between entities within complex socio-technical service systems and proposed a method for the elicitation and analysis of the requirements needed to design a service system. They propose a domain-specific profile of the Goal-oriented Requirement Language (GRL), a goal-oriented modelling language, as well as a set of heuristics for eliciting requirements for service systems based on S-D Logic principles. The study conducted by Lessard et al. (2020) recognizes the significance of capturing and representing requirements in the design and development of digital service systems. It specifically emphasizes the value-creating relationships within service systems.

The studies of Jungerius et al. (2022), Adali et al. (2021) and Dubois et al. (2012) propose GORE methods that capture value co-creation and can be used to elicit or assess (digital platform) requirements. Jungerius et al. (2022) adopted a service systems engineering perspective and proposed a method for the assessment of digital platform requirements. They used SME with an extension-based strategy to develop a method for the value proposition-driven platform requirements assessment.

Authors	Year	Publication Type (C/J)	Description	SE (Y/N)	NA (S,M,N)	RES (OT, OR, N)	VP (Y/N)	VIC (Y/N)	IA (Y/N)	REP (E,A,N)	TEE (EA, EP)	TE (A,N,F,S)	Evaluation Method
O. Adli, B. Ozkan, O.Turetken et al	2021	C	Method to guide the identification of platform requirements from value propositions in the form of use case descriptions	Y	M	OT	Y	Y	N	E	EP	(N,S)	Demonstration only
A. Ângelo, J. João	2022	J	Conceptual model of the information requirements of legionella- safe cooling towers in the era of Industry 4.0.	Y	M	N	Y	N	N	E,A	EA	(A,F)	Prototyping using a digtial twin
Dubois, E	2014	C	Framework for supporting a SS composed from several organizations in their implementation of the requirements coming from different norms, regulations and best practices.	Y	M	N	Y	N	N	E,A	EA	F	Illustration in unknow context only
E. Dubois, S. Kubicki, S. Ramel et al.	2012	C	Approach for the elicitation and the modelling of assurance requirements inherent to business services.	Y	M	N	Y	Y	N	E	EA	(A,F)	Demonstration only
G. Fragidis	2017	C	Goal model and a UML class diagram that describes the structure of the main concepts and relationships of the user-centric service ecosystem.	Y	M	N	Y	Y	N	E	N	N	N
M. Hamano, B. Ho, T. Hara et al.	2020	C	Method to predict and evaluate how customer dysfunctional behavior affects other actors by incorporating behavioral logic in social modelling.	Y	M	N	N	N	N	E	EP	(N,S)	Demonstration only
N. Jungerius, B. Ozkan, O. Adali, et al.	2022	C	Method for the assessment of a digital platform based on the requirements identified from the desired value co-creation to be enabled by the platform.	Y	M	OT, OR	Y	Y	N	E,A	EP	(N,S)	Demonstration and Focus Group Study
L. Lessard, D. Amyot, O. Aswad, et al.	2020	J	Domain-specific profile of the Goal-oriented Requirement Language, as well as a set of heuristics for eliciting requirements for SSs.	Y	M	OT, OR	Y	Y	Y	E	EP	(N,S)	Demonstration only
L. Liu, C. Chi, Jin et al.	2006	C	Service requirements ontology that is based on the actors' strategic capability.	Y	M	N	N	N	N	E,A	EP	(A,S)	Illustration only
M. Orellana, J. Silva, E. Pellini et al.	2021	J	Approach for Smart-Grid Systems Design	Y	M	N	N	N	N	E,A	EP	(N,F)	Demonstration only
A. Rifaut	2011	C	Generic, Specific and Instantiated Measurement Framework Model.	Y	M	N	N	N	N	E,A	EP	(N,S)	Demonstration only
L. Patrício, J. Falcão e Cunha, R. Fisk	2009	C	Method for the design of technology enabled multi-channel SSs.	Y	M	N	N	N	N	E,A	EA	(N,F)	Demonstration only

Table 2.5: GORE Methods or Approaches discussing Service Systems

Adali et al. (2021) adopted a service system perspective and proposed a method for the identification of digital service platform requirements. They used SME with an extension-based strategy to develop a method for the identification of platform requirements from value propositions in the form of use case descriptions. Dubois et al. (2012) adopted a business service perspective and proposed a systematic approach for eliciting and modelling assurance requirements for business services within a service system. Their approach is based on guidelines from the ISO 15504 norm and uses goal-oriented RE techniques such as I*.

Both Adali et al. (2021) and Jungerius et al. (2022) utilized the VP-BSIM method as their base method for developing their methods. The VP-BSIM method guides actors in a service system to transform their value propositions into standardized, modular resource configurations represented by business services (Adali et al., 2020). Adali et al. (2021) extended the VP-BSIM method with the Service RE Method (SREM) for a Digital Service Ecosystem of Immonen et al. (2016) and Jungerius et al. (2022) with the requirements elicitation approach of Dubois et al. (2012). The method of Dubois et al. (2012) focuses on capturing business requirements and transforming them into a business-oriented solution, which is part of a more complete methodology encompassing the service value and service software views of a service system. Although certain aspects of these methods contribute to the development of the GEA-DPR method, none of the reviewed studies specifically addressed the elicitation and assessment of requirements for a digital platform from scratch within a service system context.

Requirements Engineering and Service Systems

The studies discussed in this section do not meet inclusion criterion 3, as the methods and approaches discussed in those studies are not goal-oriented. However, to ensure that no relevant RE methods were overlooked, these studies were still evaluated. The data extraction form for the RE methods discussed in this section is available in Table B.1 in the Appendix A.

As anticipated, all three studies address the concept of service exchange and the involvement of multiple actors. Further, two out of the three studies discuss operant and operand resources, and none of the studies explicitly considers institutional arrangements. The evaluation approaches in the three studies included a retrospective application with expert evaluation and feature-based evaluation, a demonstration combined with questionnaires, and a demonstration-only. The studies highlighted a lack of consideration for value propositions, value in context, and institutional arrangements in the service systems context, indicating a research gap in the literature.

From the included studies that discuss RE methods, only the study of Immonen et al. (2016) captured more than half of the selected value co-creation elements. The study of Immonen et al. (2016) introduced a novel approach for defining the requirements of digital services in an ecosystem-based manner. They proposed a scenario-based RE method and developed a service engineering model through a comprehensive state-of-the-art ecosystems analysis. Furthermore, they proposed the use of a Use Case Description template for requirements elicitation and a Use Case Analysis template for identifying, analyzing, and specifying the requirements. Their method involves an iterative process that considers evolving requirements, feedback, and change requests. The method's focus on realistic scenarios helps identify necessary requirements and ensure stakeholder needs are met in regulated environments, making it valuable for describing and communicating digital ecosystem-based services.

The method of Berkovich et al. (2014) assumes that the requirements are already elicited and focuses on how to structure and specify them using the RDMod. This approach mainly focuses on the RDMod and not on the process of assessing requirements. On the other hand, Lee et al. (2011) proposes an approach for requirements management and service identification that incorporates value co-creation and IT convergence. While this approach includes customer feedback and goals, it does not adequately address the specific elements of value co-creation used in this research, such as operant and operand resources, value propositions, and value in context. Furthermore, the approach outlines the steps to take but lacks sufficient guidance for practitioners to follow them. All three studies were excluded from the remainder of the research, as they were found to be irrelevant to the research goal of this research and they are not goal-oriented.

2.5 Conclusions Literature Review

The results of the SLR provide valuable insights into the (GO)RE methods and approaches within the context of service systems. The findings indicate a notable gap in the availability of methods that capture value co-creation, facilitate the elicitation and assessment of digital platform requirements and possess empirical validation. While the existing works provide useful foundations, there is a need for further development and adoption to provide comprehensive guidance for practitioners in performing the necessary tasks and activities for eliciting and assessing digital platform requirements within the service system context.

The method proposed by Lessard et al. (2020) offers several advantages in developing the GEA-DPR method. Their use of a Goal-oriented Requirement Language (GRL) profile and heuristics based on a meta-model rooted in S-D Logic principles provides a strong theoretical foundation. The heuristics offer a systematic step-by-step approach for extracting the necessary data to create a high-level service system requirements model. The method is effective in identifying and modelling goal metrics, as well as dependencies on other actors, goals, and both operand and operant resources. This enables a comprehensive overview of each actor's intentions and dependencies. However, a limitation of the method is that it yields high-level service system requirements models, which may not be adequate for eliciting the detailed requirements of a digital platform. Therefore, an extension is necessary to tailor the method specifically for digital platform requirements.

On the other hand, both the method proposed by Immonen et al. (2016) and Dubois et al. (2012) are not well-suited for the objectives of the GEA-DPR method. Immonen et al. (2016)'s approach, which utilizes scenario and use case methods, can be time-intensive and may not align with the research objective of eliciting and assessing requirements from a blank slate. Furthermore, their focus on a digital ecosystem implies a different conceptualization of the system, with weaker interconnections between theoretical assumptions and the principles of S-D Logic and the broader service system engineering perspective. Similarly, Dubois et al. (2012)'s method, which primarily focuses on business services and assurance requirements, may not effectively capture the value co-creation aspect specific to digital platform design within a service system context. While the method proposed by Dubois et al. (2012) offers valuable insights into business services and assurance requirements, its applicability to the digital platform design process, particularly in the service system context, may be limited.

Additionally, the method proposed by Berkovich et al. (2014) assumes that the business requirements have already been identified and primarily focuses on the creation of a digital platform, rather than providing comprehensive guidelines for requirements elicitation and assessment. On the other hand, the method proposed by Lee et al. (2011) is helpful in eliciting requirements but lacks the incorporation of modelling and resource dependencies, making it challenging to understand the dependencies of the elicited requirements on other service system actors and resources.

Furthermore, the method proposed by Adali et al. (2021) is useful for eliciting digital platform requirements in the form of use cases but is less powerful in expressing non-functional requirements and resource dependencies. It also does not assess the feasibility of the requirements for the digital platform to be developed. Additionally, Jungerius et al. (2022)'s method is useful to elicit and assess the requirements based on the value propositions of the desired value co-creation of the digital platform. It enables the assessment of an already deployed digital platform to determine if it facilitates the desired value co-creation of platform actors. However, this method is less suitable for the initial elicitation and assessment of requirements for a digital platform created from scratch.

The studies conducted by Lessard et al. (2020), Adali et al. (2020), and Jungerius et al. (2022) share a common characteristic in their approach, as they extensively incorporate S-D logic principles and can be used to elicit and/or assess requirements. These methods focus on considering the value proposition of each actor within the service system and employ goal modeling techniques to visualize intentional elements. Drawing upon these valuable aspects, the GEA-DPR method has been developed. However, as discussed in Chapter 2, when developing an information system within a network of actors, it is typically done from scratch. The configuration of actors' value propositions and available resources determines the requirements of the information system. Therefore, the GEA-DPR method takes a holistic approach to elicit and assess digital

platform requirements, considering the service system perspective. By utilizing various GORE methods, it systematically analyzes the service system, gradually elicits the requirements of the digital platform, and assesses the feasibility of each requirement. The ultimate goal of the GEA-DPR method is to guide users through the entire process of eliciting and assessing requirements, ensuring the development of a digital platform that enables value co-creation within the service system.

Based on the conducted SLR, there is a need for a GORE method that enables a comprehensive and systematic analysis of the goals and intentions of various actors within service systems, ensuring effective elicitation and assessment of requirements for a digital platform while considering the service system context. The proposed GEA-DPR method is designed to address this gap. The base method selected for the development of GEA-DPR is the method proposed by Lessard et al. (2020). Furthermore, elements from the methods proposed by Adali et al. (2021) and Jungerius et al. (2022) were incorporated to extend the base method. For instance, one of the initial sub-activities of the VP-BSIM (Value Proposition-based Business Service Innovation Method) is the Service-Dominant Business modelling (SDBM-r) technique proposed by Turetken et al. (2019) to structure and model the value propositions of each service system actor. This technique is also included as one of the initial activities needed before using the GEA-DPR method. Overall, the GEA-DPR method aims to bridge the gaps identified in the existing methods and provide a comprehensive approach for eliciting and assessing the requirements of a digital platform in the context of service systems.

Chapter 3

Research Design

This research presents a research conducted within the field of Information Systems (IS) that utilizes the DSRM proposed by Peffers et al. (2007). DSRM is a widely used method in DSR. The emphasis within DSR is on the practical application of research via a structured process of designing, developing, and evaluating artefacts. Its application is widespread in IS research, where it provides practical solutions to real-world problems in a variety of domains (Hevner et al., 2004).

DSRM is an appropriate approach to pursue in order to achieve the objective of this research, which is to develop a comprehensive method, named GEA-DPR, for eliciting and assessing platform requirements using GORE. The entry point of the research is to provide an objective-centered solution that addresses the gaps identified in Chapter 2. The iterative DSR process, as illustrated in Figure 3.1, was used throughout this research.
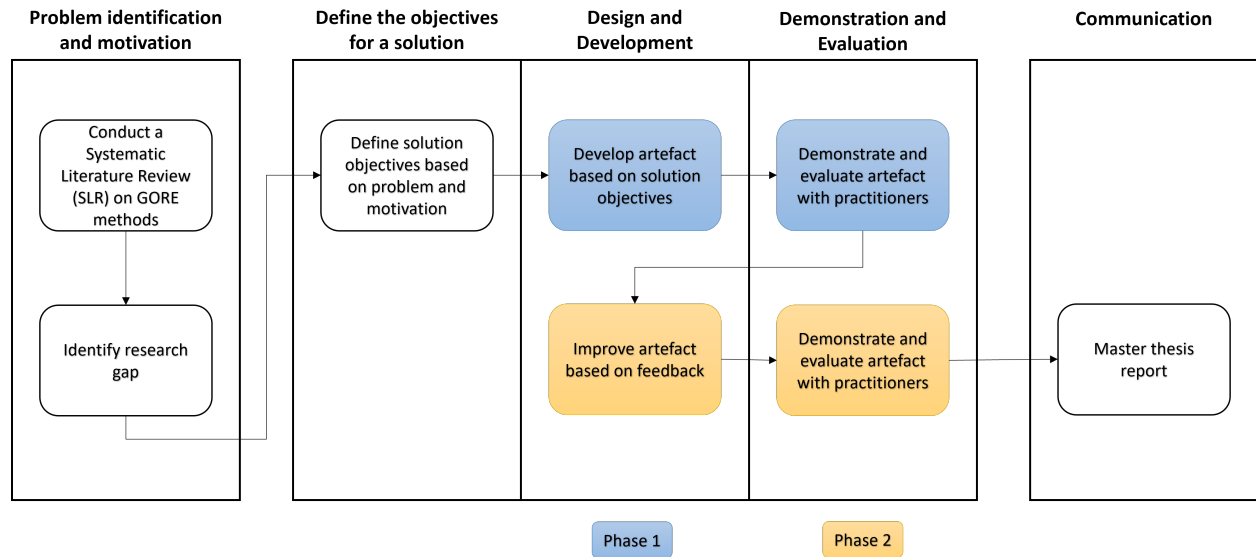
Figure 3.1: Overview Research Process

The DSR method proposed by Peffers et al. (2007) comprises six activities, all of which were used in this master thesis research. However, as illustrated in Figure 3.1 above, the design and development, as well as the demonstration and evaluation activities, were executed twice, once in phase 1 and once in phase 2 of this study.

First, a SLR with a snowballing approach was conducted to identify and motivate the problem. Second, solution objectives were formulated based on a combination of expert knowledge, an in-depth review of relevant literature, and practical insights obtained from the case study context. The design and development step and the demonstration and evaluation step of the GEA-DPR method were executed in two phases. In the first phase, the GEA-DPR method was designed and developed in accordance with these objectives using a SME approach and an extension-based strategy. Next, the application of the GEA-DPR method was demonstrated at a case company. In the second phase, the GEA-DPR method was improved based on the feedback obtained from the exploratory focus group (EFG) results. The improved method was then applied to the same company, focusing only on the modified parts, and the resulting final version of the method was evaluated through the use of a confirmatory focus group (CFG). The EFG and CFG were used to improve

the GEA-DPR method design and assess its utility, quality, and efficacy. Finally, the solution was presented orally and in the form of a master thesis report. Following this structured approach ensured a systematic and comprehensive research process, ensuring that both rigor and relevance were maintained during IS method development (Baskerville et al., 2018; Hevner et al., 2004).

The sections that follow will outline each of the activities suggested by Peffers et al. (2007) and used in this thesis. The research design will be explained in greater detail and the context of the company where the GEA-DPR method will be demonstrated and evaluated will be presented.

3.1 Problem identification and motivation

The first activity of the DSRM is to conduct a SLR to identify and motivate the problem. In Chapter 1 an overview of the need for and relevance of the identified problem is provided, while in Chapter 2 related work and background information is presented. The SLR and the snowballing approach were executed following the guidelines proposed by B. A. Kitchenham (1996) and Wohlin (2014), respectively. The SLR revealed that current GORE methods do not effectively capture value co-creation while eliciting and assessing digital platform requirements, emphasizing the need for an extension of the method proposed by (Lessard et al., 2020).

3.2 Define the objectives for a solution

The next step is to define the solution objectives, which will serve as guidelines for developing a solution by specifying how the identified problem should be addressed (Peffers et al., 2007). The solution objective is to address the identified research problem as follows:
The develop a method for business analysts that provides guidance in the process of eliciting and assessing digital platform requirements within a service system context, with a focus on enabling value co-creation.

The GEA-DPR method aims to outline the steps and activities that business analysts can follow to effectively elicit and assess digital platform requirements, considering the context of a service system. In order to effectively address the problem, the GEA-DPR method to be developed must satisfy a number of solution objectives. The development of the solution objectives was informed by a combination of expert knowledge, an in-depth review of relevant literature, and practical insights obtained from its application to a business case.

The aim of eliciting and assessing digital platform requirements is to develop a digital platform that effectively captures value co-creation. Value co-creation is a collaborative process involving multiple actors within service systems (Vargo & Lusch, 2004, 2008). Service systems are interconnected networks of people, organizations, technologies, and resources that deliver value (Lusch & Nambisan, 2015). They facilitate the exchange of knowledge, skills, and resources, enabling the mutual generation of value (Lusch & Nambisan, 2015; Vargo & Lusch, 2008). Service systems offer insights into complex contexts of value co-creation, underscoring the importance of mutual exchange relationships and resource integration (Vargo et al., 2008). Consequently, service systems serve as the unit of analysis for value co-creation. As a result, the first solution objective of this research is formulated as follows:

SO1. The method should support value co-creation and therefore employ the concept of service systems.

The elicitation of requirements is a fundamental first step in the RE process. If this step is not carried out correctly, it may result in the development of sub-optimal products, extended delivery schedules, and excessive costs (Barry et al., 1981). For example, the costs of correcting defects in software requirements in later stages can be up to 200% more expensive (Leffingwell & Widrig, 2000). However, deriving platform requirements from value propositions in a digital service system is very complex (Adali et al., 2021). Therefore, the GEA-DPR method should offer sufficient guidance to business analysts to elicit platform requirements in a service system. As a result, the second solution objective is formulated as follows:

SO2. The method should provide users with a systematic approach for eliciting digital platform requirements while considering the service system context.

To address this solution objective the GEA-DPR method should have specific techniques, tools, and guidelines that assist business analysts in effectively eliciting digital platform requirements within the context of the service system. It should facilitate a step-by-step process, ensuring that all relevant aspects of the service system are considered during the requirements elicitation phase.

Changes in an actor's value proposition have an impact on the platforms' requirements since value propositions determine the configuration of actors, resources, and value co-creation activities within the service system (Böhmann et al., 2014; Alter, 2011). In addition, the feasibility of the platform requirements is dependent on the dynamic interplay between tasks and resources performed and available within the service ecosystem, which involves multiple actors. Therefore, it is essential for the GEA-DPR method to provide users with the capability to trace back to the original intentions of each actor (strategic alignment) and systematically evaluate the feasibility of the platform requirements. As a result, the third solution objective is defined as follows:

SO3. The method should provide users with a systematic approach for assessing the feasibility of the elicited digital platform requirements using the GEA-DPR method within the service system context, ensuring traceability between requirements, their dependencies, and higher-level objectives.

To address this solution objective the GEA-DPR method should utilize requirements modelling and analysis tools. These tools enable visualizing dependencies and traceability, helping stakeholders understand the interdependencies among requirements and their contributions to the value propositions and the co-created value in use.

The configuration of the service system is influenced by the intentions and behaviors of stakeholders. Hence, it is crucial to clearly formulate the objectives as stakeholder goals. By incorporating explicit goal representations in requirement models, the completeness of the requirements can be assessed (Liu & Yu, 2004). Moreover, the utilization of models enables the reasoning about goals, thereby facilitating effective communication among stakeholders (Van Lamsweerde, 2001). As a result, the fourth solution objective is defined as follows:

SO4. The method should consider and model the intentions and behavior of each stakeholder involved in the service system and affected by the digital platform.

The GORE approach has been shown to be effective and widely used for developing coherent, effective, and efficient systems that meet the needs and expectations of stakeholders (Yu, 1997). Therefore, the GEA-DPR method should utilize goal modelling and the GORE approach to elicit and assess digital platform requirements.

This set of solution objectives will serve as the foundation for the method named GEA-DPR that will be developed.

3.3 Design and Development

This step entails determining the desired functionality and architecture of the artifact, as well as creating the actual artifact (Peffers et al., 2007). The designed artifact in this study will be a method for platform requirements elicitation and assessment. The method design components and evaluation criteria proposed by Offermann et al. (2010) will be used during the development of the GEA-DPR method. These components and criteria should contribute to the GEA-DPR method's completeness and correctness.

The GEA-DPR method is designed using a SME approach, which encompasses the entire process of developing, implementing, and adapting a software development method to specific local conditions (Henderson-Sellers et al., 2014). SME involves creating a method that is tailored to the specific situation at hand (Henderson-Sellers et al., 2014). The development of the GEA-DPR method is based on the Generic Process Model for SME proposed by Ralyté et al. (2003). This model outlines three distinct strategies for constructing methods, namely the "from scratch strategy," the "extension-based strategy," and the "paradigm-based strategy" (Ralyté et al., 2003). As previously mentioned, the GEA-DPR method is constructed based on the concepts and heuristics proposed by Lessard et al. (2020), thus applying the extension-based strategy, which involves selecting extension patterns that recognize typical extension situations and carrying out the

required extensions (Ralyté et al., 2003). The Process Model for Pattern-Matching Based Extension was utilized, starting with the specification of extension requirements (based on the solution objectives), followed by the selection and application of meta-patterns using a product and process extension approach to execute the extension. The chosen meta-patterns were selected to effectively extend the base method, ensuring that it fulfills the solution objectives. In order to ensure the quality and completeness of the designed solution, an evaluation strategy and a completeness strategy were applied as suggested by Ralyté et al. (2003). These strategies are elaborated upon in section 3.4 and Chapter 6. Furthermore, the meta-patterns will be explained in Chapter 4.

Requirements elicitation and analysis are traditionally conducted between users and analysts, and it determines the success of the later stages of a software's life cycle (Bano et al., 2018). Therefore, the intended users of the GEA-DPR method are business analysts that need guidance in the process of eliciting and assessing digital platform requirements. The GEA-DPR method is designed to offer them comprehensive guidance on how to conduct high-level activities that aim to elicit system requirements, as well as subsequent activities that facilitate the conversion of these system requirements into digital platform requirements, and to assess the feasibility of these requirements. The business analysts are typically employed by the focal organization, which plays a central role in the service system and often takes the lead in driving initiatives.

3.4 Demonstration, Evaluation, and Communication

These steps consist of demonstrating how the artifact can be used to solve one or more instances of the problem, examining and assessing how well the artifact contributes to the objective of this study, and communicating the problem and its significance to researchers and other relevant audiences, as well as the artifact, its utility and novelty, the rigor of its design, and its effectiveness (Peffers et al., 2007).

Firstly, the developed method will be demonstrated through its application to a case of a farming solution service offered by an agricultural company to the needs of smallholder farmers, located in Cambodia. The case company context is presented in section 3.5. Next, an appropriate evaluation strategy is selected and evaluation criteria are formulated. Evaluation is a critical activity because it indicates whether or not an artifact works (Herselman & Botha, 2015). Effective evaluation methods enable researchers to demonstrate the utility, quality, and efficacy of a design artifact with rigor and accuracy (Hevner et al., 2004).

The frameworks proposed by Venable et al. (2012) and Venable et al. (2016) were used to evaluate the designed artefact. Since the designed method is a socio-technical artefact it was chosen to evaluate the designed method in a naturalistic setting. According to the framework of Venable et al. (2012) a focus group methodology is suited to evaluate the designed method both ex ante and ex post. As a result, it was decided to use focus groups to collect feedback and points of improvement during the GEA-DPR method's development phase, as well as to evaluate its utility and identify points of improvement once the designed method is complete. The execution of the focus groups and the evaluation criteria used will be further discussed in Chapter 6. Finally, the GEA-DPR method is communicated in a report written for Eindhoven University of Technology and displayed in their master's thesis database. This report is also distributed to the case company and focus group participants as well. In addition, academic professionals were given a presentation on the whole process and the developed artifact, results, and findings presented in this report.

3.5 Demonstration Context

The following case was used demonstrate the application of the GEA-DPR method. The case company, Agros, operates in the agricultural sector and is located in Singapore, Myanmar, and Cambodia. Agros aims to double smallholder farmers' income while also making their farms climate-proof for future generations. They intend to accomplish this by providing farmers with a comprehensive solution that combines various technologies, inputs, advice, and financing. Farmers can reduce input costs, improve soil health, and increase yields with this comprehensive solution. By being actively present on-site and maintaining direct contact with farmers during field visits, leveraging data, and allowing the farmer to pay over time ensures adoption, sustainability, and affordability. Agros operates within a service system that connects various elements such as technologies, inputs, advice, and financing, resulting in a significant increase in farmers' profits while

concurrently reducing emissions. Agros' solutions are marketed under two distinct brands: Agrosolar and Agrosoil, which harness the power of the sun and soil, respectively, to assist farmers in increasing productivity and profitability.

Agros currently provides agricultural services with the help of an agronomist, who visits farms on a regular basis. However, Agros wants to offer its services through a sustainable farming platform. The platform will serve several purposes. Firstly, the platform will enable Agros to leverage their expertise and skills (operant resouces) in smart farming, allowing them to support farmers in maximizing the benefits of Agros' products. Agros intends to offer sustainable farming and business advice to their customer farmers, providing them with valuable insights and recommendations. To facilitate this, the platform will include an agricultural calendar that assists farmers in making informed decisions at the right time, leading to increased yields and cost reduction. Secondly, the platform should allow Agros to bring together their different brands in one place and offer both Agrosolar and Agrosoil to farmers on the platform. The platform will be a place where farmers can purchase water pumps, soil tests, and fertilizers, and schedule field visits (operand resources).

Agros wants to identify the digital platform requirements needed to enable value co-creation. They then plan to use these requirements to design a digital platform. However, they are seeking guidance in the requirements elicitation process because they are unsure how to consider all elements of the service system. They also want to understand how the digital platform will impact their current method of offering products and services. For example, they want to know if the digital platform can replace field visits or if they are still necessary. In addition to identifying the functionalities of the digital platform, Agros aims to assess the feasibility of their ideas. This assessment is crucial for ensuring that the digital platform requirements align with Agros' current operating context and can be successfully implemented. Additionally, Agros seeks to evaluate whether each requirement contributes to the achievement of their established goals and meets the expectations of their stakeholders. By conducting a feasibility assessment, Agros can make informed decisions regarding the implementation of specific requirements, prioritize resources effectively, and ensure that the digital platform aligns with their strategic objectives.

Chapter 4

Design and Development

4.1 Conceptual Underpinnings

This section will first present the theoretical underpinnings of the base method, the SDBM-r, and the meta-patterns. Subsequently, the design decisions made to extend the base method and achieve the solution objectives will be explained.

As mentioned in Chapter 3, the method is created following the generic model for SME proposed by Ralyté et al. (2003). The selected base method proposed by Lessard et al. (2020) and its first extension, inspired by Turetken & Grefen (2017) approach, both recognize the significant role of the S-D Logic in the context of SSE. The extension requirements of the base method align with the solution objectives outlined in section 3.2. Furthermore, the chosen meta-patterns effectively contribute to extending the base method to fulfill these solution objectives. The selected meta-patterns from Ohshiro et al. (2005), Letier & van Lamsweerde (2002), Amyot et al. (2009), and Amyot et al. (2010) provide practitioners with practical guidelines for goal-oriented activities and offer systematic and constructive support in software requirements elicitation, modelling, and analysis. By incorporating these meta-patterns, the extensions made to the base method in the development of the GEA-DPR method are built upon well-founded and empirically validated approaches, thereby enhancing the reliability and effectiveness of the overall development process.

4.1.1 Base method

The approach of Lessard et al. (2020) is unique as it acknowledges the significance of S-D Logic in service engineering and establishes a strong theoretical service system meta-model. Both the GLR-profile and the heuristics are based on this meta-model. To construct the service system meta-model, they began by capturing the foundational principles of S-D Logic and translating them into meta-model constructs. They then incorporated important concepts related to service systems, resulting in a comprehensive service system meta-model presented in Figure 4.1 below.
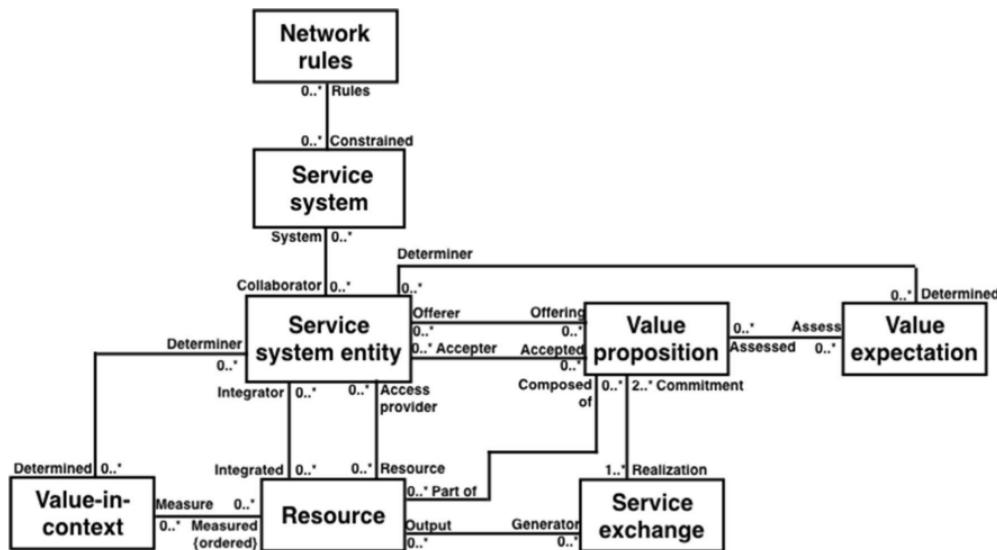
Figure 4.1: Service System Meta-Model (Lessard et al., 2020)

To develop the GRL profile, they first ensured that the service system meta-model was internally coherent and adhered to the rules of the (Unified Modelling Language) UML by applying UML's Object Constraint Language (OCL). Next, they mapped the constructs and relationships of the service system meta-model to the GRL, resulting in a lightweight profile that is specifically tailored to service systems. This mapping is presented in Table 4.1 and in Table 4.2 below.

Service system metamodel constructs	GRL construct with (« stereotype value »)
Network rules	Goal (« rule »)
Service system	Actor (« service system »)
Service sysem entity	Actor (« service system entity »)
Value proposition	Goal OR softgoal (« value proposition »)
Value expectation	Goal OR softgoal (« value expectation »)
Resource	Softgoal or task for operant resources (« operant resource »)
	Resource for operand resources (no stereotype needed)
Service exchange	Task (« service exchange »)
Value-in-context	Indicators to measure goal achievement

Table 4.1: Mapping between service system metamodel constructs and GRL constructs Service

Service system metamodel relationship	GRL relationship
Network rules < Rules... Constrained > Service System	Dependency link
Service System < System... Collaborator > Service System Entity	Calculated from model information through an OCL request: Satisfaction of "Service exchange" Task stereotype through dependency link to "Value proposition" Goal stereotype
Service System Entity < Acceptor... Accepted > Value proposition	Calculated from model information through an OCL request: Satisfaction of "Value expectation" Goal stereotype through contribution link from "Value proposition" Goal stereotype
Value expectation < Assess... Assessed > Value proposition	Contribution link from a "Value proposition" element to a "Value expectation" element
Resource < part of... Composed of > value proposition	Decomposition link
Value proposition < Commitment... Realization > Service exchange	Contribution link from "Service Exchange" to Output "Resource." If the service exchange is modelled through a UCM, then the availability of Output "Resource" can be made conditional to a scenario being fulfilled
Value-in-context < Measured... Measure > Resource	Empty correlation link (optional) from "Resource" to "Value-in-context" indicators measuring achievement of "Value expectation"

Table 4.2: Mapping between service system metamodel relationships and GRL relationships

They used other studies in the literature to map or adapt varied goal-oriented modelling languages to value co-creation concepts. This process of mapping allowed for a more complete and accurate representation of the requirements for service systems to be elicited and analyzed during the design process. The lightweight profile uses a graphical representation of service system elements and relationships, as well as a generic GRL model of a service system. The generic GRL model of the service system is presented in Figure 4.2 below.
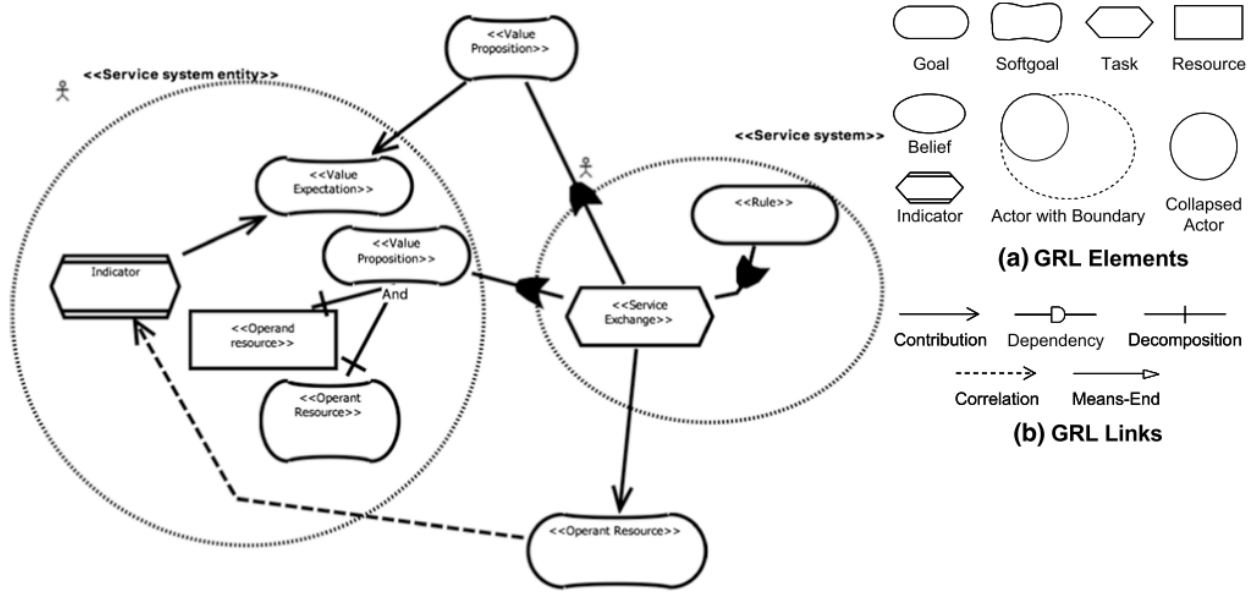
Figure 4.2: Generic GRL model of a service system (left side) and GRL elements and links used in profile (right side) (Lessard et al., 2020)

The heuristics are specifically designed to facilitate requirements elicitation, to ensure that each construct in the service system meta-model is accounted for and enabling the development of comprehensive high-level service system requirements models that align with this meta-model. These heuristics are presented in Table 4.3. By adhering to these heuristics, a high-level service system requirements model is created, which embodies the principles of S-D Logic and takes into consideration the network rules, entities, value expectations, value propositions, resources (operand and operant), service exchanges, and value-in-context of the service system. However, the resulting model focuses on the entire service system and lacks details at lower levels. Therefore, it is necessary to expand these heuristics to incorporate sufficient details to enable users to elicit digital platform requirements as well. Additionally, while the heuristics explain 'what' needs to be identified or determined for each meta-model construct, they do not provide guidance on 'how' practitioners should accomplish these tasks.

4.1.2 Service Dominant Business Model Radar (SDBM-r)

The Service-Dominant Business Model Radar (SDBM-r) developed by Turetken & Grefen (2017) is a unique business engineering tool designed to facilitate the alignment of business operations with the principles of S-D Logic. As discussed in Section 1.1, S-D Logic has transformed the way businesses create value by emphasizing collaborative processes among service system entities to co-create value through service-for-service exchanges (Vargo & Lusch, 2008). The paradigm shift in business value creation has wide-ranging implications for business engineering, requiring novel approaches that are rooted in S-D Logic principles. The SDBM-r was designed to address this need. The SDBM-r is a critical component of the business engineering framework developed to engineer network-based, service-dominant businesses (Turetken & Grefen, 2017). It utilizes several layers to represent different aspects of the business model. The SDBM-r, which serves as a tool for modelling service-dominant businesses, is presented in Figure 4.3 below.

The SDBM-r consists of five concentric layers. The first layer is the *Co-Created Value-in-Use* layer, which represents the central point in the SDBM-r and forms the main value of the solution delivered to a customer (Turetken & Grefen, 2017). All other layers are built around this layer, and it is the value that is created through the collaboration of all actors in the service network that forms the co-created value-in-use. The second layer is the *Actor Value Proposition* layer, where the value proposition of each actor in the service

Service system meta-model constructs	Heuristic (H)	Requirements elicitation information to be gathered
Service system	H1	Identify the service system and its boundaries, which will help determine which service system entities are comprised within these boundaries
Network rules	H2	Identify any rule or regulation that may constrain interactions or operations within the service system
Service system entity	H3	Identify service system entities part of the service system, thus human or non-human actors that have value expectations toward other actors in the service system
Value expectation	H4	Identify each service system entity's value expectations and the entity (or entities) expected to fulfill each expectation. If a value expectation is to be fulfilled by a service system entity that is outside of initially defined boundaries for the service system, determine if the service system boundaries need to be redefined, or if that particular value expectation is beyond the scope of the service system
Value proposition	H5	Identify the value proposition(s) that each service system entity is willing to make to other entities to fulfill its value expectations
Resource	H6	Identify the operant and operand resources needed to realize each service system entity's value propositions, as well as the provider of each resource (the service system entity itself or an external source). If a given resource cannot be provided to the service system entity needing it to realize a value proposition, determine if the access to that resource can be taken for granted by that entity, or if the resource provider plays the role of a service system entity within that service system.
Service exchange	H7	Identify service exchanges required to fulfill value expectations within the service system and the new resource(s) to be generated through each exchange. If a given value expectation is not fulfilled by any generated resource(s), determine if the required resource can be generated by adapting or adding a service exchange, or if that value expectation is beyond the scope of the service system
Value-in-context	H8	Determine metrics and target values for each service system entity's value expectation(s). Identify data to be generated by or gathered about new resources resulting from service exchanges within the service system. Identification of data should continue until the measurement of each value expectation is possible. Thus, multiple types of data may need to be generated by or gathered about the same resource, e.g., number, frequency, and patient satisfaction, for hospital visits

Table 4.3: Heuristics for eliciting requirements for service systems Service
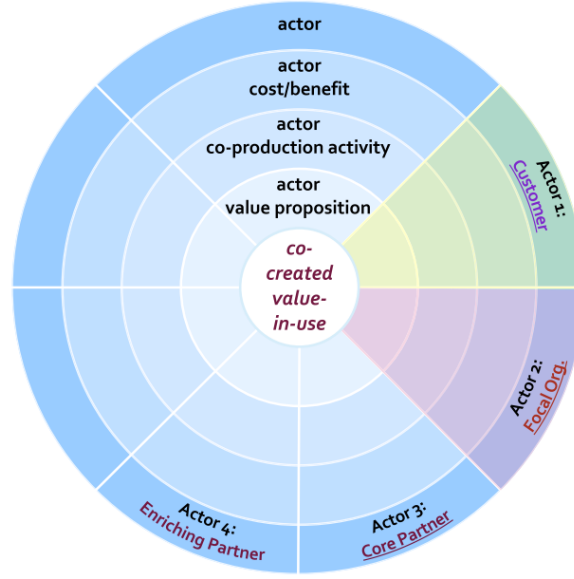
Figure 4.3: SDBMr developed by Turetken et al. (2019)

network is formulated. This layer denotes the part of the value-in-use contribution that each actor makes to achieve the co-creation of the value. The third layer is the *Actor Co-Production Activity* layer, which represents the specific activity that each actor performs to achieve the co-creation of the value or the value proposition from the previous layer. The activity of each actor contributes to the overall value-in-use and the co-creation of value (Turetken & Grefen, 2017). The fourth layer is the *Actor Cost and Benefit* layer, which defines both the financial and non-financial expenses and gains of the co-creation actors. This layer provides a clear understanding of the cost and benefits associated with each actor in the service network (Turetken & Grefen, 2017). Finally, the last layer is the *Actor Name* layer, which gives the name of the actor of that pie slice.

The actors include the customer, focal organizations, core partners, and enriching partners. The model is made for an arbitrary amount of actors. The focal organization takes the lead in establishing the business model and actively drives the solution. The customer consistently contributes to the production of the value-in-use. A core partner plays an active role in the fundamental aspects of the solution, whereas an enriching partner enhances the added value-in-use. All actors together collaborate so that each actor receives a clear benefit from the business model (Turetken & Grefen, 2017).

A business model can start with an informal scenario that serves as a source of inspiration. Throughout the design process, this scenario is refined and transformed into a customer service scenario (CSS), to provide a concise description of how the future solution will operate at a high level. The business model design process using SDBM-r should be approached as an iterative process. The result of this practice is a business model presented in a radar chart alongside a CSS, which can be conveyed through text as a story or visually as a storyboard.

All in all, the SDBM-r method represents a novel approach to business design, rooted in the principles of S-D Logic. This innovative tool allows for the modelling of service-dominant business models in a collaborative manner, fostering a clear understanding of the contributions and benefits of each actor in the service network. As a result, the SDBM-r alongside with the CSS provide useful frameworks for structuring the value propositions, the associated activities, and the costs and benefits of service system actors.

4.1.3   Meta-patterns

Four meta-patterns were selected to extend the method of Lessard et al. (2020), (1) the Goal-Oriented Idea Generation Method of Ohshiro et al. (2005), (2) the requirements elaboration approach of Letier & van Lamsweerde (2002), (3) the lightweight profile for GRL to create strategic rational (SR) models of Amyot et al. (2009), and (4) the analysis procedures to goal models of Amyot et al. (2010).

Ohshiro et al. (2005) introduced a goal-oriented idea-generation method that integrates brainstorming techniques with the goal-oriented approach, combining intuitive goal dependency representation with effective idea exploration and evaluation. Their experiment applied this method to a project involving the development of a library support system. The method's main advantage lies in its inclusive nature, involving all stakeholders and resulting in high-quality requirements. However, it should be noted that the process may be time-consuming and heavily reliant on the facilitator's expertise. The process flow of their method's activities is illustrated in Figure 4.4.
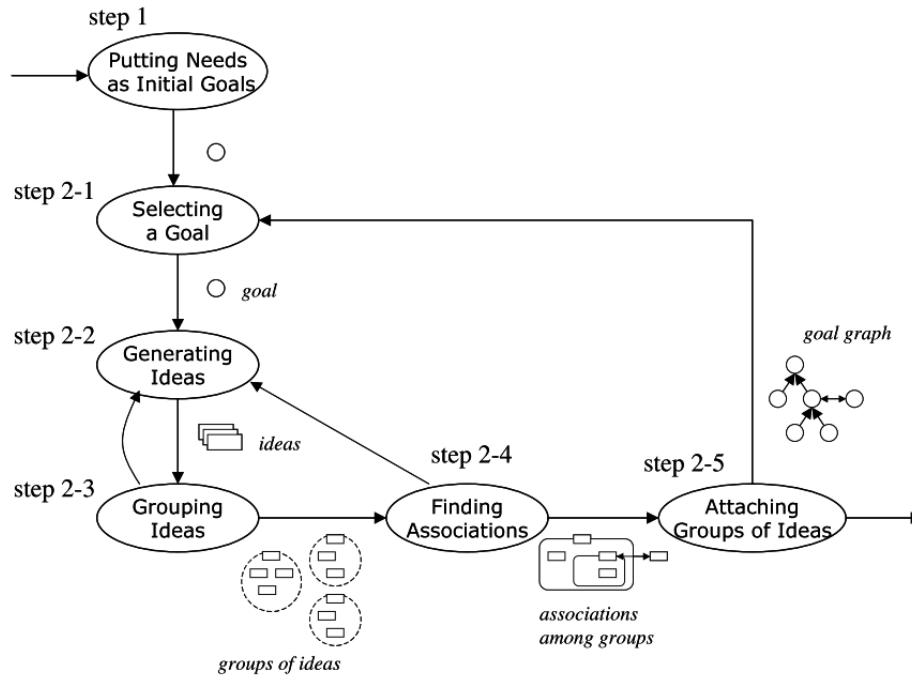
Figure 4.4: Activity Flow of Idea Generation Method developed by (Ohshiro et al., 2005)

Letier & van Lamsweerde (2002) discussed a process of elaborating on goal models, objects, agents, or operational models. According to Letier & van Lamsweerde (2002), the elaboration of a goal model involves asking both "HOW" and "WHY" questions, along with utilizing refinement patterns (Darimont & van Lamsweerde, 1996). This process also entails selecting the most suitable alternative when multiple goal OR-refinements or agent OR-assignments are considered, and assigning and operationalizing functional goals to software agents. The primary concept behind goal refinement is to decompose a goal into smaller subgoals, to ensure that each subgoal can be accomplished by a smaller number of agents. This iterative refinement process continues until goals can be assigned to individual agents as their responsibilities (Dardenne et al., 1993). The terminal goals assigned to agents during the software development process are subsequently transformed into requirements for the final software product (Letier & van Lamsweerde, 2002).

The operationalization patterns of Darimont & van Lamsweerde (1996) were used as suggested by Letier & van Lamsweerde (2002). They investigated the Stimulus-Response pattern, that will be used to operationalize the goals of the digital platform. A stimulus is an event perceived by some agent which requires

some action to be performed by the agent. The response is an agent reaction to some stimulus (Darimont & van Lamsweerde, 1996). The stimulus-response family of patterns suggests ways of operationalizing goals according to their classification:

- in case of Satisfaction goals, stimuli represent requests for services; responses indicate that the requested services have been provided;

- in case of Safety, Robustness, and Privacy goals, stimuli represent alarms that detect situations leading to goal violations; responses indicate that alarm causes have been resolved;

- in case of Information goals, stimuli represent object state changes of interest to agents; responses represent notifications

Amyot et al. (2009) proposed a lightweight GRL profile for I* that extends GRL's capabilities to encompass missing I* concepts and formal constraints, aligning GRL with the I* modelling style. This integration allows users to utilize GRL modelling and analysis tools for I* models, to ensure compliance with international standards. The I* framework captures actors, relationships, and goals, facilitating goal achievement analysis and identifying strategic re-configurations (Yu, 2009). The Strategic Rationale (SR) model within I* attributes goals, tasks, resources, and soft goals to actors, enabling goal evaluation and exploring alternative approaches (Yu, 2009). GRL analysis, focusing on evaluating the accomplishment of actors' goals within specific relationships involving human and system actors, aims to identify potential reconfigurations that enhance goal achievement and advance actors' strategic interests. Within the GEA-DPR method, the SR model is used to model the dependencies of the digital platforms' functional requirements on other actors' tasks and resources while keeping track of the initial intentions for developing the digital platform.

Amyot et al. (2010) presented a rigorous analysis approach utilizing the GRL for evaluating goal models. Their qualitative evaluation strategy involves initializing and propagating evaluation values to intentional elements based on selected strategies and determining actor satisfaction. The algorithm incorporates qualitative contribution labels such as Make, SomePositive, Help, Unknown, Hurt, SomeNegative, and Break, as well as evaluation labels including Satisfied, WeaklySatisfied, None, WeaklyDenied, Denied, Conflict, and Undecided. Additionally, qualitative importance values of High, Medium, Low, and None are considered. The algorithm follows a sequence of calculating decomposition, contribution, and dependency links to evaluate the intentional elements effectively.

4.2   Design Decisions

According to the findings of the SLR, the meta-model presented by Lessard et al. (2020) has a strong theoretical foundation and can effectively capture value co-creation in a service system while taking both operant and operand resources into account. Therefore, this method is selected as the base method for this research.

The selected base method provides a solid foundation for eliciting and modelling service system requirements aligned with the S-D Logic. Therefore, the GEA-DPR method should be based on the heuristics and lightweight GRL profile as proposed by Lessard et al. (2020) to ensure that the S-D Logic principles are captured. However, the elicited requirements following the base method are too high-level for platform design, necessitating an extension of the base method to support the elicitation and assessment of digital platform requirements within a service system context. Moreover, the heuristics proposed by Lessard et al. (2020) offer limited guidance to practitioners in executing these steps and activities effectively. Therefore, additional modifications and extensions are needed to provide practitioners with sufficient guidance in implementing them. The design decisions made to develop the GEA-DPR method based on the solution objectives defined in Chapter 3 are summarized in Table 4.4 below.

4.2.1 Solution Objectives-Based Modifications and Extensions

#	Solution Objective	Contributions base-method	Shortcomings base-method	Desgin Decisions based on solution objectives	Reference
1	The method should support value co-creation and therefore employ the concept of service systems.	Metamodel of service systems based on S-D Logic principles.	Lack of guidance on how to connect all the service system elements.	Organize a business modelling workshop utilizing the SDBM-r tool.	Turetken & Grefen 2017
2	The method should provide users with a systematic approach for eliciting digital platform requirements while considering the service system context.	Set of heuristics for eliciting requirements for service systems.	The heuristics result in a too high-level service system requirements model.	Organize a goal-oriented idea generation workshop and apply model elaboration methods to refine the platform's goals into requirements.	Ohshiro et al. 2005 Letier & van Lamsweerde 2002
3	The method should provide users with a systematic approach for assessing thr feasibility of digital platform requirements within the service system context, to ensure traceability between requirements, their dependencies, and higher level objectives.	None.	The heuristics do not include a specific approach for assessing requirements.	Create SR models and organise a gap analysis workshop applying a goal-model evaluation strategy.	Amyot et al. 2010 Amyot et al. 2009
4	The method should consider and model the intentions and behavior of each stakeholder involved in the service system and affected by the digital platform	A domain-specific profile of the Goal-oriented Requirement Language for eliciting requirements for service systems.	None.	Use GRL-profile.	Lessard et al. 2020

Table 4.4: Design Decisions based on Solution Objectives

The first five heuristics as proposed by Lessard et al. (2020) aim to identify and determine critical aspects of the service system, such as its boundaries, network rules, entities, value expectations, and value propositions. However, these heuristics lack guidance on how to determine the service system and its boundaries, which can have a significant impact on the output generated by following these heuristics. To address this, the heuristics presented in the base method were integrated with Turetken et al. (2019)'s business design approach, which provides a structured way for users to discuss and structure the value propositions of each service system actor. The service-dominant business modelling workshop using the SDBM-r framework was chosen as a preliminary step that must be completed before implementing the GEA-DPR method. Including this preliminary step ensures that method users have a more complete understanding of the service system by visualizing the value propositions, costs, and benefits associated with each actor's participation in the co-created value-in-use offering.

A collaborative validation session was conducted with the first author of Lessard et al. (2020) to explore the extensions and modifications of the heuristics proposed in their work, using the SDBM-r modelling tool introduced by Turetken & Grefen (2017). During the session, a consensus was reached on how to use elements of the SDBM-r tool as a source of input for certain service system meta-model constructs. The sources of identification for service system constructs are based on the heuristics proposed by Lessard et al. (2020), elements of the SDBM-r method developed by Turetken & Grefen (2017), or a combination of both. These sources are presented in detail in Table 4.5 below.

On the one hand, heuristics 1, 3, 4, and 5 are considered redundant as their outputs can be effectively replaced by the results of the SDBM-r modelling workshop, which already identifies the same service system elements. The business model blueprint, which is the output of creating a business model using the SDBM-r

Service system meta model constructs	Heuristics used	Inputs from SDBM-r method
Service system	None	All businesss model blueprint elements
Network rules	H2	None
Service system entity	None	Actor
Value expectation	None	Actor benefit
Value proposition	None	Actor value proposition
Resource	H6	Actor cost
Serivce exchange	H7	Actor co-production activity
value-in-context	H8	None

Table 4.5: Sources of Identification for Service System Constructs

tool, identifies the boundaries of the service system. These boundaries encompass all the actors representing a slice in the radar. Subsequently, these actors will be referred to as 'service system entities,' comprising both human and non-human entities. On the other hand, heuristics 2 and 8 are necessary for identifying the network rules and value-in-context elements, respectively. These heuristics will be used without any modifications. Heuristics 6 and 7 will be supplemented with elements from the SDBM-r method. The actor cost and actor co-production activities will be utilized to support the process of identifying the resources and service exchanges required in the service system, respectively.

The integration of the SDBM-r method and heuristics provides practitioners with improved guidance in understanding the interconnectedness of service system elements. During the SDBM-r modelling workshop, stakeholders discuss the contributions that each actor should make to the co-created value-in-use, taking into account the associated costs and benefits for each actor. This workshop effectively facilitates and fosters stakeholder engagement and active participation from the start of the digital platform development process. Furthermore, the workshop involves the collaborative creation of customer service scenarios, which can be expressed as textual stories or graphically depicted through storyboards. These scenarios help in understanding the shared vision and scope that all stakeholders have for the digital solution offering. By combining these approaches, practitioners can more effectively capture service system elements and their relationships, improving overall understanding and alignment among stakeholders.

As outlined in Subsection 4.1.1, the base method incorporates a light-weight GRL (Goal-oriented Requirements Language) profile alongside the heuristics. This profile serves as a tool to create a requirements model of the service system, utilizing the identified service system constructs. These constructs are identified by employing various sources of identification, as presented in Table 4.5. However, the resulting model lacks the necessary level of detail for eliciting digital platform requirements. Therefore, it is essential to provide more specific guidance to translate the high-level service system requirements into platform-specific requirements. To achieve this, the base method is extended by integrating various existing methods and approaches.

To understand how meta-patterns are used to extend the base method a short overview of the main activities that the users of the GEA-DPR method should be able to execute will be presented. The meta-patterns explained in Subsection 4.1.3 are used to execute two main steps, eliciting and assessing digital platform requirements. To elicit digital platform requirements, the following activities are being executed; goal decomposition to transition from service system goals to platform goals. This goal decomposition includes creating Goal Requirement Trees (GRTs) to specify functional requirements and elaborating the GRTs to validate and refine the requirements. Next, these requirements are operationalized to identify dependencies between digital platform requirements and the tasks and resources of other service system entities. Furthermore, the operationalization of the digital platform requirements is needed in order to

assess the feasibility of the elicited requirements. The steps and activities of the GEA-DPR method will be explained in more detail in Chapter 5.

The goal-oriented idea generation method proposed by Ohshiro et al. (2005) is one of the four selected patterns identified for extending the base method. This method is specifically chosen for its ability to facilitate user participation in the development process of digital platform requirements. User participation is widely acknowledged as vital in agile requirements engineering, particularly in complex service systems Schön et al. (2017). The goal-oriented idea generation method plays a crucial role in refining high-level service system goals into platform goals. The method consists of two main steps and five substeps in task 2, as depicted in Figure 4.4. A direct link is established with the base method by selecting the value propositions from the high-level service system requirements model that directly relate to the digital platform as root goals (step 1). These selected root goals represent the value propositions of service system entities that depend on tasks or resources enabled by or required by the digital platform. Next, step 2 is executed, involving the generation of ideas, their grouping, identification of associations, and the attachment of idea groups to a goal graph. This approach leads to the creation of a goal refinement tree (GRT) for each value proposition. This comprehensive and interconnected refinement process enables a smooth transition from system goals to platform goals.

A part of the method suggested by Ohshiro et al. (2005) is repeating step 2.1 till step 2.5 until each leaf goal is a task that can be assigned to an agent. However, given the time-consuming nature of repeating step 2.1 till step 2.5 and limited guidance in decomposing and refining the generated ideas into specific goals for the digital platform, the requirements elaboration method described by Letier & van Lamsweerde (2002) is chosen as a meta-pattern to optimize the efficiency and quality of the goal decomposition and refinement activities. The requirements elaboration method proposed by Letier & van Lamsweerde (2002) is used to ensure that each leaf goal is aligned with the root goal and vice versa. The requirements elaboration method consists primarily of asking 'why', 'how', and 'how else' questions, followed by the use of goal refinement patterns to operationalize the goals into functional requirements. According to Dardenne et al. (1993), the process of refining goals should be treated as a discovery or inquiry process, where the analyst engages in a continuous questioning approach. By asking relevant questions, it becomes possible to refine, operationalize, and reorganize goals effectively. This highlights the significance of questioning as a valuable strategy for goal refinement. Combining the methods of Ohshiro et al. (2005) and Letier & van Lamsweerde (2002) results in a structured framework for refining the value propositions of service system entities into the functional requirements of the digital platform, promoting active stakeholder participation and idea generation, and fostering collaboration and consensus-building among stakeholders.

GRTs are highly effective in identifying functional requirements and establishing their connection to the underlying intentions of the involved service system entities. However, they do not provide clear dependencies between these tasks and other entities, tasks, and resources within the service systems. According to Yu (1997), it is crucial to have a comprehensive understanding of the embedding environment and task domain of the information system being developed. Therefore, the decision was made to develop an SR model of the functional requirements of the digital platform, which represents the task and resource dependencies in a more explicit manner. This will enable effective communication with stakeholders and help to prevent project failure (Yu, 1997). Creating a SR model brings clarity, structure, and traceability to the requirements engineering process. It enables effective communication, conflict resolution, and decision-making while accommodating flexibility and change in development (Yu & Mylopoulos, 1998). To create the SR model, the operationalized leaf nodes of the GRTs were modelled in the SR model as the platform tasks. Furthermore, the dependencies of the digital platform's tasks on other service system entities' resources and tasks were modelled. The conceptual elements used in the SR model are displayed in Figure 4.5 below.

As the intentions of each actor were already captured in the strategic model of the service system requirements, this operational model focuses solely on representing the value propositions that the tasks and resources (in yellow) contribute to, rather than detailing every individual actor's value expectations and propositions. The SR model was created using the GRL. To maintain consistency with the original I* style used in SR model development, the lightweight profile proposed by Amyot et al. (2009) was adopted.

Since the heuristics of Lessard et al. (2020) do not offer guidance in the assessment of requirements,
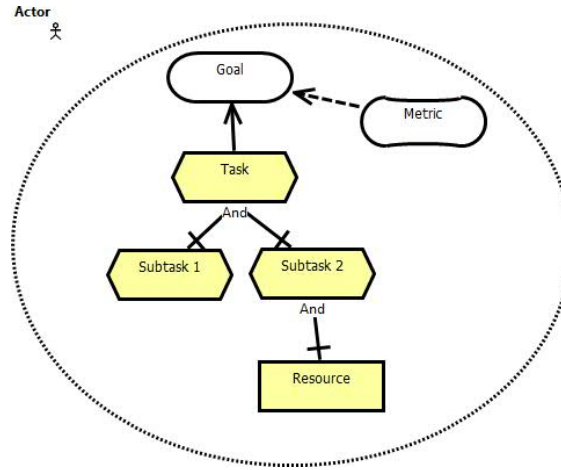
Figure 4.5: Visual representation of Conceptual Elements of the SR model in the GRL

the SR model is evaluated using the qualitative evaluation strategy proposed by Amyot et al. (2010). The objective of this evaluation is to provide a comprehensive assessment of the feasibility of the platform's requirements within the complex service system. To achieve this, labels are propagated across the SR model to evaluate goal achievement. The usage of these labels is clearly defined, aiming to facilitate the evaluation process and enable gap analysis for requirements feasibility. Table 4.6 below provides the definitions for each label utilized in the assessment of tasks performed by the human service system entities.

Label	Definition
Satified (100)	Task is being executed correctly
WeaklySatisfied (50)	Task is being executed correctly but application migration is needed
None (0)	No data available related to the task execution
WeaklyDenied (-50)	Task is being executed incorrectly and application migration is needed
Denied (-100)	Task is not being executed
Conflict (-101)	Tasks is not possible to perform
Undecided (-102)	Conflicting information is available.

Table 4.6: Definition of Label Usage for Task Execution Status

The values associated with the labels represent the numerical evaluation value that is automatically assigned to an element when it is evaluated with that label. The definitions for each label used in the evaluation of the resources available to the service system entities are presented in Table 4.7.

By employing this evaluation strategy and utilizing the defined labels, method users can effectively assess the platform's requirements, enabling them to obtain a comprehensive overview of the system and identify any existing gaps that need to be addressed. These gaps may include the availability of resources by other service system entities and the execution status of tasks that the digital platform relies on. The evaluation process plays an important role in examining the feasibility of the requirements identified for the digital platform, to ensure that all essential dependencies and interactions with other service system entities are appropriately accounted for.

Label	Definition
Satified (100)	Correct resource is available
WeaklySatisfied (50)	Correct resource is available but application migration is needed
None (0)	No data available related to the resource availability
WeaklyDenied (-50)	The resource is available, but changes and application migration are needed.
Denied (-100)	Resource is not available
Conflict (-101)	Resource can not be made available
Undecided (-102)	Conflicting information is available.

Table 4.7: Definition of Label Usage for Resource Availability

4.2.2 EFG-Based Modifications and Extensions

In Chapter 6, the evaluation protocol will be presented, including an explanation of the evaluation criteria and the focus group methodology used to evaluate the GEA-DPR method. It should be noted that the findings from the EFG had a notable influence on the design of the GEA-DPR method. Therefore, this section will explore the most significant findings regarding potential improvements for the GEA-DPR method and discuss the design decisions that were informed by the results obtained from the EFG.

After demonstrating the application of the GEA-DPR method at the case company, EFG participants were asked to respond on their initial impression of the GEA-DPR method and on the selected evaluation criteria. Participants recognized the usefulness of the GEA-DPR method, however, concerns were raised about the complexity of the method.

P4 *"I find the method initially heavy and complex, but I recognize its efficiency and usefulness."*

Furthermore, the EFG participants expressed confusion about the scope and activities of the GEA-DPR method. Concerns emerged regarding the size of the model due to the numerous potential dependencies and the complexity associated with executing the method's activities.

P3 *"I am curious if this method offers guidance on knowing when to stop and if there is clarity on defining and determining the level of detail for each activity."*

P5 *"The value can be compromised when you forget about some the dependencies, but I think it's also the other way around. If you have someone who goes too deep in all the different experts and dependencies you can like, lose yourself in the method. So I think it's very important that you know what the boundaries are and what the scope is of the method."*

Additionally, it was observed that the method is primarily focused on specifying the tasks of the digital platform as functional requirements. However, for the actual implementation of these requirements, more defined and specific requirements are necessary. Additionally, the effective utilization of the GEA-DPR method requires an experienced user. Participant 1, in particular, provided valuable insights in this regard.

P1 *"The method is particularly useful for business developers or analysts, whereas systems engineers may require more defined and specific requirements before actually implementing these requirements."*

P1 *"I believe that without an experienced user, there is a potential for things to go wrong in the process. Discussions among stakeholders may easily become skewed or fixate on irrelevant factors or challenges that do not align with the core goal. It is crucial to have someone knowledgeable and skilled in modelling who can guide the discussions, ask pertinent questions, and keep the focus on the essential aspects of the goal."*

The provided quotes emphasize the concerns expressed by the participants and underscore the importance of establishing clarity regarding the method's scope, level of detail, and boundaries. Additionally, they highlight the necessity of developing technical specifications for the requirements prior to implementation, as

well as the requirement for an experienced user to effectively apply the GEA-DPR method. By addressing these concerns, the ease of use and efficacy of the GEA-DPR method can be enhanced.

To tackle these concerns and limitations, several design decisions were implemented. The design decisions made to improve the GEA-DPR method are summarized in Table 4.8 below.

Evaluation Criterion	Feedback	Design Decision
Ease of use	The scope, level of detail of each activity, and model size of the method are unclear and the method was perceived as heavy at the first impression.	Incorporate consistency control criteria and clearly define roles and responsibilities.
Efficacy	The method requires experienced users, and further refinement is necessary before implementing the identified requirements.	Use a informal requirements documentation structure.

Table 4.8: Design Decisions based on EFG results

Firstly, consistency control criteria were introduced for each step of the method, to ensure the accurate execution and satisfactory quality of the activities before proceeding further. Secondly, the roles within the method were clarified, to provide a clear overview of the responsibilities and qualifications required for users at each step. Lastly, the previous formal refinement patterns were replaced with a more user-friendly requirements documentation structure, to increase the efficacy of the method and to make the method easier to use. These modifications will be elaborated in the following paragraphs.

The consistency control criteria should ensure that the steps will be executed correctly before proceeding to the next step. The structure used to explain each step is presented in Table 4.9 below. The specification structure serves as a guide for users of the GEA-DPR method, to provide them with insights into the purpose and execution of each step.

Element	Description
Purpose	The purpose of performing the step.
Tasks (sub-steps)	The specific tasks that need to be performed to complete the step.
Consistency control	The conditions that needs to be checked and satisfied before moving to the next step.

Table 4.9: Method Step Specification Structure

The use of formal refinement patterns during the GEA-DPR method pilot run was discovered to be overly complex, particularly for business analysts. The requirement to understand temporal logic, which may be unfamiliar to general business analysts, contributes to the complexity. As a result, they must devote time to learning temporal logic concepts before they can effectively apply formal patterns. Furthermore, the EFG participants emphasised the importance of further specifying the requirements before they can be implemented. The time required to grasp the patterns and operationalize the identified requirements, as well as the need to further specify the requirements, were perceived as having a negative impact on the GEA-DPR method's efficacy. As a result, the decision was made to simplify the process of elaboration and operationalization. Instead of using formal refinement patterns, the method was modified to use a informal (natural language) requirements documentation structure using and engage in discussions with service system entities to determine the necessary tasks and resources for supporting the digital platform's tasks. The goal of this modification was to improve the method's efficacy and ease of use. The structure of the informal requirements specification is shown Table 4.10 below. The structure is intended to simplify task elaboration

Element (based on formal patterns)	Description
1. Goal Classification	Identify the specific goal category to which the requirement belongs.
2. Stimulusect state	Describe the stimulus or trigger that initiates the requirement.
3. Response	Specify the expected response or action that should occur when the stimulus is received.
4. Contextual Details	Provide any additional contextual information that is relevant to the requirement.

Table 4.10: Informal requirements documentation structure

and operationalization for business analysts, with the goal of making the method more user-friendly by reducing its complexity.

Based on the following comments, the EFG results led to improvements in the focus group protocol, clarifying the inclusion of network rules and regulations, as well as the metrics for use as acceptance criteria. Although these elements were already addressed in the GEA-DPR method, they do not appear to have been effectively communicated.

P3 " I believe it's important to consider that not everything in business is solely driven by value. There are legal and regulatory aspects that may not directly contribute to value but are necessary to comply with. When focusing on business value, I question whether we may overlook these limitations and restrictions."

P1 "In software or business development, having clear and well-defined acceptance criteria is crucial at all levels, including user stories, tasks, and overall vision. This helps determine when the product meets customer satisfaction and ensures a successful alignment between product features and user needs. By setting boundaries and aligning stakeholders' expectations, acceptance criteria contribute to project success and facilitate effective budgeting and resource allocation."

Due to time constraints, these elements were only briefly covered during the case company demonstration. It was decided, however, that visualising them in the model would help participants better understand the method. Furthermore, it was agreed that a clearer formulation of the method's scope should be provided at the start of the focus group session. Using EFG results to refine the CFG script improves participants' understanding of the GEA-DPR method's steps, activities, responsibilities, and potential. This enables them to provide more insightful feedback on the method, reducing the time needed to become familiar with it.

Before implementing the identified requirements, additional requirements specification activities such as experiments or user stories must be completed. The formal refinement patterns proposed by Darimont & van Lamsweerde (1996) are still valuable for later stages of digital platform development, but they were outside the scope of this study. Agile techniques like user stories, prototyping, and scenarios are already established for the subsequent steps needed to develop the digital platform Schön et al. (2017). These techniques offer effective means of requirements communication, elaboration, validation, and documentation in an agile environment Schön et al. (2017).

In this research, the focus is on eliciting and assessing digital platform requirements within a service system context, rather than extensively exploring these conventional requirements engineering practices. The method's current scope primarily emphasizes the early phase of requirements engineering Yu (1997). It considers how the digital platform can meet stakeholders' goals, the need for the digital platform, implications for stakeholders, and addressing stakeholders' interests and concerns. Additionally, the method addresses

requirements analysis by informally elaborating and operationalizing the digital platform requirements to understand their dependencies and assess the feasibility of these elicited requirements. The GEA-DPR method aims to define the rationale and functional requirements of a digital platform by first analyzing the service system and then eliciting the digital platform requirements needed to facilitate the intended co-created value-in-use.

Chapter 5

Method

 This section provides a detailed description of the method, explaining each step along with its individual activities. As defined by Offermann et al. (2010), a method is a systematic, structured, and repeatable approach used to achieve a specific goal within a given context, such as problem-solving or task completion. In this section, the following components will be addressed: (1) Method purpose, (2) Method context, (3) Method input (information, data, or resources that are required to apply a method), (4) Method output (results or outcomes that are produced by applying the method), (5) Method activities, (6) Method roles, (7) Method guidelines, and (8) Method resources. These components align with the components proposed by Offermann et al. (2010) for method design theories, providing a structured approach to designing methods with improved usability.

5.1   Method purpose, context, and overview

The purpose of the method, as discussed in Chapter 1, is to assist practitioners in eliciting and assessing digital platform requirements while considering the service system context. The ultimate goal is to facilitate value co-creation on the digital platform.

The method's context, as outlined in Chapter 2, revolves around a service system that consists of multiple interconnected service system entities that collaborate in resource integration and service exchange to create value. These entities are linked internally and externally through value propositions to other service systems. Within this context, method users are expected to accomplish two main tasks: eliciting and assessing digital platform requirements. Figure 5.1 depicts an overview of the newly developed GEA-DPR method.
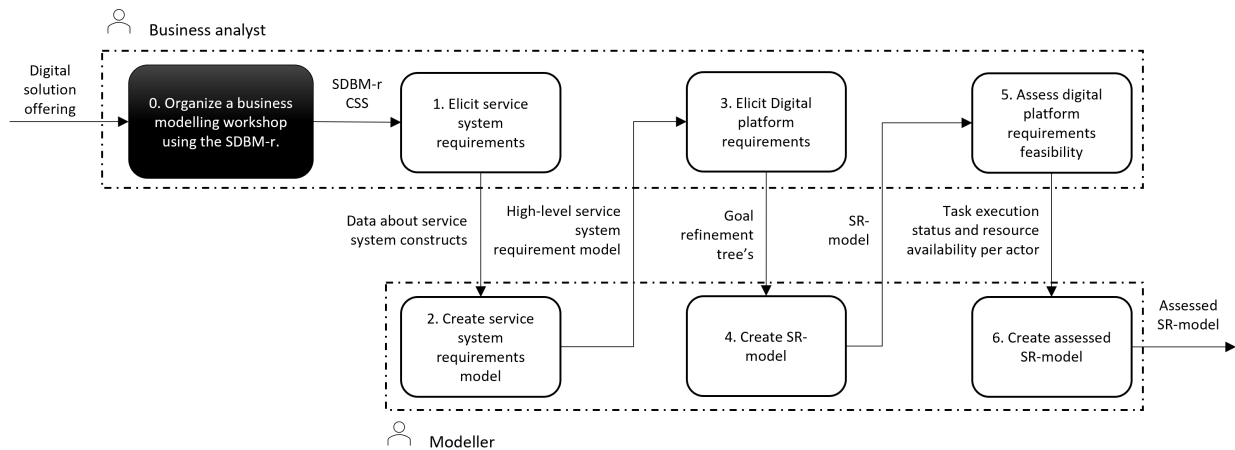
Figure 5.1: Method overview

As can be seen, the GEA-DPR method is composed of six steps and relies on a SDBM-r and a CSS as inputs while generating an assessed SR model as an output. In addition, two main method roles were identified: business analyst and modeller. The activities associated with each step of the GEA-DPR method, including the preliminary step, will be outlined in this section.

The process begins with engaging multiple stakeholders who are interested in participating in a particular digital solution offering. An important first step before applying the GEA-DPR method is to organise a

Service-Dominant Business modelling workshop using the SDBM-r tool and involving all stakeholders. The focal organization takes on the responsibility of arranging this workshop and selecting a qualified moderator experienced in the use of SDBM-r.

During step 1 of the GEA-DPR method, the business analyst utilizes the heuristics proposed by Lessard et al. (2020) and the SDBM-r elements as sources of identification for each of the service system constructs. The details of these sources are presented in Table 4.5. By utilizing these sources of identification, the business analyst successfully elicits the service system requirements. Moving on to step 2, the modeller constructs a high-level service system requirements model that represents these identified requirements using the GRL profile proposed by Lessard et al. (2020). This model visualizes the strategic dependencies of the service system's entities, goals, tasks, and resources.

In step 3 of the GEA-DPR method, the business analyst implements a goal refinement strategy. The high-level goals (value propositions) related to the digital platform are broken down into more detailed sub-goals, which can then be refined further until they become specific and can be formulated as the functional requirements of a digital platform. The refinement strategy begins with organizing a brainstorming session using the Goal-Oriented Idea Generation Method proposed by Ohshiro et al. (2005) and ends with the goal model elaboration strategy proposed by Letier & van Lamsweerde (2002) with questions about "how", "how else", and "why" to validate and refine the GRTs as well as an informal requirements specification structure as specified in Table 4.10 to elaborate and operationalize the requirements. The business analyst organises a workshop session for each value proposition, with workshop participants potentially varying from session to session. For this brainstorming session, it is important that the moderator is experienced with the brainstorming technique. The GRTs that are created represent the value propositions of the digital platform in the root goals and the tasks to be executed by the digital platform in the leaf goals. Finally, using the informal requirements specification structure, these leaf goals are elaborated and operationalized, yielding the functional requirements for the digital platform.

In step 4, these tasks are modelled in an SR model using the lightweight profile proposed by Amyot et al. (2009), representing the tasks to be executed by the digital platform and the dependencies of these tasks on other entities' tasks and resources. In step 5, the business analyst organizes a gap analysis workshop with all stakeholders together or separately to discuss the task execution status and resource availability of each entity using the labels as defined in Table 4.6 and Table 4.7. Finally, in step 6, the modeller implements these labels resulting in an assessed SR model with the digital platform's requirements and dependencies displayed.

5.2   Method inputs and outputs

An overview of the inputs and outputs of the GEA-DPR method is presented in Figure 5.2 below.

Before applying the GEA-DPR method, a preliminary step, referred to as Step 0, involves organizing a service-dominant business modelling workshop. This workshop serves as a foundation for the method by providing the service-dominant business model radar (SDBM-r) and the customer service scenario (CSS) as input. Following the steps outlined in the GEA-DPR method, several intermediate outputs are generated. The first output is a high-level service system requirements model, which represents the strategic dependencies of each entity involved in the service system. This model provides insights into the interdependencies and relationships among the entities, highlighting their roles and contributions within the system. Second, the outputs are multiple GRTs, which represent the specific tasks that the digital platform should be capable of executing. These trees break down the overall goals into smaller, more detailed tasks, enabling a more granular analysis of the platform's functionalities. Third, the goals are refined and operationalized following the requirements documentation structure displayed in Table 4.10, resulting in multiple tables with refined goals. The final output of the GEA-DPR method is an assessed SR model. This model displays the dependencies of the digital platform's tasks on the availability of resources and the execution status of tasks performed by other entities. It provides a comprehensive overview of how the tasks of the digital platform rely on the resources and tasks of other entities within the service system. By considering the resource availability and task execution status of other entities, the SR model helps identify potential bottlenecks and to assess the feasibility of the digital platform requirements.
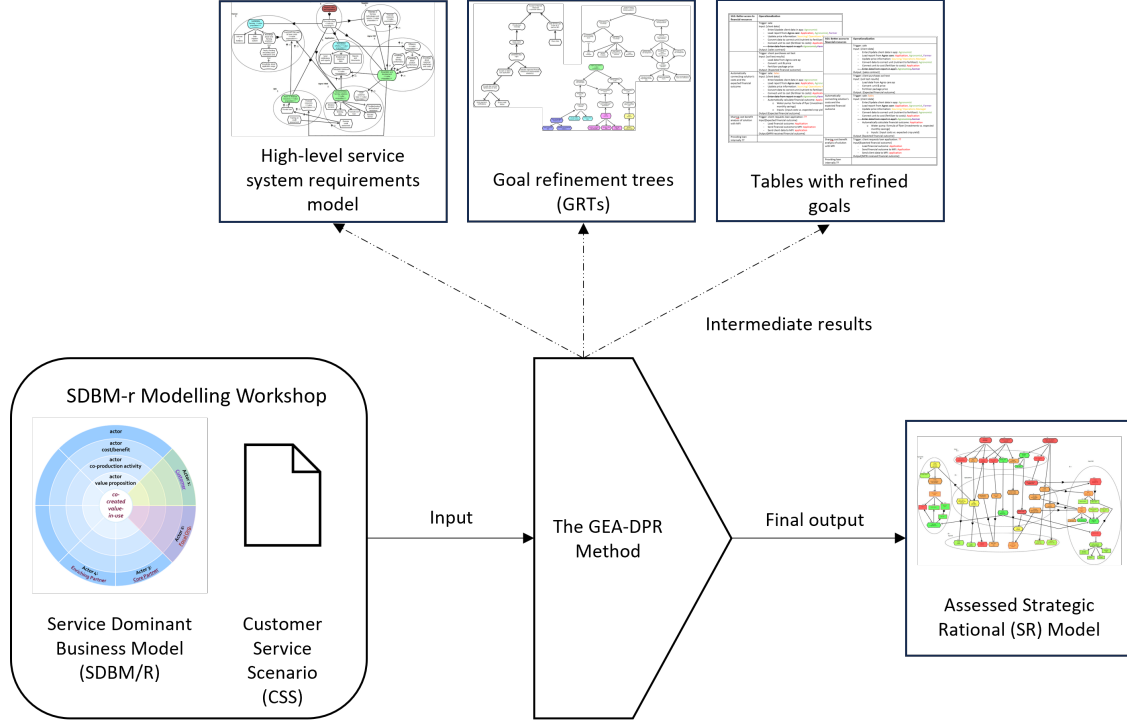
Figure 5.2: GEA-DPR Input-Output Overview

5.3 Method roles

This section provides a more detailed explanation of the roles and qualifications necessary to execute each step of the GEA-DPR method. Various roles and qualifications are required for effectively eliciting and assessing digital platform requirements within a service system context. As mentioned before, the application of the GEA-DPR method involves two primary roles: a business analyst and a modeller. Additionally, different participant profiles are involved in the collaborative activities of the GEA-DPR method. As depicted in Table 5.2, the business analyst is responsible for steps 0, 1, 3, and 5, while the modeller is responsible for steps 2, 4, and 6. The specific roles and qualifications required for users of the GEA-DPR method are outlined in Table 5.1 below.

In the GEA-DPR method, the roles of business analyst and modeller are critical and cannot be replaced. It should be noted, however, that the same person can fulfil two different roles if they have the necessary qualifications and expertise. Furthermore, there are optional roles that can aid in streamlining the process and more effectively carrying out the steps. For example, the business analyst may consider hiring a moderator with expertise in the specific topic during the SDBM-r workshop and the goal-oriented brainstorming workshop. Effective communication is essential for success between the business analyst, modeller, stakeholders, and software developer. It is the business analyst's responsibility to deliver the final output, the assessed SR model, to the software developer and to ensure that the development team understands the rationale for developing the digital platform and the expected functionalities.

Furthermore, the identified human service system entities must actively participate in the SDBM-r modelling, goal-oriented idea generation, and gap analysis workshops. Their active participation ensures that their goals and intentions are taken into account throughout the process. This helps to align the value propositions and ensures that metrics based on value expectations can be used as acceptance criteria. Furthermore, their participation helps to accurately and completely represent the digital platform's tasks and resource dependencies, allowing for a feasibility assessment based on the accurate task execution status and resource availability level.

Role	Description	Qualification
Business analyst	The business analyst is in responsible of eliciting and assessing the digital platform's requirements in collaboration with stakeholders. They use the GEA-DPR method and a service system perspective to ensure the platform aligns with stakeholder objectives. The business analyst facilitates effective communication between stakeholders and the development team, encouraging user involvement and collaboration.	1. Capable of leading software development projects. 2. Capable of moderating workshops. 3. Goal-Oriented Requirments Engineering skills. 4. Service-dominant business model design skills. 5. Brainstorming skills.
Modeler	The modeller is in responsible for creating two models: a high-level service system requirements model and a tasks and resource dependency model of the digital platform's functional requirements. The GRL is used in these models to represent the platform's dependencies. The modeller helps to visualise and understand the interrelationships between different components and stakeholders within the platform by mapping out these dependencies.	1. Capable of creating a goal model. 2. Capable of analyzing a goal model. 3. Experienced with the GRL and I* language.

Table 5.1: Roles and qualification

Furthermore, the GEA-DPR method's collaborative steps necessitate the participation of a diverse range of participant profiles. These profiles are essential for ensuring the method's success. The presence of representatives from the customer, focal organisation, core partner(s), and enriching partner(s) is required during Step 0, the preliminary step of the GEA-DPR method. This initial Service-Dominant Business Modelling workshop is critical in shaping the direction of the digital solution offering's design and development, specifically the digital platform. As a result, it is essential that the representatives have sufficient decision-making authority to ensure that the agreements reached in Step 0 are valid throughout the project without the need for frequent adjustments. In addition, the presence of representatives from the targeted customers is important for ensuring a user-centered approach in the design and development of the digital solution offering. The business analyst can carry out Step 1 by gathering input from each service system entity and communicating the service system requirements to the modeller. Step 2 can be completed solely by the modeller.

The goal-oriented brainstorming workshop requires the active participation of service system entities involved in or impacted by the selected value proposition(s). These entities provide valuable knowledge, contribute to sub-goal identification, and offer diverse perspectives based on their expertise and experiences (Ohshiro et al., 2005). Following the creation of the GRTs, the identified sub-goals must be validated and operationalized into tasks that the digital platform can execute. These activities can be carried out either immediately after the goal-oriented brainstorming workshop or in a separate session. It is recommended that all service system entities and a representative from the software development team participate in this activity because it involves decisions about task allocation to service system entities, operationalization of digital platform tasks, and selecting the best approach for goal OR-refinements or entity OR-assignments.

Finally, the business analyst can conduct the gap analysis by communicating with each service system entity to assess their task execution status and resource availability. However, it is recommended that the identified gaps be addressed in a joint session involving all service system entities, as this facilitates the process of finding solutions, such as proposing alternative digital platform tasks or identifying ways to enable the required tasks and resources. It is recommended that a representative from the software development team participate in this step once more to ensure the technical feasibility of the digital platform tasks.

5.4 Method guidelines and resources

Table 5.2 provides a comprehensive overview of the method, covering various key aspects. The "Step" column specifies the name of the preliminary step as well as the names of the six steps of the GEA-DPR method. The "Input" column lists the prerequisites, including operand and operant resources, needed to execute the specific steps. The "Output" column displays the results or outcomes obtained as a result of carrying out the specific steps. The "Role Qualification" column specifies the roles and qualifications of the individuals involved in carrying out a specific step of the GEA-DPR method. The "Guidelines" column outlines the guidelines or principles that govern how the specific steps are applied. Finally, the "Resources" column identifies the resources required for successfully completing the method step, such as tools, software, or materials. By presenting these elements in a structured manner, Table 5.2 provides a comprehensive and detailed understanding of each step of the method, including the required inputs, activities involved, expected outputs, individual roles and responsibilities, guidelines to follow, and resources required for effective implementation.

5.5 Method Activities

The preliminary step and each of the six steps in the GEA-DPR method will be explained, following the method step specification structure presented in Table 4.9. Each step consists of multiple activities that contribute to the overall process of eliciting and assessing digital platform requirements within a service system context.

5.5.1 Step 0: Organize a business modelling workshop

The GEA-DPR method assumes that the information in the input models (SDBM-r and CSS) is correct and complete. Although step 0 is not part of the GEA-DPR method itself, this section will explain this step to ensure a comprehensive understanding.

Purpose: Enhancing the understanding of the interconnections between all service system constructs and evaluating the net benefit for each entity involved. The aim of the workshop is to align the value propositions and co-production activities of each entity involved. Furthermore, the workshop setting is a means to bring all stakeholders together, fostering collaboration, and promoting active stakeholder participation.

Tasks (sub-steps): Before the workshop takes place, a stakeholder analysis must be executed in order to identify the relevant entities. Generally, the focal organization organizes the workshop involving all the stakeholders identified and hiring an experienced moderator. This workshop is structured into two parts, beginning with an explanation of the service-dominant business concept and the application of the SDBM-r. In the second part, the interactive use of the SDBM-r is employed to design a business model.

During the workshop, stakeholders engage in discussions related to the digital solution they intend to offer to a specific customer. This collaborative effort aims to develop a co-created value-in-use on a digital platform. The initial steps in the workshop involve reaching an agreement among the stakeholders regarding the target customer and the co-created value-in-use:

A1 Define target customer.

A2 Define co-created value-in-use.

To enable the co-created value-in-use, active participation and contributions from each stakeholder are essential in the digital solution offering. The subsequent steps involve the definition of each stakeholder's contribution to the co-created value-in-use and the identification of their associated roles (entities):

A3 Determine value propositions

A4 Determine entities

    A4.1 Determine focal organization.

Step	Input	Output	Role {*Qualification*}	Guidelines	Resources
0. Create Service Dominant business model	Digital solution offering	Business model blueprint + Customer Service Scenario	Business analyst {*should be experienced with the SDBM-r*}	Organize business modelling workshop with all stakeholders together.	Printed SDBM-r, Sticky notes and Pens
1. Elicit SS requirements	Business model blueprint + Customer Service Scenario	Data about service system constructs: - Co-created value-in-use - Value propositions - Value expectations - Actors - Activities - Costs and benefits - Resources - Metrics	Business analyst {*Capable to elicit/design service system requirements*}	Identify missing service system constructs and validate service system requirements with all stakeholders.	Requirements documentation template
2. Create SS requirements model	Data about service system constructs	Service system requirements model	Modeler {*Understanding of goal modeling and the GRL language*}	Create a model using the GRL-profile of Lessard (2020).	jUCMNav tool
3. Elicit digital platform requirements	Service system requirements model: - Value propositions - co-production activity	Goal refinement trees With associations + table with refined goals.	Business analyst {*Capable to elicit platform requirements and experienced with brainstorming*}	Organize user-group-specific brainstorming workshops to generate ideas. Refine the goals into specific tasks for the digital platform.	Sticky notes, Pens and requirements documentation template
4. Create SR model	Goal refinement trees With associations + table with refined goals.	SR-model of digital platform	Modeler {*experienced with goal modelling the GRL and the I* language*}	Use refined goals and Comply with I* modelling rules.	jUCMNav tool
5. Requirements assessment	SR-model of digital platform	Gap-analysis output: Task execution status and resource availability of each actor	Business analyst {*experienced with requirements engineering and gap analysis based on goal models*}	Organize a gap-analysis workshop with user groups to assess the current task execution status and resource availability levels.	Printed SR-model.
6. Create assessed SR model	Gap-analysis output	Assessed SR-model of digital platform	Modeler {*experienced with goal model evaluation strategies in the GRL language*}	Update the model for changes in functionalities, task status, and resource availability	jUCMNav tool

Table 5.2: Method Overview Table

   A4.2 Determine core partner.

   A4.3 Determine enriching partner(s).

   Finally, the workshop will address the associated costs and benefits for each entity participating in the digital solution offering, ensuring that the net benefit for each entity is positive when both costs and benefits are considered. This critical aspect ensures the active participation of entities in the digital solution offering. Additionally, the workshop will delve into the discussion of the high-level activities that each entity needs to undertake in order to actualize their respective value propositions:

 A5 Determining the costs and benefits for each entity.

 A6 Determining the high-level activities that realize the entity-value proposition for each entity.

   The SDBM-r business model design process should be approached iteratively. The moderator should be experienced with SDBM-r in order to facilitate active communication and collaboration to generate innovative ideas. The moderator should encourage "out-of-the-box" thinking and assist stakeholders in developing a business model that addresses the challenges and opportunities faced by their organization.

Consistency control: The SDBM-r is utilized to facilitate collaboration among stakeholders and facilitate discussions on the central value proposition, activities, and costs and benefits associated with each entity. Therefore, the conditions that must be satisfied in this step are the following:

- The SDBM-r comprehensively represents all stakeholders of the digital solution offering.

- Each entity slice within the SDBM-r encompasses essential information from all layers and is validated by the respective entity itself.

- There is a positive net benefit for each entity participating in the digital solution offering.

5.5.2 Step 1: Elicit service system requirements

At this point, it is assumed that the SDBM-r and CSS are accurate and correct. This step is executed by a business analyst most likely working for the focal organization.

Purpose: To develop a high-level service system requirements model.

Tasks (sub-steps): In order the elicit the requirements of the service system, the business analyst uses the business model blueprint created and CSS in the preliminary step, and heuristics 2, 6, 7, and 8 of Lessard et al. (2020). This step involves:

 1.1 Identify service system constructs using the sources of identification as presented in Table 4.5.

 1.2 Formulate the value proposition and value expectation of the digital platform as a service system entity based on the co-created value-in-use.

 1.3 Identify any rule or regulation that may constrain interactions or operations within the service system.

 1.4 Identify the operant and operand resources needed to realize each service system entity's value propositions, as well as the provider of each resource (the service system entity itself or an external source). Base the identification of the resources on the entity's costs in the business model blueprint and align the resources needed per entity with the entities' costs. If a given resource cannot be provided to the service system entity needing it to realize a value proposition, determine if the access to that resource can be taken for granted by that entity, or if the resource provider plays the role of a service system entity within that service system.

 1.5 Identify service exchanges required to fulfill value expectations within the service system and the new resource(s) to be generated through each exchange. If a given value expectation is not fulfilled by any generated resource(s), determine if the required resource can be generated by adapting or adding a service exchange, or if that value expectation is beyond the scope of the service system.

 1.6 Determine metrics and target values for each service system entity's value expectation(s). Identify data to be generated by or gathered about new resources resulting from service exchanges within the

service system. Identification of data should continue until the measurement of each value expectation is possible.

Consistency control: the requirements are used as input to refine the goals for the digital platform and to understand the context of the digital platform. Therefore, it is important that the elicited requirements are complete, correct, and coherent with the SDBM-r. Resulting in the following control checklist rules:

- The service system boundaries align with those defined in the SDBM-r.

- The service system entities encompass the entities identified in the SDBM-r, along with any additional non-human entities identified.

- All value propositions can be achieved using the identified resources.

- All value expectations can be measured using the defined metrics and metric values.

- All value expectations can be realized through service exchanges.

- All value propositions and value expectations are aligned at the same strategic level.

5.5.3 Step 2: Create service system requirements model

This step is carried out by a modeller, typically employed by the focal organization, who possesses the necessary knowledge and expertise in GRL. The GRL-lightweight profile, as described in Lessard et al. (2020) and presented in Table 4.2, will be utilized for constructing the model.

Purpose: The purpose of the model is to facilitate communication and collaboration among stakeholders by providing a visual representation of the strategic dependencies within the service system. It serves as a communication tool to foster discussions and ensure a shared understanding of these dependencies among the stakeholders.

Tasks (sub-steps): The profile's original application is deemed suitable, requiring no modifications. The service system elements identified in Step 1 can be directly employed for the model creation process. It is important to recognize that service systems are dynamic in nature; thus, the resulting GRL model should also be considered dynamic. Any alterations in value propositions, value expectations, or resource availability necessitate the development of a new model (Lessard et al., 2020).

2.1 Model the digital platform as a non-human entity in the center of the model, serving as a direct enabler of co-created value in use.

2.2 Map service system metamodel constructs and relationships to GRL constructs and relationships according to Table 4.1 and Table 4.2.

2.3 Share the high-level service system requirements model with the business analyst.

Consistency control: The model serves as a communication tool to establish a shared understanding of the strategic dependencies of each service system entity. It also documents the agreed-upon decisions and metrics, providing an overview of the desired service system. To ensure accuracy and completeness, the following control checklist rules are applied:

- The value propositions and co-production activities of each entity in the SDBM-r are displayed as soft goals and tasks in the model.

- The model accurately represents the goals, tasks, resources, and indicators identified for each entity in Step 1.

- The model complies with the mapping between service system metamodel and GRL constructs and relationships.

- The business analyst has validated the model with each service system entity.

5.5.4 Step 3: Elicit digital platform requirements

This step is executed by the business analyst, using the previously created and validated GRL model.

Purpose: The purpose of this step is to convert the platform goals into specific functional requirements for the digital platform.

Tasks (sub-steps): The process begins by identifying the value propositions that should be enabled directly by the digital platform under development. Following that, a brainstorming session is held to convert value propositions into requirements, which are then structured and elaborated through targeted questioning to ensure alignment with digital platform objectives and entities' requirements.

3.1 Select value propositions from the GRL model that should be enabled on the digital platform.

The goal-oriented idea generation method of Ohshiro et al. (2005) is used to refine the selected value propositions into digital platform requirements. A separate face-to-face brainstorming session is organized for each value proposition, involving all stakeholders who collaborate to make the value proposition possible. The following activities are executed during the brainstorming session:

3.2 Generating ideas related to the value proposition.

3.3 Grouping the generated ideas.

3.4 Finding associations among the groups of ideas.

3.5 Attaching the groups of the ideas and their associations to a goal graph.

Activity 3.5 ensures that the number of goal graphs produced is consistent with the number of value propositions generated initially. As a result, there are as many goal graphs as selected value propositions. Letier & van Lamsweerde (2002) describes five steps to elaborate models. The steps related to the goal model and relevant to the method are used to validate and refine the goal trees defined during the brainstorming session. Each of the following activities is executed once per goal tree.

3.6 Elaborate the goal tree by asking HOW questions (top-down goal refinement) and WHY (bottom-up goal abstraction);

3.7 Elaborate each goal by using the requirements documentation structure provided in Table 4.10;

3.8 Assign and operationalize functional goals to service system entities;

3.9 Select the most suitable alternative when multiple goals OR-refinements or entity OR-assignments are considered.

By completing these activities, the individual tasks represented by the leaf nodes of each tree are assigned to an agent responsible for their execution. The informal refinement patterns help the business analyst to define 'What' (goal) needs to happen, 'When' (stimulus), and 'How' (response). The operationalization of functional goals is informally achieved through discussions with workshop participants, determining which entity is responsible for each task and providing the necessary resources to enable the execution of tasks assigned to the digital platform.

Consistency control: The tasks identified for the digital platform can be considered as functional requirements. Ensuring the completeness and correctness of these requirements is crucial, highlighting the importance of validation during this step.

- The root goals in the goal trees are traceable to the value propositions and co-production activities in the high-level service system requirements model.

- The leaf goals are tasks that can be executed by the digital platform.

- Each of the leaf goals contributes to a value proposition.

- Each user group agrees with the goal tree, which represents their value proposition being translated into digital platform tasks.

- The task and resource dependencies of each of the identified functional requirements of the digital platform are elicited.

Each identified functional requirement of the digital platform plays a role in contributing to one or more value propositions. As a result, any changes in the value propositions will have an impact on the corresponding functional requirements required for the digital platform. Therefore, it is crucial to accurately represent the value propositions during this step, ensuring that they align with the current understanding and expectations. If any modifications occur in the value propositions, the business analyst should return to step 1.

5.5.5 Step 4: Create SR model

This step is carried out by the modeller, who uses the operationalized tasks created by the business analyst in the previous step.

Purpose: The purpose of this step is to create an SR model that visualizes the tasks and resource dependencies of the digital platform in relation to other service system entities.

Tasks (sub-steps): To comply with the I* rules, a SR model is created using the lightweight profile of Amyot et al. (2009) presented in section A.1. The SR model is created using GRL and includes the entities, tasks, and resources identified in the previous step, as well as the value propositions they contribute to:

4.1 Put the digital platform as a central entity in the service system and model the other entities around the digital platform.

4.2 Paste the tasks assigned to a specific entity in the GRTs within that entity's boundaries.

4.3 Model the value propositions as soft goals

4.4 Decompose value propositions into the tasks identified in the GRTs

4.5 Share model with business analsys who should discuss with stakeholders missing tasks, resources, or associations.

4.6 Finalise the SR model using the profile.

The resulting model provides an overview of the strategic dependencies of the digital platform on other entities, tasks, and resources.

Consistency control: The model created in this step is used as a communication tool between business managers and software engineering. Therefore it is important that the displayed tasks and resources are correct as well as their contribution to the value propositions. Resulting in the following consistency control checklist:

- The functional requirements of the digital platform are validated by the service system entity to which the value proposition, influenced by these functional requirements, belongs.

- The completeness of the SR model elements, including tasks and resources, is validated by the business analysts in collaboration with the service system entities.

- The SR model accurately reflects the operational dependencies of the digital platform on other entities, tasks, and resources.

- The SR model adheres to the I* modelling rules and guidelines.

5.5.6 Step 5: Assess the feasibility of the requirements of the digital platform

This step is executed by the business analyst, using the validated SR model as input.

Purpose: The purpose of this step is to assess the feasibility of the functional requirements of the digital platform in order to identify any potential bottlenecks or challenges that may arise during implementation.

Tasks (sub-steps): The business analyst has two options for engaging with the entities: organizing a workshop involving all entities together or conducting individual one-on-one sessions with each entity. In both cases, the purpose is to perform a gap analysis, discuss resource availability, and assess the status of task execution based on the qualitative evaluation labels in Table 4.6 and Table 4.7:

5.1 Assess resource availability of human entities

5.2 Assess task execution status of human entities

The gap analysis provides insight into the feasibility of the digital platform's functional requirements. If resources are unavailable or entities are incapable of performing certain tasks, the requirements must be revised until no gaps are identified. As stated in subsection 5.3, including a representative from the software development team in this step is strongly advised, as they can assess the technical feasibility of the functionalities. When functionality is deemed technically infeasible, immediate steps can be taken to investigate alternative solutions or make necessary adjustments. This iterative approach ensures alignment between the digital platform's functional requirements and the available resources and tasks performed by other entities within the service system. This alignment increases the possibility. This alignment increases the likelihood of successful implementation and adoption.

Consistency control:

- The resource availability and task execution status are accurately represented.

- The values of the initial labels of the tasks and resources of the human service system entities are communicated to the modeller.

As long as not all the functional requirements of the digital platform are assessed as feasible, the business analyst must actively search for solutions. The initial step involves discussing the issues with relevant stakeholders to explore possibilities for enabling specific resources and/or tasks. However, if a service system entity lacks the capability to deliver the required tasks or resources, the implementation of the digital platform's functional requirements becomes infeasible, which directly impacts the value proposition they contribute to. Therefore, it is necessary for the business analyst to return to step 3 and explore new ideas and options in order to achieve the intended value proposition.

5.5.7   Step 6: Create assessed SR model

This step is executed by the modeller, using the gap-analysis results as input.

Purpose: To create an assessed SR model to visualize the operational dependencies of the digital platform on other service system entities' resources and tasks, and the feasibility of the functional requirements.

Tasks (sub-steps): put initial values to the non-human service system entities using gap-analysis output of the previous step and the approach presented in Amyot et al. (2010). Qualitative satisfaction labels need to be assigned to the tasks and resources of each human entity in the GRL model. These labels are then propagated to the tasks and resources of each non-human entity in the GRL model. Finally, the labels are further propagated to the value propositions that each task and resource contributes to, considering the contribution types.

6.1 label the tasks and resources of human entities with the evaluation labels.

6.2 Change satisfaction levels of tasks and resources of non-human entities from automatically propagated "satisfied" to "partly satisfied."

6.3 Update the satisfaction levels of tasks and resources for non-human entities from "partly satisfied" to "satisfied" upon successful implementation of their functionality.

Initial values are assigned to each human entity's tasks and resources based on the gap analysis performed during Step 5. If tasks are decomposed into multiple resources and sub-tasks, the task itself does not need an initial label as the decomposition components provide sufficient information.

The assessed SR model visually represents resource availability and task execution levels, facilitating the identification of conflicts or missing elements. When all tasks assigned to the digital platform are labeled green, it indicates that the functional requirements can be implemented. This signifies that the resources and tasks of other entities, on which the digital platform depends, are deemed satisfied. The green label confirms that the necessary conditions for successful task execution by the digital platform have been met, enabling the development of the required functionality using best practices for the software engineering development phase.

Consistency control:

- All tasks and resources should have a qualitative evaluation label.

- The initial set of qualitative evaluation labels is automatically propagated forward to the tasks that the digital platform should execute and the corresponding value propositions they contribute to.

Chapter 6

Demonstration and Evaluation

6.1 Demonstration

The application of the GEA-DPR method will be demonstrated at a case company called 'Agros'. The context of the case company is explained in detail in Chapter 3. First, the preliminary steps required before applying the GEA-DPR method will be showcased. This will be followed by the demonstration of steps 1 and 2, which both emphasize service system requirements. Subsequently, steps 3 and 4 will be demonstrated, focusing on digital platform requirements. Lastly, steps 5 and 6 will be presented, highlighting the evaluation of the feasibility of the digital platform requirements. The method is developed in two phases, and the demonstration will present the final version of the method, incorporating the feedback received from the EFG. The GEA-DPR method was implemented by the author of this research at the Agros, with the assistance and guidance of employees from the Agros and potential users of the GEA-DPR method.

6.1.1 Preliminary steps

The case company, Agros, played a central role as the focal organization in the development of the digital platform and took the lead in identifying key stakeholders (steps A1 and A4). They identified five stakeholders: farmers (target customers), sales and operations department, management and engineering team (core partners), suppliers (core partners for products and reports), and micro-financing organizations (enriching partners). The SDBM-r for the one-stop shop for sustainable farming solutions is presented in Figure 6.1 below.
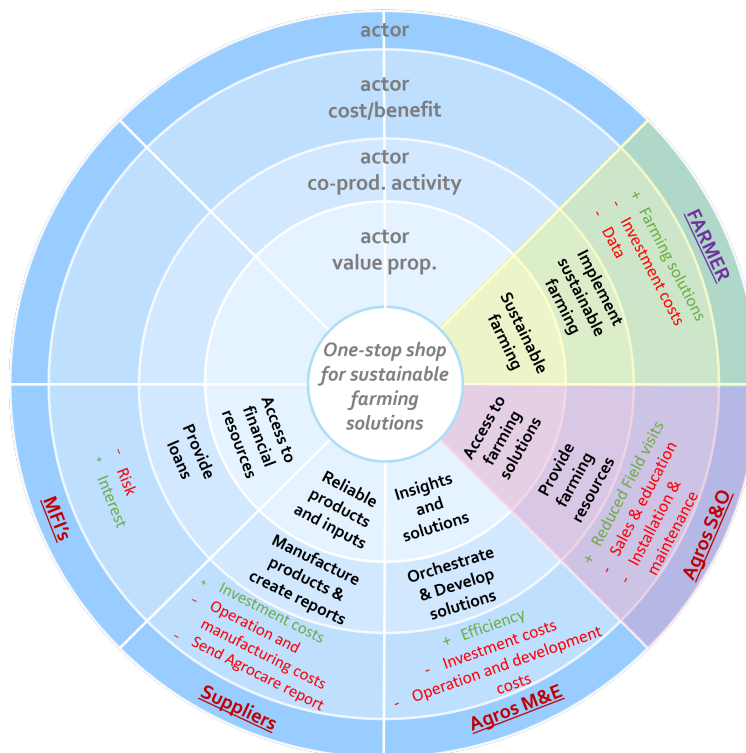

Figure 6.1: SDBM-r Agros

During the initial workshop (step A2), the co-created value-in-use was defined as a centralized one-stop shop for sustainable farming solutions, providing access to operant resources (knowledge and advice) and operand resources (water pumps, fertilizers, financing, etc.). The value propositions of each service system entity were discussed, and multiple options were mentioned. The moderator took the lead in formulating them (step A3). The focal organization is divided into two departments: sales and operations, and management and engineering. The sales and operations department provides farming solutions directly to farmers, while the management and engineering team offers insights and solutions. Suppliers play a crucial role in manufacturing the necessary parts and creating customized soil health reports. They also provide inputs for fertilization based on the report recommendations. Microfinance institutions (MFIs) offer financial resources to farmers for investing in Agros' farming solutions. Finally, the impact of farming solutions offered to farmers is determined by how the farmer implements sustainable farming practises. Each of the identified service system entities is dependent on each other, and the one-stop-shop for sustainable farming solutions binds everything together. However, if one entity ceases to contribute its value propositions, the value of the one-stop-shop for sustainable farming solutions diminishes or even disappears.

Costs and benefits for each service system entity were discussed (step A5). Implementing the one-stop shop could reduce field visits for the sales and operations department, but efforts would be needed to educate farmers about the platform. Support visits would still be required for product installation and maintenance. The management and engineering team anticipated enhanced business efficiency through the digital platform but must also invest in its development. Suppliers expected compensation for their products and reports, while MFIs could generate interest income but face repayment risks. Farmers can access improved farming solutions by sharing data and investing in Agros' products. Activities enabling the value propositions for each service system entity were formulated (step A6). These include the sales and operations department providing farming resources and knowledge, the management and engineering team orchestrating solutions, suppliers manufacturing products and creating reports, the MFI offering loans, and farmers implementing sustainable farming practices.

6.1.2   Steps 1 and 2: service system requirements

Service system constructs are identified and modelled in steps 1 and 2 of the GEA-DPR method. After the first workshop, some business model blueprint elements can directly be used as service system constructs (step 1.1). The following service system constructs can directly be identified from the business model: the service system and its boundaries, the service system entities, the value expectations, the value propositions, and the service exchanges. However, the network rules, resources and value-in-context are missing or incomplete, therefore heuristics 2,6,7, and 8 are being applied.

The value expectations of the digital platform were discussed per entity (step 1.2). Farmers expected increased profit, the MFI and suppliers expected financial compensation, Agros'SO expected increased sales, Agros'ME expected increased efficiency, and it was determined that the digital platform required adequate resources as input. Next, any rules or regulations that may have an impact on the value of co-creation should be taken into account (step 1.3). Employees of the case company noted that they were subject to different rules in Cambodia and Myanmar, highlighting the importance of accounting for rules and regulations. However, due to time constraints, no final set of rules and regulations were defined. To provide a comprehensive overview of the GEA-DPR method, the rules, and regulations are still shown in the model but without any information (hence the red colour).

The operant and operand resources required to realise the value propositions of each service system entity, as well as the providers of these resources (whether the service system entity itself or an external source), were identified based on the costs identified in the SDBM-r and following heuristic 6 (step 1.4). Farmers require a variety of resources, including soil tests, fertilisers, solar irrigation systems, and knowledge of best farming practises. Acquiring this knowledge entails understanding application usage, timely checking, and acting on notifications and reports, which ultimately facilitates the implementation of sustainable farming practises. The sales and operations department requires dependable products, inputs, and reports. They are also in charge of data entry, advisory services, soil testing, troubleshooting, technical assistance, and farmer education. The MFI requires only farmer data, while suppliers require only the completed soil test. To send notifications and reports to farmers, the digital platform requires reports, documents, product data,

and customer data.

Next, the service exchanges required to meet each value expectation within the service system were discussed(step 1.5). Almost all value propositions contribute to the value expectations of other service system entities. For example, data entered on the digital platform by the sales and operations department, as well as the farmer, generates knowledge for the management and engineering team about farming performance, product performance, customer satisfaction, and credit. In the next step, metrics and target values for the value expectation(s) of each service system entity were defined (step 1.5). Since not all stakeholders were present to define the target values, some of them remained unspecified in the model (therefore the red color).

The farmers' value expectation is met when applying sustainable farming solutions resulting in x% higher crop yield and y% lower costs. The sales and operations department is satisfied when the turnaround time of service cases is reduced by x%, the prospect lead conversion time is reduced by 50%, and x% of customers make recurring purchases in the one-stop shop. The management and engineering team is satisfied when 100% of the impact data is automatically generated, and when x% of product development or improvement projects are based on product and customer data. The MFIs are satisfied when they receive x% interest from the farmers. Suppliers are satisfied when they are paid for their products. All stakeholders agreed that the digital platform requires adequate resources as input, specifically accurate and error-free data about customers and products.

Finally, the constructs of the service system meta-model are used to create a high-level service system requirements model. This model is created in step 2 using the GRL profile and is shown in the Figure 6.2 below. The model depicts all the identified service system constructs, displaying the high-level requirements of the one-stop shop for sustainable farming solutions. The identified service system entities are positioned in the model as follows: the service system at the top, the digital platform in the middle, the farmer at the left-top, the MFI at the left-bottom, Agros S&O at the bottom, Agros M&E at the right-middle, and the suppliers at the right top. It can be seen how the one-stop shop for sustainable farming solutions depends on the value propositions of each service system entity. Furthermore, the tasks and resources required to enable the value proposition, as well as the value expectations and defined or undefined metrics (red), are displayed within the boundaries of each entity. Furthermore, it is demonstrated how one entity's value propositions contribute to the other entity's value expectations. The network rules and regulations are highlighted in red because they were not defined in the demonstration for this specific context.
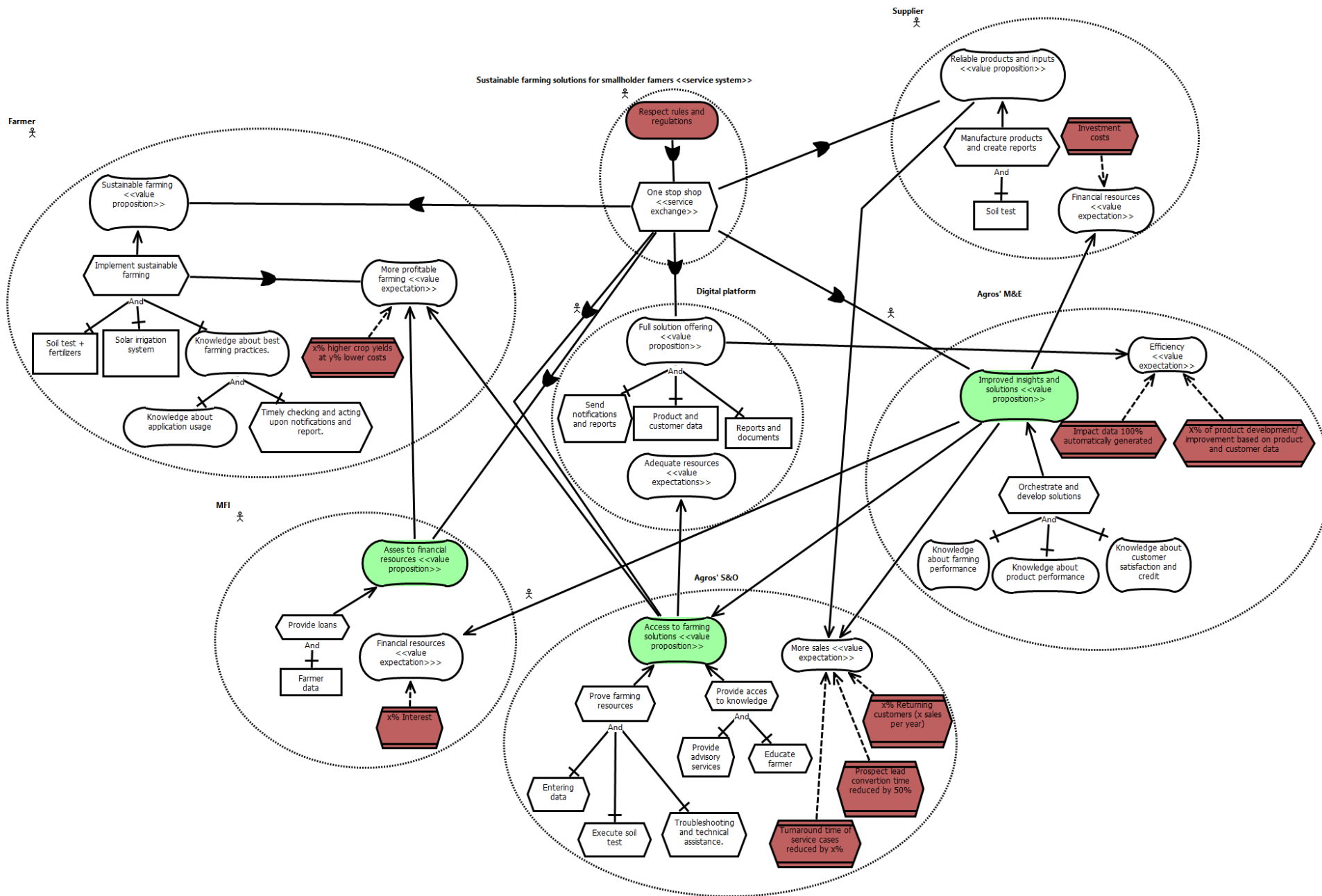
Figure 6.2: High-level requirements model for Agros' one-stop shop for sustainable farming solutions

6.1.3   Steps 3 and 4: digital platform requirements

After critically analyzing the service system requirements model, only the value propositions of entities that should be enabled by the digital platform were selected (step 3.1). Next, the goal-oriented idea generation method and the goal model elaboration method were applied to refine the value propositions (colored green in Figure 6.2) into functional requirements of the digital platform. For each value proposition that was being refined, workshop participants were present that represented the service system entity belonging to that value proposition. To optimize space utilization in this paper, only the refinement of the value proposition 'insights and solutions' attributed to the Agros management and engineering team will be presented in this section.

First, the workshop participants were asked to generate ideas related to the value proposition and to write them on sticky notes (step 3.2). This resulted in more than 46 ideas. Next, the participants were asked to group the ideas (step 3.3) this resulted in 3 groups; affordability, quality, and personalization. Next, the participants were asked to find associations among the grouped ideas (step 3.4). There were no constraints identified between the grouped ideas and it was determined that the groups were complementary to each other. Next, the groups of the ideas and their associations to a goal graph were organized on the board with sticky notes (step 3.5). Finally, each goal tree was refined by asking 'HOW', 'HOW ELSE" and 'WHY' (step 3.6), resulting in the GRT presented in Figure 6.3 below.
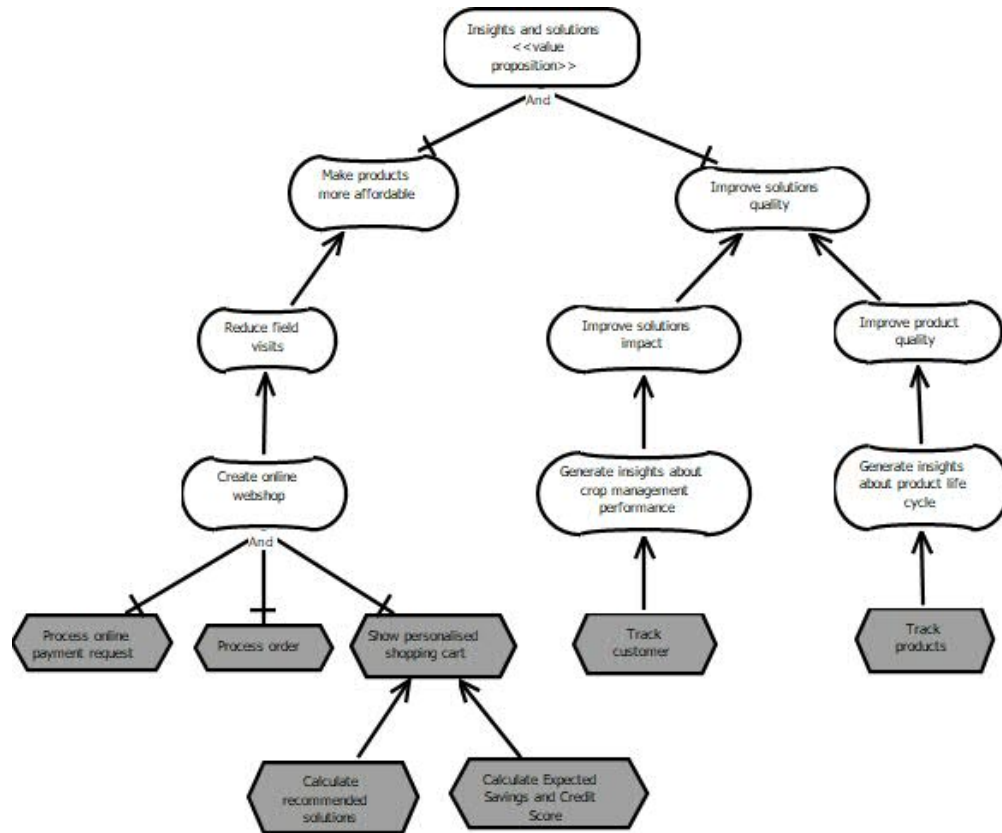

Figure 6.3: GRT: Insights and Solutions

Next, the elaboration and operationalization of each leaf goal were carried out using the structure outlined in Table 4.10 (step 3.7). An illustrative example of this process can be seen in Table 6.1 below, showcasing the detailed elaboration of the 'process order' functional requirement.

Goal	Achieve online sale
Trigger	Purchase Product
Response	To process the order:
	- Order must be approved
	- Ordered item must be available
	- Order must be paid (cash or payment plan)
Context	The farmer places an order and Agros' S&O must approve this order based on sales report. In order to create a sales report, a sale representative must have visted the farm of the farmer at least once. Furthermore, the farmer can request a payment plan and pay after harvest or can pay directly cash. Processing the online payment request is an other tasks that the digital platform should be able to execute.

Table 6.1: Example of requirement 'process order' elaboration

The comprehensive document containing all operationalized tasks of the digital platform can be accessed in Appendix B. It is worth noting that although formal refinement patterns were initially considered for step 3.7, they were deemed overly complex and unsuitable for implementation by business analysts based on the feedback from the EFG. Consequently, a decision was made to adopt informal operationalization patterns for the elaboration and operationalization of the platform tasks. The purpose of this step is not to produce fully executable functional requirements, but rather to generate a clear understanding of the rationales and functionalities of the digital platform being developed. By presenting the SR model displaying these operationalized requirements, these operationalized requirements serve as a foundation for assessing their feasibility and facilitating effective communication among stakeholders involved in the development process.

During this step, the tasks of the human service system entities became clear. Furthermore, it became clear that the Sales & Operations department of Agros will be an important user group of the application. Besides approving orders, they also need to create personalized shopping carts for the farmers and enter product and customer data. Furthermore, they are responsible for creating a service ticket when maintenance is performed and generating a sales report after selling and installing a product. This enables effective tracking and management of product lifecycles within the management and engineering team.

Next, agents were assigned to the leaf goals that were made operational in collaboration with the service system entities involved (step 3.8). During this step, it was identified that the 'Agronomist' was also an important user of the application for the farmer to provide farmers with knowledge. Finally, the most suitable alternative was selected when multiple goal OR-refinements or agent OR-assignments were present (step 3.9).

The first step to create the model was to position the digital platform in the center of the SR model, with all other entities being modelled around it. The farmer was positioned above, the agronomist on the left, the sales and operations department on the right, and the management and engineering team below (step 4.1). Subsequently, the digital platform tasks (represented in dark grey) were placed within the boundaries of the digital platform, while all the identified tasks and resources of other service system entities (identified in step 3.7, 3.8 and 3.9) were allocated within their respective boundaries (step 4.2). The value propositions were represented at the top of the SR model and connected to the co-production activities that were decomposed into the tasks that contribute to achieving these propositions (steps 4.3 and 4.4). Next, it was discussed whether the platform was able to execute each task it was assigned based on the tasks and resources of other entities available (step 4.5). Based on the identified tasks and resources, the following SR model was created using the GRL profile of Amyot et al. (2009), as shown in Figure 6.4.
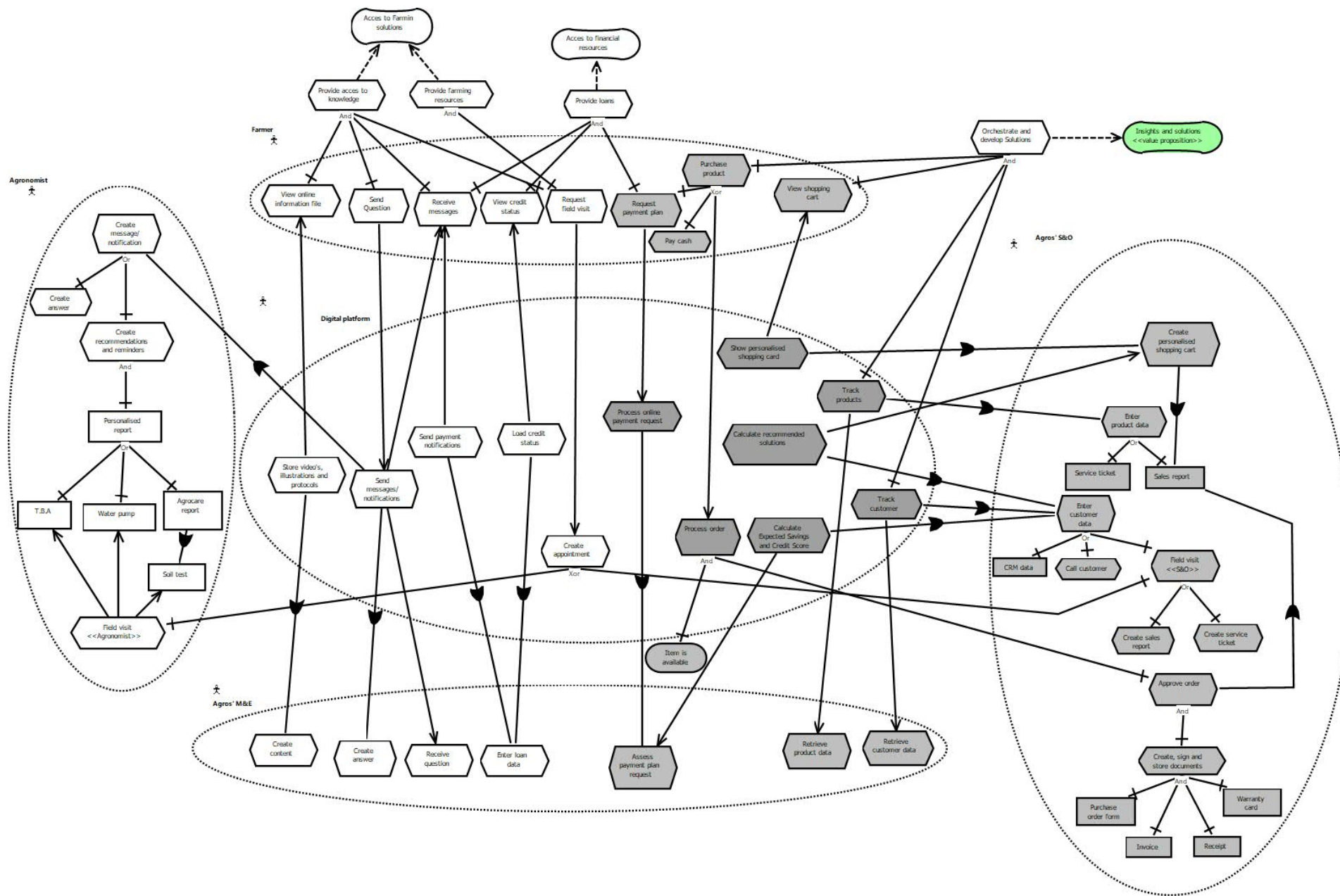
Figure 6.4: SR model Agros

6.1.4 Steps 5 and 6: feasibility of digital platform requirements

The SR model displays how the functional requirements of the digital platform depend on other entities' resources and tasks. Per entity, the resource availability (step 5.1) and task execution status were discussed (step 5.2). To demonstrate how these steps were applied the focus will be only on the sales and operations department. In Table 6.2, the assessment of tasks assigned to the sales and operations department is presented along with the corresponding reason behind it.

Task	Label	Reason
Create personalized shopping cart	Denied	Personalized advice is given in the field and not online
Enter product data	WeaklySatisfied	Automatic propagation
Enter customer data	WeaklyDenied	Digital tools are irregularly used to store customer data
Call customer	Satisfied	Farmers are being called to collect crop yield data
Field visit	Satisfied	Field visits are done quite often and result in high sales
Approve order	Denied	Sales only happen in the field where no approval is needed
Create, sign and store documents	WeaklySatisfied	Automatic propagation

Table 6.2: Labeling decisions of the task execution status of sales and operations department

Currently, the sales and operations department's work is primarily based on face-to-face interactions with farmers in the field. They are not accustomed to accurately entering data into online tools, as they already need to use the CRM tool to document their leads and sales, but they are not doing this with precision. In Table 6.3, the assessment of resources availability by the sales and operations department is presented along with the corresponding reason behind it.

Resource	Label	Reason
Service ticket	WeaklySatisfied	Paper service ticket is created, scanned, and send in Telegram
Sales report	WeaklySatisfied	Paper sales report is created, scanned, and send in Telegram
CRM data	WeaklyDenied	Data silos: Mixed usage of paper, Excel, Telegram and several other digital systems
Purchase order form	WeaklySatisfied	Paper service ticket is created, scanned, and send in Telegram
Invoice	WeaklySatisfied	Paper invoice is created, scanned, and send in Telegram
Receipt	WeaklySatisfied	Paper receipt is created, scanned, and send in Telegram
Warranty card	WeaklySatisfied	Paper warranty card is created, scanned, and send in Telegram

Table 6.3: Labeling decisions of resource availability of sales and operations department

As can be seen, the majority of resources are already available, but application mitigation is required to enable the operational use of these resources with the newly developed digital platform. It is crucial to improve the CRM data, as the current data is scattered across various locations, leading to a lack of a comprehensive overview for each farmer. The assessed SR model, shown in Figure 6.5, was developed by the modeller (Step 6) using the labels identified in Step 5.
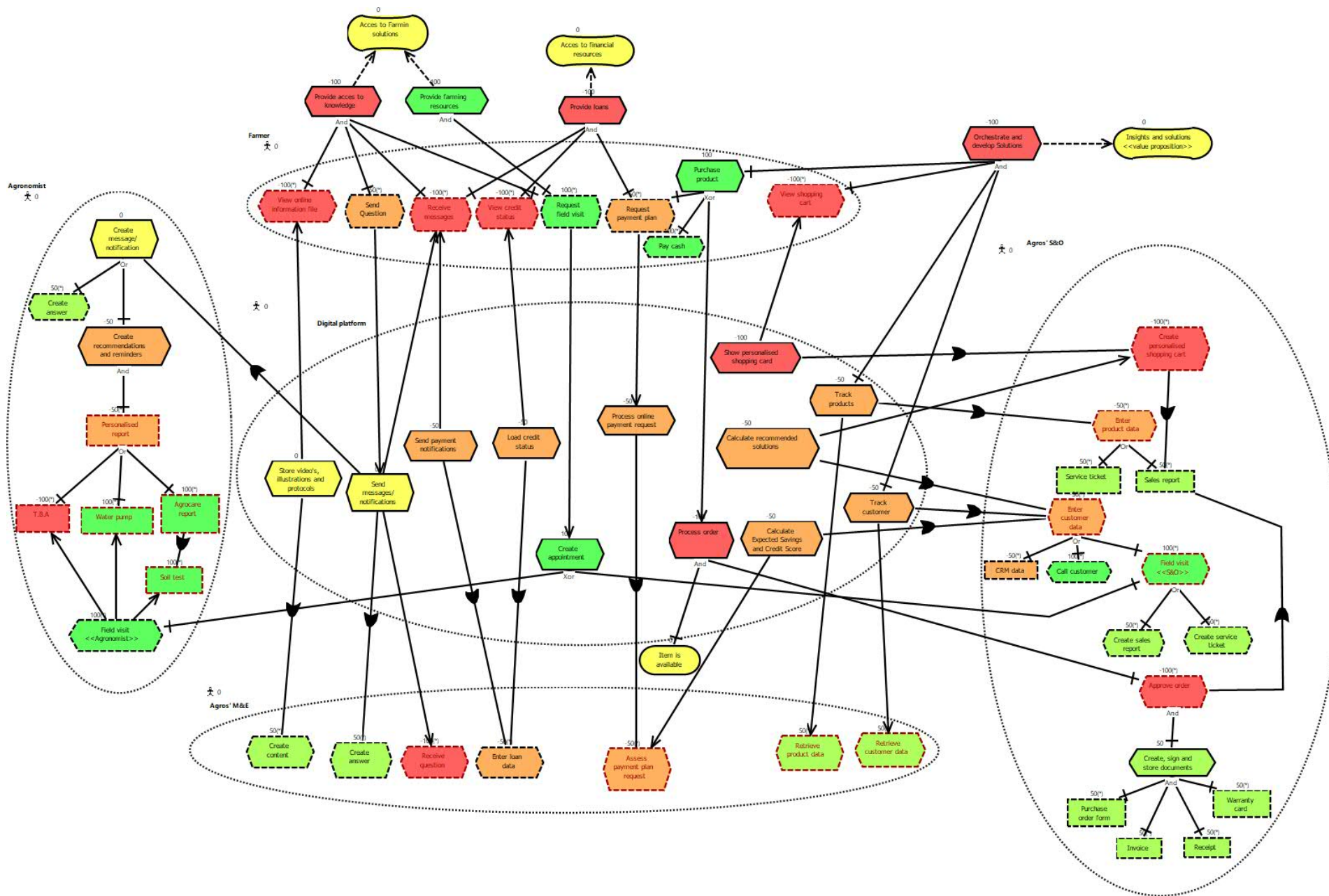
Figure 6.5: Assessed SR model Agros

The assessment of the tasks in the SR model reveals several findings. The activities assigned to farmers are mostly labeled red (denied) due to their lack of familiarity with using applications, making them currently incapable of performing online tasks. However, the functionality "create appointment" is labeled light green (partly satisfied) because, both farmers and the sales and operations department are already accustomed to executing and requesting field visits, making the development of this functionality relatively straightforward.

On the other hand, the tasks "process order" and "show personalized shopping cart" are labeled red (denied) because farmers have never viewed an online shopping cart with Agros products, and the sales and operations department has no prior experience approving online orders or creating personalized shopping carts. These tasks will require significant education and training before the entities can perform them accurately.

Some tasks are labeled orange (partly denied) indicating that there are issues such as incorrect CRM data or manual processes involved in assessing payment requests that cannot be easily digitized. Automating these processes is necessary to address the partial denial. Lastly, certain tasks are labeled yellow (None) due to insufficient information to determine whether they are denied or satisfied based on task dependencies. This situation occurs when the tasks they depend on are also labeled as None or partly satisfied. Overall, the assessment highlights the need for education, process automation, and data improvement to enable the successful execution of tasks within the SR model.

When all of the tasks that comprise a value proposition are labelled as satisfied via forward propagation, it is clear that the value proposition itself is satisfied. This means that all of the tasks and resources it encompasses are available and operational, satisfying the satisfaction criteria.

It should be noted that during the demonstration of the GEA-DPR method, difficulties arose due to a language barrier between the customer and the focal organisation, making active participation in the collaborative sessions difficult. To mitigate the negative consequences, additional face-to-face meetings with farmers were held in order to involve them as much as possible in the process. However, it should be noted that this may have had an impact on the quality of the results obtained through the use of the GEA-DPR method.

6.2 Evaluation Method

It is crucial to evaluate the utility, quality, and efficacy of newly developed artifacts (Venable et al., 2016). The GEA-DPR method is a complex socio-technical artifact that requires human interaction for its utility (Venable et al., 2012). Therefore, it was decided to evaluate the method in a naturalistic setting, both ex ante and ex post. The ex ante evaluation took place before full implementation, while the ex post evaluation occured after implementation. An EFG was employed for the ex ante evaluation to gather feedback on the method's design and identify potential issues or areas for improvement. For the ex post evaluation, a CFG was utilized to gather feedback on the actual use of the method and assess its effectiveness in achieving the solution objectives defined in Chapter 3 and it's fit with the environment.

According to Krueger (2014), focus groups are carefully planned discussions designed to obtain perceptions on a defined area of interest within a permissive and non-threatening environment. The use of focus group research is well-suited in this context as it provides valuable insights into the experiences, observations, and opinions of group members regarding the designed method (Massey, 2011). The study followed the guidelines proposed by Tremblay et al. (2010) for applying a Focus Group Methodology in Design Science Research (DSR).

6.2.1 Focus Group Protocol

According to Tremblay et al. (2010), the recommended participant range for focus groups in design research is typically between 4 and 12 individuals. However, they also acknowledge that demonstrating complex artifacts can pose challenges when conducting larger focus groups (consisting of more than six participants). As a result, it was decided to aim for a focus group size of 4 to 6 participants while considering the possibility of participants not showing up. To account for potential absences, 7 or 8 participants were invited by e-mail.

Additionally, initial contact was made with some potential participants through LinkedIn messages, based on their profiles aligning with the desired criteria for suitable focus group participants.

Both focus groups aimed to include participants with specific backgrounds and expertise relevant to the research topic. The recruitment process targeted individuals from the case company who had direct involvement in the application of the GEA-DPR method. Additionally, individuals with experience in requirements engineering for software development and individuals experienced in service system design and value co-creation were also included. This deliberate selection ensured a diverse and relevant group composition, offering the advantage of generating a wide range of perspectives and ideas related to the research question or topic being studied (Tremblay et al., 2010).

The objectives of the exploratory focus group were; (1) to identify areas of improvement and any missing elements in the GEA-DPR method based on the five selected criteria with the aim of incorporating them into future iterations of the design artifact and (2) to improve the script for the CFG. Information about the participants can be found in Table 6.4 below. Out of the 7 recruited participants, 5 showed up (a Senior Business Analyst and a Senior IT Consultant Requirements Engineering were missing).

	Role	Company	Years of SSD or SSE experience	Years of RE experience
1	Product Owner	ABN AMRO	12	15
2	Software Developer	Self-employed	5	12
3	Transformation Consultant	Deloitte	4	4
4	COO	Agros Pte	15	0
5	Data Analyst	PostNL	2	1

Table 6.4: Exploratory Focus Group (EFG) Participants

- Participant 1 (product owner at ABN AMRO): responsible for managing the product backlog, prioritizing user stories, and collaborating with stakeholders of ABN AMRO to ensure the development of valuable product features that align with the overall strategy. P1 has expertise in designing and implementing business processes and procedures, conflict of interest resolution, monitoring insider securities dealing, privileged identity management, and compliance risk management. P1's role involves aligning these areas with IT solutions and collaborating with stakeholders to achieve optimal outcomes.

- Participant 2 (self-employed software developer): designs, develops, and automates highly scalable systems on cloud platforms like AWS, Azure, and GCP. P2 has extensive programming experience in Python, JavaScript/TypeScript, Node.js, Java, and PHP and is proficient in Linux, Docker, Kubernetes, CI/CD pipelines, and Terraform, with a preference for serverless architecture. p2's role involves automating processes and optimizing infrastructure for cost efficiency, reliability, performance, and security.

- Participant 3 (Transformation Consultant at Deloitte): supports clients from Deloitte in defining and executing their business strategies, helping them achieve new growth opportunities, cost reduction, increased efficiency, and executing large-scale business transformations. P3 has experience with digitization and business analysis and is focusing on leveraging available technologies for optimal outcomes.

- Participant 4 (Chief Operations Officer at Agros): responsible for leading the operations and driving the strategic vision of Agros Pte Ltd, focusing on sustainable agriculture solutions for small and medium-sized farmers. P4 executes activities such as defining growth strategies, building high-performance teams, and implementing transformative initiatives, leveraging over 25 years of executive experience in diverse industries and multicultural environments. P4 is responsible for the development of the one-stop shop for sustainable farming solutions that Agros wants to develop.

- Participant 5 (Data Analyst at PostNL): responsible for analyzing data related to post-processing activities in the retail sector. P5 activities revolve around developing dashboards and providing data-

driven insights to improve understanding and decision-making processes. At PostNL, Participant 5 is actively involved in the development and maintenance of the Post-NL application. Furthermore, Participant 5 brings valuable experience in information management for governmental bodies.

The goal of the confirmatory focus group was to assess how well the GEA-DPR method met its solution objectives and how well it fits into the environment. Out of the 7 recruited participants, 4 showed up (two Requirements Engineers and one Business Model Consultant were missing). Information about the participants can be found in Table 6.5 below.

	Role	Company	Years of SSD or SSE experience	Years of RE experience
6*	Lecturer and Researcher	IE, UII	10	10
7	Head of Design	Roseman Labs	6	6
8	Head of Product	Agros Pte	10	0
9	Software Engineer	CodeNext21	1	1

Table 6.5: Confirmatory Focus Group (CFG) Participants

*works at the Industrial Engineering (IE) department of Universitas Islam Indonesia (UII).

- Participant 6 (Lecturer and Researcher at UII): specialized in Enterprise Resource Planning (ERP), Service Management, Business Process Management (BPM), and Cost Analysis and Estimation. Has experience with operationalizing service-dominant business models.

- Participant 7 (Head of Design at Roseman Labs): responsible for driving user-centered design and delivering stable and scalable software solutions. P7's activities include aligning user needs with business goals, creating delightful user experiences, and collaborating with cross-functional teams. P7 has extensive experience in leading UX teams, managing talented designers and researchers, improving UX practices, and creating a user-centered product development environment. P7 is skilled in user experience (UX), leadership, strategy, and user-centered design.

- Participant 8 (Head of Product at Agros): responsible for overseeing product development and strategy. P8's activities involve improving and developing solutions for smallholder farmers. Currently, at Agros, the focus is on solar-driven water pumps, soil tests, fertilizers, and inputs. P8 is a specialist in productive energy and climate-smart agriculture, and drives innovation and sustainability in these areas.

- Participant 9 (Software Engineer at CodeNext21): responsible for engineering software tailored for clients, incorporating influences of Machine Learning and AI. P9 has experience with Java and graph databases.

Both focus groups were conducted online via an MS Teams meeting, with the EFG lasting 83 minutes and the CFG lasting 93 minutes. The sessions followed a structured agenda as recommended by Tremblay et al. (2010). Initially, participants were introduced to one another and the session's purpose was explained (± 5 min). This was followed by presenting background information on the research topic, highlighting the complexity of designing digital platforms within service systems (± 10 min). Subsequently, a comprehensive overview of the GEA-DPR method was provided, accompanied by a demonstration of its application in the case company (± 10 min). An open discussion was then facilitated to assess the method against pre-established criteria (± 45 min), during which participants actively engaged and shared their insights. Finally, participants were requested to complete an online questionnaire (± 15 min) to evaluate the method's utility. The questionnaire employed a 5-point Likert scale to rate the method based on the evaluation criteria described in the following subsection.

6.2.2 Evaluation Criteria

During the focus group sessions, participants were actively engaged in providing feedback on the demonstrated method as well as responding to statements related to the selected evaluation criteria. Furthermore,

participants were given the opportunity to complete a questionnaire that allowed them to evaluate the GEA-DPR method quantitatively using predefined evaluation criteria as well as qualitatively by providing valuable feedback through open-ended questions.

The evaluation criteria employed in the focus group discussion and questionnaire to evaluate the GEA-DPR method are based on the structured framework presented by Prat et al. (2015). They utilize a systems approach to evaluate complex artifacts; by adopting a holistic view, a more comprehensive understanding of the artifact's behavior and effectiveness can be obtained. The evaluation criteria of Prat et al. (2015) are utilized to assess various aspects of the GEA-DPR method, focusing on the goal and environment dimensions. The goal and environment dimensions are further subdivided into more discrete and measurable evaluation criteria and statements, as illustrated in Table 6.6 below.

System dimension	Criterion	Statement
Goal	Efficacy	The method facilitates a systematic process of eliciting and assessing digital platform requirements considering the service system context.
	Utility	The method enhances the capture of operant and operand resources, value propositions and value in context as well as institutional arrangement, while also improving traceability between elicited requirements and higher-level objectives compared to traditional RE methods.
Environment (people)	Ease of Use	I found that the demonstrated method is easy to use.
	Perceived Usefullness	I found that the demonstrated method improves the execution of eliciting and assessing digital platform requirements by considering the platform's context.
Environment (organization)	Alignment with business	I believe that the method demonstrated could assist the case company in collaboratively developing a digital platform that is aligned with their strategic objectives.

Table 6.6: Evaluation criteria

The goal dimension is centered around the specific objectives and desired outcomes that the artifact intends to achieve (Prat et al., 2015). It aims to evaluate the extent to which the artifact fulfills its intended purpose. Therefore, the goal dimension is used to assess to which extent the GEA-DPR method fulfills the solution objectives defined in Chapter 3. This is done by evaluating the GEA-DPR method on the goal attainment criterion, which is split down into the efficacy, and the utility criterion. These criteria are defined as follows:

- Efficacy: The degree to which the artifact achieves its goal considered narrowly, without addressing situational concerns (Venable et al., 2012).

- Utility: Utility measures the value of achieving the artifact's goal, i.e. the difference between the worth of achieving this goal and the price paid for achieving it (Gregor & Hevner, 2013)

On the other hand, the environment dimension involves the evaluation of external factors that influence or interact with the evaluated artifact (Prat et al., 2015). These factors include social, cultural, economic, and political contexts, which may significantly impact the artifact's practical effectiveness. The environment dimension can be split into two dimensions: people and organization. The organization criterion refers to the organizational context in which the artifact is used, including factors such as organizational structure,

culture, and processes (Prat et al., 2015). The people criterion refers to the individuals or groups who use or are affected by the artifact, including users, stakeholders, and other relevant parties (Prat et al., 2015).

The environment dimension, with a focus on people, serves to evaluate the GEA-DPR method in terms of its ease of use and usefulness. These criteria are defined as follows:

- Ease of use: The degree to which the use of the artifact by individuals is free of effort (Davis, 1989).

- Perceived usefulness: The degree to which the artifact positively impacts the task performance of individuals (Davis, 1989).

The environment dimension, with a focus on the organization, aims to assess the GEA-DPR method's alignment with the business. Alignment with business is defined as follows:

- The congruence between the artifact (in this case, the GEA-DPR method) and the organization's (Agros) overall strategy (Henderson & Venkatraman, 1999).

This evaluation criterion is already sufficiently detailed, so no further clarification was required. It serves to assess the extent to which the GEA-DPR method achieved the objectives of Agros, the case company, in eliciting and assessing digital platform requirements within the context of farming solutions for smallholder farmers in Cambodia.

6.3 Evaluation Results

In this section, the results of the EFG, CFG, and questionnaire will be presented and discussed per evaluation dimension. The feedback provided by the EFG participants, which was utilized to enhance the GEA-DPR method during the second design and development phase, will not be discussed in detail in this section, as it has been previously discussed in Chapter 4. Quantitative results from the questionnaire will be combined with supporting quotes obtained from the focus group sessions per evaluation criterion. In addition, general comments provided by focus group participants, as well as responses to open questionnaire questions that provide valuable insights for the GEA-DPR method, will be examined. The transcript of the focus groups and the outcomes of the online questionnaire can be found in Appendix B.6. The descriptive statistics of the evaluation criteria, derived from the questionnaire results, are presented in Table 6.7.

	EFC				CFG			
Criterion	$\bar{x}$	σ	min	max	$\bar{x}$	σ	min	max
Efficacy	4,20	0,40	4	5	4,25	0,43	4,00	5,00
Utility	4,80	0,40	4	5	4,25	0,43	4,00	5,00
Ease of use	3,80	0,75	3	5	3,75	0,43	3,00	4,00
Perceived Usefullness	4,20	0,40	4	5	4,50	0,50	4,00	5,00
Alignment with business	4,80	0,40	4	5	4,50	0,50	4,00	5,00

Table 6.7: Descriptive Statistics of Evaluation Criteria

As can be seen, the criterion "Alignment with business" received the highest scores in both the EFC and CFG evaluations, with scores of 4.80 and 4.50, respectively. In contrast, the criterion "Ease of use" received the lowest scores in both the EFC (3.80) and CFG (3.75).

6.3.1 Goal dimension

Efficacy and Utility

The efficacy criterion achieved high ratings of 4.2 and 4.25 from the EFG and CFG participants, respectively. Additionally, the utility criterion received even higher ratings of 4.8 from the EFG participants and 4.25

from the CFG participants. These ratings are supported by quotes from the focus group discussions.

EFG participants highlighted the efficacy of the method in eliciting requirements within a service system context aiming at value co-creation, as expressed by the following quotes:

P2 *"The demonstrated method could help business developers/analysts to define goals and tasks, and software developers to execute them."*

P4 *"The method is relevant to get the requirements and to dive deeper into the core aspects needed to develop the digital platform such that it's valuable to each user."*

This effectiveness was confirmed by CFG participants, with one participant stating:

P6 *"I consider this method to be beneficial for gathering platform requirements."*

EFG participants acknowledged the GEA-DPR method's effective guidance in eliciting and assessing digital platform requirements step by step, as stated by one participant:

P4 *"Following the method step by step helps in understanding the needs and gradually uncovering the necessary context. It allows for a more focused and systematic approach, eventually leading to potential solutions."*

The CFG participants also found the step-by-step approach effective, with the initial step of developing a service-dominant business model being praised, followed by a service system analysis and a gradual transition to the elicitation and assessment of digital platform requirements. Participants stated:

P6 *"I find the method's usefulness in starting with the SDBMR as an easy way to explain the concept to others. It ensures that each value proposition contributes to the co-created value, allowing developers to stay focused on the goal. Overall, I believe this approach facilitates clarity and enhances comprehension."*

P8 *"The initial step of defining the business model was crucial in ensuring a clear understanding of the value propositions. Breaking down the process into models provided a structured project management tool to elicit and assess the platform's functionalities."*

Participants also appreciated the GEA-DPR method's utility in fostering a common understanding among stakeholders. They emphasized its clarity, traceability, and differentiation from traditional requirements engineering practices. Quotes from participants include:

P1 *"It provides more clarity compared to other tools used in the field of requirements engineering and helps stakeholders who may not be technically inclined to understand their field of interest or challenge."*

P2 *"I personally appreciate the difference between traditional linear methods and the presented approach. The visual representation of interconnected dependencies and multiple actors in this method provides a logical and intuitive understanding, unlike the cumbersome Excel documents commonly used in business analysis."*

The CFG participants valued the GEA-DPR method's goal-oriented approach and stakeholder involvement, emphasizing its utility in promoting collaboration and fostering a common understanding. Participants expressed:

P7 *"The method seems to be highly goal-oriented, which is one of its strengths. It emphasizes not just what needs to be implemented, but also the connections and relationships between different aspects of the project or program."*

P9 *"I find the utility of this method quite clear as it effectively presents a business proposition and encourages critical thinking about it. I appreciate how it prompts the organization of workshops to bring together the necessary individuals."*

The quotes provided by participants support the positive assessment of the GEA-DPR method's goal dimension. Its efficacy and utility in eliciting requirements and guiding the process are highlighted. Participants

value its goal-oriented approach, clarity, and traceability, which differentiates it from traditional methodologies, and they emphasise the importance of stakeholder participation and collaboration.

6.3.2 Enviornment (people)

Ease of use and Perceived usefullness

The EFG and CFG participants gave the ease of use criterion the lowest ratings of 3.8 and 3.75, respectively. The perceived usefulness criterion received high ratings of 4.2 from EFG participants and 4.5 from CFG participants. Quotes from focus group discussions back up these ratings.

EFG participants provided varied feedback on the ease of use of the GEA-DPR method, with some highlighting the clear and logical models, while others acknowledged its complexity and heaviness. Quotes from participants include:

P2 *"I found the method to be highly interpretable and logical, effectively showcasing how everything is dependent on each other."*

P3 *" I think the method itself, looks very clear and coherent."*

P4 *" I find the method initially heavy and complex, but I recognize its efficiency and usefulness."*

CFG participants expressed concerns about the size and complexity of the models, making them challenging for non-technical users to understand. One participant mentioned that larger diagrams posed comprehension difficulties.

P8 *" The complexity of the diagrams and dependencies made it difficult for non-technical individuals to grasp without genuine interest. It became simpler when breaking it down into trees, but larger diagrams posed challenges to understanding."*

However, another participant recognized the value of managing the model's size and emphasized the need to prioritize and skip parts to prevent overwhelming complexity.

P9 *" I believe we should be cautious about the model's size to avoid it becoming overwhelming and difficult to understand. We can prioritize and skip parts based on importance, preventing it from becoming a confusing mess. If the model becomes too large, it indicates a lack of focus and understanding in our work. The model's visualization helps us identify and rectify the issue of attempting to handle too many things simultaneously."*

Furthermore, the importance of user experience in the success of the GEA-DPR method was emphasised by EFG participants. Participants' quotes include:

P1 *" I find that the presented method offers a clear and comprehensive view of the entire field and that it is easy enough to use but requires some tooling and experience."*

P2 *" I tend to agree with P1's viewpoint that the success of utilizing this method relies heavily on the skills of the business analyst and how effectively they execute it."*

The need for user experience was not discussed in the CFG. Furthermore, EFG participants emphasised the GEA-DPR method's usefulness as a project management tool, particularly during the execution phase. Quotes from participants include:

P1 *" The method provides a structured approach to define project goals and maintain alignment throughout the program execution phase, allowing for periodic checks to ensure teams stay on track and avoid diverging paths. Based on the model, you can shape your backlog management enabling an overview and linkage to individual executions, supported by acceptance criteria, fostering effective coordination among teams."*

P2 *"I believe the method holds even greater value during the execution phase of the project. It allows for the creation of a plan, breaking it down into smaller tasks, and visually presenting progress. With a*

framework in place, outlining goals, tasks, and dependencies, it enables quick action and provides a visual representation of progress."

P3 *I liked the colored indicators in the model and find them helpful in tracking the progress of each actor's capabilities."*

Furthermore, EFG participants emphasised the GEA-DPR method's usefulness in fostering common understanding among project teams. Participants' quotes include:

P1 *Based on my experience working in a large company with interdependent teams, including platform teams, development teams, and value proposition teams, I strongly agree that the method's output (if it is consistent) fosters a common understanding among teams, which is a key success factor in delivering valuable software or products."*

p2 *" I think your method is especially useful for big companies. I am convinced that if you take an average software company of more than 10 people, this method creates enormous value."*

The CFG participants found the method useful as a communication tool as well. Among the quotes from participants are:

P7 *" I really appreciate the transparency of the model. I find the model to be highly useful in facilitating conversations and serving as a starting point for discussions. The color-coded blocks provide clear indications of where attention needs to be focused when certain blocks turn red.*

P9 *" The method empowers each actor to express their opinions and gather them in a centralized manner for better understanding. It helps bridge the gap between software engineers and business people, who often struggle to communicate effectively due to differences in technical and business terminology. By breaking down tasks into executable units and focusing on functionality, the method provides clarity and alignment between the two groups. It promotes collaboration and ensures that everyone involved can comprehend and contribute to the project, which is a significant advantage in our field."*

The lower rating for ease of use was confirmed by participant feedback, which mentioned challenges with the model size, the complexity of getting started with the method, and the need for an experienced user. Participants, on the other hand, recognized the GEA-DPR method to be useful as a project management and communication tool, fostering understanding among stakeholders and facilitating communication between software engineers and business people. This supports the higher perceived usefulness rating.

6.3.3 Enviornment (organization)

Alignment with business

Alignment with business received 4.8 and 4.5 ratings from EFG and CFG participants, respectively.

The case company employees' initial difficulties in comprehending the method, as well as their initial perception of the models as overwhelming, did not overshadow their overall positive assessment of the method's outcomes for their organisations. They were pleased with the method's impact and benefits, emphasising its value and thus alignment with business.

One case company employee expressed that the method improved their understanding of the requirements for the application.

P4 *: "I can see the value in having a clear methodology for processing various projects and products. Overall, I feel that our understanding of the application requirements and dependencies has significantly improved thanks to your method. This approach is effective and has been beneficial for me in guiding the development of the farmer application."*

Furthermore, the method assisted them in thinking critically about the application, assisting in the elimination of elements that did not fit and avoiding mistakes.

P8 *"The method helped us move from high-level concepts to detailed activities, allowing us to identify and eliminate elements that didn't fit. Overall, I find this method highly useful and valuable for our*

organization.

P8   *"I find the method highly useful, although it may be challenging for some individuals in our organization to fully grasp. I believe that developing clear guidelines and terms of reference through this process will greatly benefit our communication with app developers and help us avoid mistakes."*

Furthermore, one case company employee stated that the method was time-consuming, but that the organization viewed the participant-centric approach positively.

P8   *" It takes time for people to get used to this method, and multiple sessions may be necessary. The biggest challenge may be getting everyone to allocate sufficient time. However, the overall response to the participant-centric methods has been positive, and our organization's director even expressed the desire to use them more frequently."*

Despite the method's initial complexity and challenges in understanding, the overall positive perception of the method's outcomes by case company employees, P4, and P8, suggests a possible explanation for the high rating received. However, it is important to note that the high ratings may be skewed because all focus group participants voted based on their belief about the method's alignment with the business rather than their actual experience.

6.4 Summary of focus group results

During the EFG, participants appreciated the effectiveness of the method in fostering a shared understanding of the service system and digital platform requirements. Understanding stakeholder needs and contextual requirements was facilitated by the step-by-step approach, which simplified the complex task of app development. In addition, the visualisations of dependencies at the strategic and operational levels were deemed intuitive and logical, surpassing conventional methods of requirements engineering. Participants acknowledged that these visualisations helped non-technical stakeholders comprehend their domain and difficulties. Appreciation was also shown for the use of colour to assess feasibility and identify gaps. However, participants expressed concern over the growing complexity of the model as a result of the definition of numerous activities and the visualisation of extensive dependencies. To mitigate this, they emphasised the importance of clearly defining the scope and boundaries of the method. In addition, it was unclear to participants when a step was deemed to have been performed in sufficient detail. Finally, they emphasised that the success of the method depends heavily on the user's skills and experience.

Participants in the CFG agreed that the method was effective at eliciting digital platform requirements within the context of a service system. They emphasised the method's strategic and goal-oriented approach, which encompasses all pertinent components, entities, and activities. Again, the service-dominant business modelling workshop was praised for its ability to gather stakeholders, foster critical thinking about the "why" of the project, and facilitate understanding of value propositions before diving defining platform functionalities. They mentioned that this approach helps to align tasks with business objectives. Furthermore, the active participation of stakeholders in the development process, with equal participation was appreciated. In addition, participants emphasised the importance of the models in fostering a common understanding among stakeholders and bridging the gap between business and technical perspectives. During the initial development phase, the method was deemed extremely valuable for promoting stakeholder participation, the establishment of shared goals, communication, transparency, and collaboration. However, CFG participants also expressed concerns about the size of the model, which can become very large and result in diagrams that are difficult for non-technical stakeholders to comprehend.

Overall, the most attractive aspects of the GEA-DPR method were its preliminary step to create a service-dominated business model which directly forced stakeholder involvement and alignment of strategic objectives. Furthermore, the holistic approach of the GEA-DPR method was valued as it guides users in the consideration of the objectives of all stakeholders, facilitation of effective communication, and promotion of a shared understanding of the rationale behind each requirement and the necessary functionalities of the digital platform, as well as the interdependencies between the tasks and resources of other actors. The visualisations of strategic and operational level dependencies were deemed intuitive and logical, surpassing conventional requirements engineering techniques. The use of colour to evaluate feasibility and identify gaps

was additionally pointed out as an advantage of the method. The less appealing aspects of the GEA-DPR method were the size of the models and the activities required to produce the final output. Participants required time to comprehend the steps, and it was challenging to ensure that users spent sufficient time on each step to execute them correctly.

Based on the positive assessment of the evaluation criteria for the goal and environment dimensions, it can be concluded that the GEA-DPR method successfully achieves its solution objectives. However, improvements can be made to enhance the ease of use of the method. In addition, it should be noted that, although the alignment with business criteria was rated highly, the technical skills and language barriers of the participants may have an impact on the GEA-DPR method's ease of use and output quality. Greater technical proficiency and the absence of language barriers among participants in the method's collaborative activities are likely to facilitate a smoother and more efficient implementation, resulting in improved outcomes.

6.5   Summary of questionnaire

The open-ended questions in the questionnaire yielded valuable insights into specific aspects of the GEA-DPR method. Participants were asked to express their opinions on the most and least appealing or effective aspects of the demonstrated method, share their envisioning of how the GEA-DPR method would work, and provide any points of improvement they identified. The detailed responses of the participants can be found in Appendix B.6. However, a summarized overview of the most important advantages, concerns, and suggestions mentioned by the participants for the method is presented in Table 6.8 below.

Most applealing	Least appealing	Suggestions
SDBM radar	Relation to other models	Linking/integrating with other methods
Two-dimensional representation	Complex diagrams	Planning, sizing, prioritizing
Connected to the why	Boundaries of dependencies	Coherence with non-functional requirements
Identifying dependencies	Scope of activities	Shaping the approach and steps
Seeing all dependencies		Tracing models
Describing tasks		Keeping overview
		Demonstration of importance
		Short summary with updates
		Feedback loop
		Assign in-company champion

Table 6.8: Summary of Online Questionnaire Responses

The feedback from EFG and CFG participants is consistent in terms of the most and least appealing aspects of the GEA-DPR method resulting from the open questions in the questionnaire. The SDBM radar and the method's goal-oriented approach, in particular, were found to be extremely useful in facilitating stakeholder and user involvement. The GEA-DPR method allows organisations to develop a shared understanding of the rationale for developing digital platform tasks and how they are linked with other actors and resources. Concerns were raised, however, about the model's potential for becoming excessively large and the possibility of endless dependencies. The participants' suggestions for improvements were used to formulate a suggestion for future research in Chapter7.

Chapter 7

Conclusion

Digital platforms facilitate value co-creation through collaborative resource exchange among actors, generating value propositions and delivering services (Lusch & Nambisan, 2015). Therefore, designing digital platforms should prioritize enabling this value co-creation process, acknowledging its significance in shaping the platform ecosystem and guiding design decisions (Lusch & Nambisan, 2015; Hein et al., 2020). In this research, a service system perspective was adopted, considering service systems as the unit of analysis for comprehending and analyzing value co-creation. The objective of this research is to develop a goal-oriented requirements engineering method to elicit and assess digital platform requirements within the context of a service system, with a specific emphasis on value co-creation.

The research outcome introduces the GEA-DPR method, which offers users clear guidelines for effectively eliciting and assessing digital platform requirements while taking into account the service system context. The method comprises six steps, each consisting of multiple sub-activities that serve as effective guides throughout the process of eliciting and assessing digital platform requirements. These requirements are based on the value propositions of the stakeholders involved and the co-created value-in-use that each stakeholder seeks to enable.

A systematic literature review was conducted to provide insights into the current state-of-art GO(RE) methods taking the service system as a unit of analysis for value co-creation. From the findings of this review, the need for the GEA-DPR method became evident since none of the methods was designed to guide users in the process of first analyzing the service system and then gradually eliciting and assessing digital platform requirements based on this analysis. Furthermore, the SLR results facilitated the identification and selection of a strong base method and a method to serve as input for the development of the GEA-DPR method. The GEA-DPR method was evaluated and further improved based on the exploratory focus group results with 5 experts in the field of service systems design and requirements engineering.

The GEA-DPR method was evaluated with a confirmatory focus group with 4 field experts on the solution objectives, ease of use, perceived usefullness, and alignment with business. The results of the evaluation revealed that the GEA-DPR method demonstrated efficacy in achieving its intended purpose of eliciting and assessing digital platform requirements within the service system context, effectively satisfying the solution objectives. Furthermore, the GEA-DPR method exhibited its utility in facilitating communication between business and IT personnel, as well as fostering stakeholder involvement and alignment.

7.1 Theoretical Implications

This research makes a significant contribution to the existing body of literature through the development of the GEA-DPR method, which introduces several notable advancements.

First, the newly developed method bridges service system engineering and requirements engineering disciplines. Conceptual links between requirements engineering and the concept of value co-creation in the context of digital platform design were established. A novel end-to-end method was developed to facilitate platform requirements analysis by integrating high-level and abstract dimensions of service systems and low-level operational dimensions of software platform design concerns.

Second, the newly developed method impacts the requirements engineering domain by responding to an identified literature gap indicating a scarcity of empirically validated methods or approaches for requirements elicitation and/or assessment capturing value co-creation. The GEA-DPR method addresses this gap by encompassing all service system elements identified in the study by Lessard et al. (2020) and integrates goal models with service systems and digital platform concepts. This integration allows for a comprehensive

approach to eliciting and assessing digital platform requirements while taking into account the service system context and the intentions of each stakeholder.

Thirdly, the newly developed method makes a theoretical contribution by integrating a unique combination of formal and informal patterns in the elicitation and assessment of digital platform requirements. It leverages formal patterns that are empirically validated, ensuring a strong foundation based on established models and methods. Additionally, it incorporates informal patterns that foster open discussions, idea generation, and a more intuitive exploration of requirements, without imposing strict rules or predefined structures. This blending of formal and informal approaches sets it apart from conventional requirements engineering methods, offering a holistic approach to GORE for digital platform design.

The outcomes of this study exceed those of previous research efforts. Prior studies focused on proposing methods or approaches for digital platform requirements elicitation and assessment, but their main emphasis was on already deployed platforms or they lacked sufficient consideration of resource dependencies Jungerius et al. (2022); Adali et al. (2021). Furthermore, while service system requirements engineering techniques effectively incorporate the elements of S-D Logic (S-D Logic), they tend to produce too high-level requirements models for digital platform elicitation and assessment Immonen et al. (2016); Lessard et al. (2020). In contrast, this research makes a significant contribution by identifying, integrating, and modifying various methods and approaches that collectively address the identified solution objectives in an empirically validated manner, thereby advancing the existing literature.

In conclusion, this study has several implications for the existing body of literature. Firstly, it contributes by providing an up-to-date systematic literature review, offering a comprehensive overview of the current state of research in the field. Secondly, it introduces a goal-oriented method for eliciting and assessing digital platform requirements within the context of a service system. This method is further enhanced through an empirical iterative improvement process, ensuring its validity. Thirdly, the study presents the results of exploratory and confirmatory focus groups involving the intended end-users, evaluating the extent to which the predefined solution objectives were met. Lastly, the developed method serves as a foundational framework for integrating service system engineering and software engineering, offering a service system perspective. Together, these contributions advance our understanding and approach to digital platform requirements elicitation and assessment.

7.2 Practical Implications

The GEA-DPR method allows for eliciting and assessing digital platform requirements within a service system context. Users are guided to first analyze the service system and gradually elicit and assess the resulting digital platform requirements. The input of the GEA-DPR method is a service-dominant business model and a customer service scenario. The output of users applying the GEA-DPR method is an assessed SR model, representing the operational dependencies of the digital platform functionalities as well as how the rationale behind each functionality and whether this rationale is achieved.

Results show that the GEA-DPR method is effective for the early phase requirements engineering, involving the stakeholders, enabling traceably between intentional elements and digital platform functionalities as well as providing a clear overview of the strategic and operational dependencies of the digital platform operating in a complex service system. Due to this overview, the GEA-DPR method has been found to be extremely useful as a communication tool between business and IT employees enabling them to communicate about intentions, resources, tasks, and metrics. However, for the actual development of the digital platform further operationalization is needed. However, there are already several best practices that could be used to execute this requirements engineering phase.

In conclusion, the GEA-DPR method offers three significant implications. Firstly, it enables the elicitation and assessment of digital platform requirements. Secondly, it facilitates the involvement and alignment of stakeholders' value propositions. And thirdly, it enhances communication between business and IT employees as well as all stakeholders involved through the utilization of models and the establishment of traceability between functional requirements and intentional elements.

7.3   Limitations

This study has several limitations, first, the limitations of the purposed GEA-DPR method will be discussed and next the limitations of the design and development process of the GEA-DPR method will be discussed.

The GEA-DPR method combines a foundational base method that effectively captures value co-creation with additional modified methods and approaches. These extensions aim to guide users in analyzing the service system and gradually eliciting and assessing digital platform requirements. It is important to note that the method's scope is limited to the requirement analysis phase, with further steps required for the subsequent specification phase. Additionally, the integration of these diverse methods may have impacted the efficiency of the GEA-DPR method, leading to challenges for focus group participants. The multiple steps involved and the presence of multiple models with information at different levels (strategic and operational) may have contributed to the difficulty in using the method.

Additionally, it is crucial to emphasize that the successful implementation of the GEA-DPR method relies on users with specific roles and qualifications. To fully harness the method's potential, active participation from all stakeholders is essential. This can be facilitated by an experienced user who can create a shared understanding of the necessity to invest time and effort in each step. Furthermore, having an effective moderator during the workshop sessions is vital for guiding discussions and ensuring productive outcomes. The reliance on highly-experienced users and the extensive nature of the steps and activities involved in the GEA-DPR method may have an impact on its adoption rate. The method's complexity and the expertise required from users may present barriers to widespread implementation.

The development process of this study encountered four limitations. Firstly, due to time constraints, the development and evaluation of the GEA-DPR method were limited. Ideally, multiple design iterations with different EFGs would have been conducted to iteratively improve the method based on the results. Additionally, as highlighted by Tremblay et al. (2010), a comprehensive investigation of the artifact would require the execution of multiple CFGs, which was not feasible within the time constraints of this study. Furthermore, conducting multiple demonstration rounds in diverse contexts would provide a more comprehensive understanding of the strengths and weaknesses of the GEA-DPR method. These iterations are also needed to validate the combination of the base method with the four selected meta patterns and to streamline the process such that the number of activities can be reduced.

Secondly, it should be noted that the demonstration of the GEA-DPR method at the case company coincided with its development and refinement. This means that the case company encountered initial inefficiencies or suboptimality that were subsequently addressed. It is important to consider that these early challenges could have influenced their perception of the method's "ease of use". Their familiarity with the development process may have initially made it appear more complex and challenging to understand.

Thirdly, the context of smallholder farmers in Cambodia, in which the method was demonstrated, may not be the most suitable context for its application. Language barriers posed a challenge during the method demonstration, limiting the effective involvement of all stakeholders in the digital platform. Although representatives were present, this limitation could have affected the quality of the identified requirements and created models. Participants in the CFG acknowledged this shortcoming, which may have impacted the evaluation results of the criterion "alignment with business" due to difficulties in executing the workshops as intended with all stakeholders involved, necessitating the use of representatives. Efforts were made to minimize the impact of this limitation through subsequent validation with farmers in the field regarding the identified requirements, tasks, and resource dependencies. Considering these factors, the GEA-DPR method may be more appropriate for use in environments involving SMEs or multinational organizations with highly educated stakeholders who can more easily participate in the SDBM-r modelling workshop, goal-oriented brainstorming workshop, and gap analysis workshop.

Fourthly, it is important to note that the demonstration and focus group evaluations conducted in this study should ideally be followed by a longitudinal study. This longitudinal study would aim to validate the operational effectiveness of the service platform that is designed based on the service platform requirements defined using the GEA-DPR method. By observing the platform's performance and user experiences over

an extended period of time, valuable insights can be gained regarding its functionality and alignment with the intended goals and value propositions.

In conclusion, the GEA-DPR method combines a foundational base method with additional modified methods to guide users in analyzing service systems and eliciting digital platform requirements. However, its scope is limited to the requirement analysis phase, and further steps are needed for specification. Integration of diverse methods may impact efficiency and pose challenges for focus group participants. Successful implementation requires qualified users and active stakeholder participation. The study also faced limitations due to development constraints, contextual suitability, language barriers, and the need for longitudinal validation. These findings emphasize the method's potential barriers and the need for further research.

7.4 Suggestions for Future Research

In this section, suggestions for future research and further development of the GEA-DPR method are proposed. The identified opportunities for future research are threefold: linking the GEA-DPR method to project management tools, automating the requirements elicitation and assessment steps and modelling, investigating opportunities to simplify the steps of the method, and developing the connection to the requirements specification phase.

To fully realize the potential of the GEA-DPR method, it is recommended to conduct another DSR cycle focused on enhancing its ease of use and integration with other agile requirements specification and implementation tools. This additional cycle would allow for iterative improvements, streamlining the steps and activities, providing clear guidelines, and developing intuitive user interfaces and supporting software, making the method more user-friendly and accessible.

The opportunities for future research were identified based on the results of the focus groups and the questionnaire results. Participants expressed interest in establishing connections between the GEA-DPR method and (agile) project management tools. For instance, the identified metrics for each value expectation can be used to track whether these expectations are met and ensure the project remains aligned with its objectives. Additionally, the service-dominant business model and service system requirements model can facilitate consensus building in project roadmaps. Furthermore, the GRTs could be used to do some functionality testing to see whether it aligns with the customers' expectations. The assessed SR model can also serve as an iteration overview, where the completion of functionality implementation is visually represented. This integration with project management tools should consider the links to planning (time estimation), sizing (task magnitude), and prioritizing (task importance). Further investigation in these areas can enhance the practical applicability of the GEA-DPR method.

Furthermore, participants recommended simplifying the GEA-DPR method by automating certain steps and modelling activities. For instance, automating the linking of digital platform requirements to dependencies would allow users to filter and customize the level of detail displayed. This filtering capability enables analysis without overwhelming users with excessive elements in the model. It is essential for these extensions to facilitate analyses at both strategic and operational levels while maintaining a manageable overview of the models, without adding unnecessary complexity.

Additionally, efforts have been made to connect the different steps of the GEA-DPR method smoothly, such as linking elements of the SDBM-r and the service system meta-model constructs. However, further enhancements are necessary to improve the method's usability. These improvements should aim to address the challenges posed by the complex structure and extensive steps, ensuring a more user-friendly experience for participants.

Finally, the study results indicated the potential for integrating the GEA-DPR method with execution-focused methods, such as agile backlogs. It is recommended to investigate and test the refinement patterns from Darimont & van Lamsweerde (1996) specify the requirements, followed by operationalization patterns discussed in Letier & van Lamsweerde (2002) to operationalize the functional requirements. These operational requirements can be directly used for development or transformed into user stories or scenarios. However, given the abundance of existing best practices for requirements specification, the focus of future

research should be on determining the optimal output of the GEA-DPR method and validating this with software developers.

By conducting another DSR cycle and taking into account the opportunities for improvement, researchers can enhance the practical applicability of the GEA-DPR method and contribute to more efficient and effective service system analysis and digital platform design. Integrating requirements engineering, service system engineering, and software engineering methods and tools contribute to developing the GEA-DPR method to its full potential.

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Appendix A

Appendix: theory

A.1 Modelling constraints

Strict constraints as defined by (Amyot et al., 2009)

- Contribution links must only have softgoals as destinations.
- Decomposition links must not have softgoals, resources or beliefs as a destination.
- Decomposition links must not have beliefs as a source.
- Dependency links must never completely be inside of an actor boundary.
- Dependency links in an SD model must always have a dependum, i.e., there should never be a dependency link from an actor to an actor.
- SD models must not have links other than dependency and actor association links.

Loose constraints as defined by (Amyot et al., 2009):

- Beliefs should not be the destination of element links.
- AND decomposition links should only have tasks as destinations.
- Means-end links (i.e., OR/IOR decomposition links in GRL) should only have goals as destinations.
- Dependency links in an SR model should always have a dependum.
- The only links that cross actor boundaries should be dependency links.

Appendix B

Appendix: results

B.1   Customer Service Scenario

Agros is currently developing a one-stop shop for sustainable farming solutions, which will be implemented in Cambodia and Myanmar. Agros aims to enable farmers to switch to sustainable and profitable farming practices by providing a unique combination of technology, inputs, financing, and advisory services. The ultimate goal is to improve the lives of 100,000 farmers over the next five years while also lowering carbon emissions, creating a win-win situation for both people and the planet. This one-stop shop will give Asian smallholder farmers access to sustainable and profitable farming solutions.

Agros typically serves farmers in small villages across Asia who are struggling to make a profit due to rising fuel and input prices. These farmers often have a long history of farming practices, focusing on green revolution principles with high input models. However, due to climate change, soil degradation and high input prices, this model is not effective anymore and leaves farmers with low profit margins. When an Agros S&O representative demonstrates the solutions that Agros offers, the farmer becomes interested but lacks the financial resources to invest in them (not always the case/pay after harvest). Agros conducts a credit assessment and either provides a pay-after-harvest solution or sends the results to a trustworthy/partner MFI for longer-term credit arrangements. Now the farmer has enough financial resources and can buy a solution via the webshop.

Once the solution is implemented in the field, Agros enters the farmer's data into an application, which sends notifications reminding the farmer to perform best practices. Furthermore, installation data is stored in the application. When service is provided this data is updated. Enabling Agros M&E department to track the product's life-cycle. The farmer also has bought a soil test and inputs, therefore a S&O representative goes to the field to execute the soil test and sends the sample to their supplier of soil health reports. This report is updated with personalized advice from the Agronomist and sent via the application back to the farmer.

However, the farmer has difficulties trusting new solutions and does not always check his phone for notifications. Luckily, Agros has a knowledge center where the farmer can go to receive advice and see proof of the impact of Agros' solutions. Over time, the farmer gains enough trust to cooperate with Agros and use the products and services offered in the one-stop-shop correctly for multiple seasonal packages becoming part of the Agros' community.

The one-stop shop for sustainable farming solutions is envisioned to function in the following manner:

The application has an online web shop (created by the S&O department) where farmers can:

- Purchase products and services offered by Agros.

- Request field visits for activities like soil testing, troubleshooting/maintenance, and guidance.

Raw data is entered by Farmer, Agronomist or S&O department about:

- Potential customers, farmers, and products in the application.

- Personal, farm, product, and financial details.

- Contracts and documents.

The application processes the data to track products and customers in terms of:

- Performance.

- Maintenance/troubleshooting.

- Credit.

Agros enters a customized farming plan for each customer, including:

- notifications.

Farmers can send personalized questions to Agros at any time and receive Agros answers.

- Receive and send messages

B.2 SLR results RE methods

Authors	Year	Public ation Type (C/J)	Description	SE (Y /N)	NA (S,M, N)	RES (OT, OR, N)	VP (Y /N)	VIC (Y /N)	IA (Y /N)	REP (E,A, N)	TEE (EA, EP)	TE (A,N, F,S)	Evaluation Method
M. Berkovich, J. Leimeister, A. Hoffmann et al.	2014	J	Approach using a RDMod to address coordination and integration issues in the development of PSSs, providing a clear structure and facilitating traceability and conflict resolution.	Y	N	OT, OR	N	N	N	A	EA, EP	(A,F)	Retrospective application, expert evaluation, and feature-based evaluation.
A. Immonen, E. Ovaska, J. Kalaoja et al.	2016	J	Scenario-based service requirement engineering (RE) method for the digital service ecosystem.	Y	Y	OT, OR	Y	Y	N	E,A	EP	(N,S)	Demonstration and questionnaire
J. Lee, V. Sugumaran, S. Park et al.	2011	C	Approach for requirements management and service identification that utilizes value co-creation and IT convergence.	Y	M	N	N	Y	N	E	EP	(N,S)	Demonstration only

Table B.1: RE Methods or Approaches discussing service systems
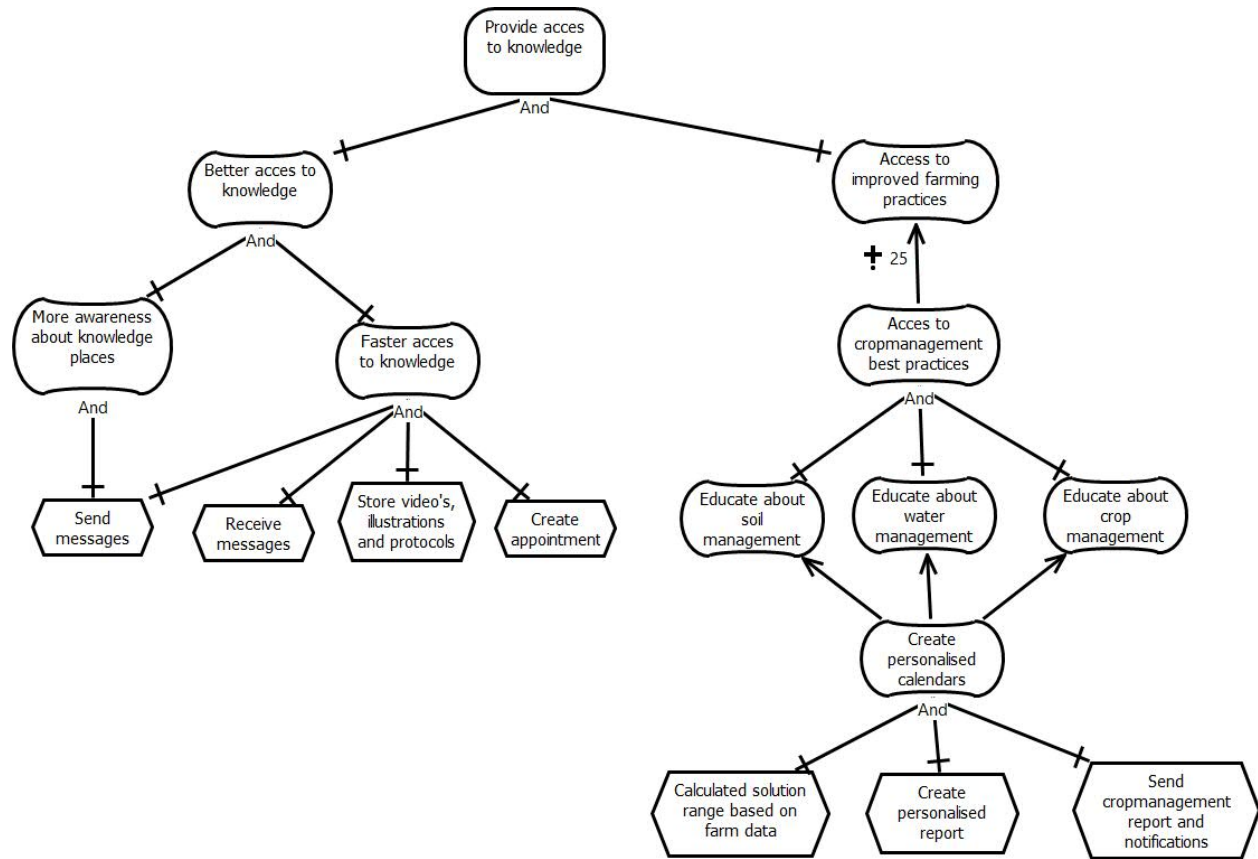
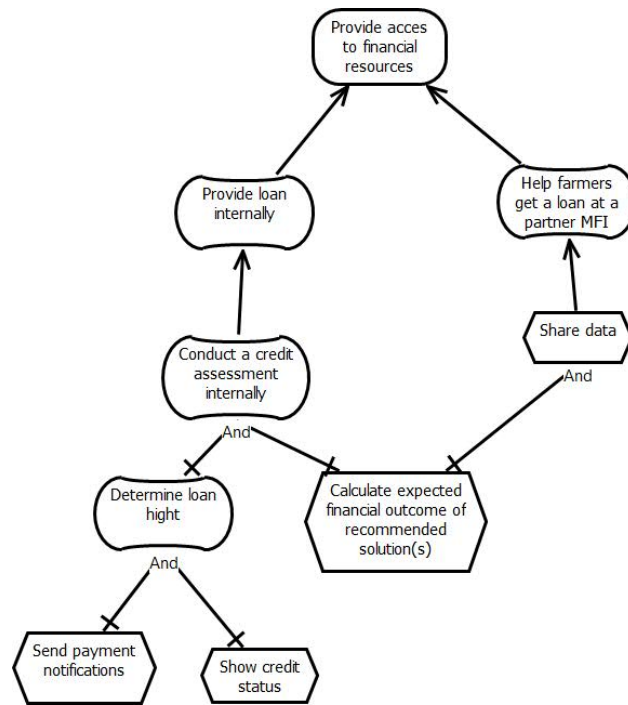## B.3 Goal Refinement Trees

Figure B.1: GRT Access to knowledge

Figure B.2: GRT Access to financial resources

B.4   Requirements operationalization

SG1: Better access to financial resources	Operationalization

	Trigger: sale
	Input: {client data}
	  - Enter/Update client data in app: Agronomist
	  - Load report from **Agros care**: Application, Agronomist, Farmer
	  - Update price information: Sourcing/ Operations Manager
	  - Convert data to correct unit (nutrient to fertilizer): Agronomist
	  - Connect unit to cost (fertilizer to costs): Application
	  - ~~Enter data from report in app?: Agronomist, Farmer~~
	Output: {sales contract}

	Trigger: client purchases soil test
	Input: {soil test results}
	  - Load data from Agros care ap
	  - Convert: unit & price
	  - Fertilizer package price
	Output: {Expected financial outcome}

Automatically connecting solution's costs and the expected financial outcome	Trigger: sale: Sales
	Input: {client data}
	  - Enter/Update client data in app: Agronomist
	  - Load report from **Agros care**: Application, Agronomist, Farmer
	  - Update price information: Sourcing/ Operations Manager
	  - Convert data to correct unit (nutrient to fertilizer): Agronomist
	  - Connect unit to cost (fertilizer to costs): Application
	  - ~~Enter data from report in app?: Agronomist, Farmer~~
	  - Automatically calculate financial outcome: Application
	      o Water pump: formula of flyer {investments vs. expected monthly savings}
	      o Inputs: {input costs vs. expected crop yield}
	Output {Expected financial outcome}

Sharing cost benefit analysis of solution with MFI	Trigger: client requests loan application: ??
	Input{Expected financial outcome}
	  - Load financial outcome: Application
	  - Send financial outcome to MFI: Application
	  - Send client data to MFI: application
	Output{MFRI received financial outcome}

Providing loan internally ??	

SG2: Better access to knowledge	Operationalization

Create notification function	Trigger: event of Marketing/Agronomist
	Input{Message created by Sales/Marketing}
	  - Create receiver(s): Sales/Marketing
	  - Create receiver's lists: Sales/Marketing
	  - Select receiver(s): Sales/Marketing
	  - Send notification: Application
	Output{Notification}

Create chat function	Trigger: question of Farmer

	Input{question} - Receive question: Application - Create answer: Back-office hot-line/ Application - Send answer: Application Output{automatic/manual reply?}
Create online storage place for video's, protocols and lectures	Trigger: file by Back-office Input{file} - Select folder - Upload file - Remove file - Create title - Safe file and details Output{content on webpage or application} Trigger: search of farmer Input{search string} - Show results - Press file - Show file - Close file Output{}
Provide farmer with watering calendar	Trigger: water pomp sale by sales Input{Agrosolar report} - Load report - Extract data - Show financial outcome - Create calendar → Agronomist + Application - Store calendar - Send calendar Output{watering calendar}
Provide farmer with input calendar	Trigger: input sale by sales Input{Agrosoil report} - Load report - Extract data - Calculate financial outcome - Store financial outcome - Create calendar → Agrocares report+ Agronomist (tailor made) - Store calendar - Send calendar → report {total} + notifications {per event} Output{input calendar}
Provide farmer with crop management calendar	Trigger: ? Input{?} - Load report - Extract data - Store financial outcome - Create calendar → Agronomist: instructions (+application?) - Store calendar - Send calendar Output{crop management calendar}

Has the app a role in providing better access to accurate and relevant market knowledge?	Not yet, long-term but wanted.

SG3: Improve solutions quality	Operationalization
Achieve: Collect data about product performance	Trigger: pomp installation Input{ } - Enter which data? - Online check-list? - Enter data –> Delivery team o Data: datum, foto, gps, pomp, report Output{ } Trigger: service request Input{ } - Fill in online form → delivery team - Analyze form → service manager - Store data → application Output{ } Retrieve client and product data: - Call or visit client Create service ticket Output{ } Trigger: end of service contract Input{ } - New service contract → sales - Pay for service → sales Output{ }
Achieve: Collect data about client performance	Trigger: field visit → Argos' sales & Operations or Agronomist Input{call or system booking} Store impact data in application (old vs new): - Crop yield: base-line vs end-line - Crop cycle: rainy seasons, dry season (1-4 cycles) -

B.5 Transcript of the Focus Groups

B.5.1 Goal dimension

Efficacy

EFG

P2 : *"During the execution phase of a project, I believe the method holds even greater value. It allows for the creation of a plan, breaking it down into smaller tasks, and visually presenting progress. This becomes crucial when changes occur, teams shift, and clients are no longer involved. With a framework in place, outlining goals, tasks, and dependencies, it enables quick action and provides a visual representation of progress, utilizing colors like red and green to indicate completion status. I find this particularly beneficial in the execution phase of a project. "*

P4 : *"It appears to be efficient, particularly when approaching a complex task like this. Following the method step by step helps in understanding the needs and gradually uncovering the necessary context. It allows for a more focused and systematic approach, eventually leading to potential solutions."*

P4 : *"The method is relevant to get the requirements and to dive deeper into the core aspects needed to develop the digital platform such that its valuable to each user."*

CFG

P6 : *"I consider this method to be beneficial for gathering platform requirements. However, it is important to recognize that obtaining requirements is just the initial step in software development. To proceed to the specification phase, which is better understood by technical IT professionals, it is crucial to ensure that the results of the requirement gathering can be easily transformed and translated into specifications. Therefore, it is recommended to engage in discussions with IT experts to ensure the model's output can be effectively utilized for generating specifications*

P8 : *" The initial step of defining the business model was crucial in ensuring a clear understanding of the value propositions. Breaking down the process into models provided a structured project management tool to elicit and assess the platforms funcationalities."*

P9 : *"I found the model useful, however, it is essential to strike a balance between designing the model and implementing it. Defining measurable metrics and validating the model's correctness are crucial steps to avoid wasting time on unnecessary implementation. The model facilitates this process effectively, but one should remain cautious and not overlook the importance of metrics and quick iterations to align with user needs and avoid overdesigning."*

Utility

EFG

P1 : *"It provides more clarity compared to other tools used in the field of requirements engineering and helps stakeholders who may not be technically inclined to understand their field of interest or challenge."*

P1 : *"I'm unsure if it qualifies as a requirement engineering practice or more as a part of requirements modeling. It serves as a visual tool to capture goals and facilitate discussions, but expertise and experience are necessary to ensure the right goals are addressed."*

P2 : *"I personally appreciate the difference between traditional linear methods like agile frameworks or Kanban boards and the presented approach. The visual representation of interconnected dependencies and multiple actors in this method provides a logical and intuitive understanding, unlike the cumbersome Excel documents commonly used in business analysis."*

P4 : *"I can see the value in having a clear methodology for processing various projects and products. Overall, I feel that my understanding of the application requirements and dependencies has significantly*

improved thanks to your method. This approach is effective and has been beneficial for me in guiding the development of the farmer application."

CFG

    P7 : *I believe that the method is not only valuable for defining and aligning goals, but also for tracking and maintaining focus on those goals. It seems to be highly goal-oriented, which is one of its strengths. In comparison to traditional requirement methods that mainly focus on implementation, the method you have created takes a more strategic approach. It emphasizes not just what needs to be implemented, but also the connections and relationships between different aspects of the project or program. This broader perspective is what sets it apart from traditional methodologies.*

    P7 : *"The method is highly valuable in the initial phase of application development to ensure comprehensive consideration of all parts, actors, and activities involved."*

    P9 : *"I find the utility of this method quite clear as it effectively presents a business proposition and encourages critical thinking about it. It facilitates gathering input from various stakeholders, ensuring comprehensive perspectives are considered. I appreciate how it prompts the organization of workshops to bring together the necessary individuals, which is often overlooked. This method's ability to achieve such collaboration is a positive outcome."*

B.5.2 Enviornment (people)

Ease of Use

EFG

    P1 : *"I find that the presented method offers a clear and comprehensive view of the entire field and that it is easy enough to use but requires some tooling and experience."*

    P2 : *"When I first encountered the method, I found it to be highly interpretable and logical, effectively showcasing how everything is dependent on each other."*

    P3 : *"I think the method itself, looks very clear and coherent."*

    P4 : *"I find the method initially heavy and complex, but I recognize its efficiency and usefulness."*

CFG

    P8 *"The complexity of the diagrams and dependencies made it difficult for non-technical individuals to grasp without genuine interest. It became simpler when breaking it down into trees, but larger diagrams posed challenges to understanding."*

    P9 : *"I believe we should be cautious about the model's size to avoid it becoming overwhelming and difficult to understand. We can prioritize and skip parts based on importance, preventing it from becoming a confusing mess. Empowering all actors to contribute is crucial, often overlooked by both software engineers and business people. If the model becomes too large, it indicates a lack of focus and understanding in our work. The model's visualization helps us identify and rectify the issue of attempting to handle too many things simultaneously."*

Perceived usefullness

EFG

    P1 : *" The method is particularly useful for business developers or analysts, whereas systems engineers may require more defined and specific requirements before actually implementing these requirements."*

    P1 : *"The method provides a structured approach to define project goals and maintain alignment throughout the program execution phase, allowing for periodic checks to ensure teams stay on track and avoid diverging paths. Based on the model, you can shape your backlog management enabling an overview*

and linkage to individual executions, supported by acceptance criteria, fostering effective coordination among teams."

P2 : *"I tend to agree with P1's viewpoint that the success of utilizing this method relies heavily on the skills of the business analyst and how effectively they execute it. Defining tasks, subtasks, and their dependencies can be a challenging task. It becomes crucial to determine where to draw the line and break down problems into smaller components. While the overview provided by the method is valuable, its usefulness diminishes rapidly if a few dependencies are overlooked. Missing even a few can potentially disrupt the entire planning and execution process. Therefore, having a competent individual is essential to initiate and navigate this method successfully."*

P2 : *"I find the overview quite impressive. It provides a clear visual representation of the relationships between different elements, allowing for immediate comprehension. I appreciate this aspect as it enables a quick understanding of the interconnectivity. Therefore, if the method incorporates such an overview created correctly, it undoubtedly holds value and usefulness."*

P2 : *"I think your method is especially useful for big companies. I am convinced that if you take an average software company of more than 10 people, this method creates enormous value."*

P3 : *"You start with "why" and I really like it. Furthermore, I liked the colored indicators in the model and find them helpful in tracking progress of each actor's capabilities."*

P5 : *"I think it's a very meaningful method and I think it could be very helpful in my work as well."*

CFG

P6 : *I find the method's usefulness in starting with the SDBMR as an easy way to explain the concept to others. Gradually transitioning from the simple to the complex helps individuals build their understanding effectively. It ensures that each value proposition contributes to the co-created value, allowing developers to stay focused on the goal. By tracking tasks and production activities, it becomes traceable and helps prevent misunderstandings. Overall, I believe this approach facilitates clarity and enhances comprehension.*

P7 : *"I really appreciate the transparency of the model. In my current role, I've noticed that there is less frequent interaction with external stakeholders compared to internal ones. I find the model to be highly useful in facilitating conversations and serving as a starting point for discussions. The color-coded blocks provide clear indications of where attention needs to be focused when certain blocks turn red.*

P8 : *"As a participant in the process and from the business side, I found the method insightful but also complicated. It helped us move from high-level concepts to detailed activities, allowing us to identify and eliminate elements that didn't fit. Overall, I find this method highly useful and valuable for our organization.*

P8 : *"I find the method highly useful, although it may be challenging for some individuals in our organization to fully grasp. I believe that developing clear guidelines and terms of reference through this process will greatly benefit our communication with app developers and help us avoid mistakes."*

P8 : *"It takes time for people to get used to this method, and multiple sessions may be necessary. The biggest challenge may be getting everyone to allocate sufficient time, especially when there is a rush for sales and deadlines. However, the overall response to the participant-centric methods has been positive, and our organization's director even expressed the desire to use them more frequently."*

P9 : *it's useful, especially at the beginning as a currently pointed out, you can keep focusing on parts that are actually needed. you can also together say OK, now we want this part of the model to be finished which is also a very good thing.*

P9 : *"The method empowers each actor to express their opinions and gather them in a centralized manner for better understanding. It helps bridge the gap between software engineers and business people, who often struggle to communicate effectively due to differences in technical and business terminology. By breaking down tasks into executable units and focusing on functionality, the method provides clarity*

and alignment between the two groups. It promotes collaboration and ensures that everyone involved can comprehend and contribute to the project, which is a significant advantage in our field."

B.5.3 Enviornment (organization)

Alignment with business

EFG

P1 : *"The method is highly valuable in shaping the project's goals and the final product, providing a clear focus on particular activities and their alignment with the end goal. This is particularly beneficial during the initial phase of the project."*

P1 : *"Based on my experience working in a large company with interdependent teams, including platform teams, development teams, and value proposition teams, I strongly agree that the method's output (if it is consistent) fosters a common understanding among teams, which is a key success factor in delivering valuable software or products."*

P2 : *"In my observation, I have noticed a significant disconnect between the management level's definition of project requirements and the actual implementation by developers. This can result in a loss of alignment and understanding. The method, especially the radar, can address this issue by providing a clear visualization of goals and the different layers involved in translating them into requirements and code. This ensures that everyone involved in the project is aware of the common goals and understands their role, which greatly benefits the developers."*

CFG

P7 : *"I believe that a good fit between companies, objectives, and platform capabilities is crucial, and the method facilitates aligning tasks with business goals and set priorities."*

P6 : *In software development projects, there are typically two distinct groups of individuals: business-oriented professionals and technical experts. Often, these two groups speak different languages, creating a communication barrier. However, this model aims to bridge the gap and facilitate communication between these groups, allowing them to speak a shared language, albeit with different dialects.*

P7 *"I appreciate the power of the method in treating all actors on an equal level. It ensures that every actor has an equal voice and influence within the platform, regardless of their position or role. I think this will increase trust. This approach contributes to a more collaborative and inclusive environment. Recognizing the human aspect and considering the perspectives of all individuals involved is a valuable aspect of the method."*

P8 : *"As a participant in the process and from the business side, I found the method insightful but also complicated.*

P8 : *"I believe that this method fits well within our organization, despite some initial clumsiness and disorganization. It forced us to think through our processes and challenge our assumptions, which is not something that private sector companies often prioritize."*

B.5.4 questions/remarks

P1 : Because it brings a modeler and also tracks dependencies for all stakeholders. As you see in what I see in practice is that there are some dependencies. And that relates to multiple particular topics. Do you have a way to filter those out, or is that just additional arrows that you need to model?

P1 : if you simplify the method a bit, it could be useful to discuss with the senior management team what you want to develop and where you need funding. I think the SDBM-r makes it very nice.

P1 : In software or business development, having clear and well-defined acceptance criteria is crucial at all levels, including user stories, tasks, and overall vision. This helps determine when the product meets customer satisfaction and ensures a successful alignment between product features and user needs. By

setting boundaries and aligning stakeholders' expectations, acceptance criteria contribute to project success and facilitate effective budgeting and resource allocation.

P1 : you could lose yourself in the details of the model. So it's good to define the boundaries within that initial approach. Just focusing on the core and then from there maybe looking at the additional topics.

P1 : "I believe that without an experienced modeler, there is a potential for things to go wrong in the process. Discussions among stakeholders may easily become skewed or fixate on irrelevant factors or challenges that do not align with the core goal. It is crucial to have someone knowledgeable and skilled in modeling who can guide the discussions, ask pertinent questions, and keep the focus on the essential aspects of the goal."

P2 : but I was wondering if there also some waiting or prioritizing or planning involved in the system or is it really just an overview of all the different components? To say this is important than that or this will be a very big task as compared to this small task. This will be six weeks this one day, that kind of stuff.

P3 : "I believe it's important to consider that not everything in business is solely driven by value. There are legal and regulatory aspects that may not directly contribute to value but are necessary to comply with. When focusing on business value, I question whether we may overlook these limitations and restrictions."

P3 : I have a question regarding when I can consider myself done or if I have reached the appropriate level of detail. I appreciate frameworks that provide predefined topics to ensure comprehensive coverage. I am curious if this method offers guidance on knowing when to stop and if there is clarity on defining and determining the level of detail for each activity.

P5 : The value can be compromised when you forget about some the dependencies, but I think it's also the other way around. If you have someone who goes too deep in all the different experts and dependencies you can like, lose yourself in the method. So I think it's very important that you know what the boundaries are and what the scope is of the method."

P6 : I believe that if the business people appreciate and understand this method, it signifies a good fit. Their positive reception is an important indicator for the company's suitability for this approach. However, the presence of a language barrier among the actors involved in co-creation could pose challenges and needs to be addressed. The involvement of all actors is crucial as it determines the platform's capabilities. If any link in the chain is missing, the company's objectives may not be fully achieved. Therefore, resolving these issues is essential to make this method successful and aligned with the organization."

P7 : I find it valuable that the method goes beyond implementation and focuses on understanding what we are actually doing and tracking our goals. Metrics play a crucial role in this process, providing helpful insights. It would be beneficial to map the sources of new activities, whether they stem from metrics, customer requests, visual considerations, or maintenance needs. Neglecting maintenance can have adverse effects, so it is essential to recognize its importance and ensure its inclusion in the project.

P7 : "As the application evolves over time, it may become more complex, requiring the breakdown of interconnected models, which poses a future challenge for developers. However, the method still offers clarity and understanding of the situation in the early stages, with the need to encourage active participation from all actors."

P9 : it is important to have someone who possesses both technical knowledge and understanding of business when working with the model. A software engineer alone may not fully comprehend value propositions and dependencies, highlighting the need for a person who can bridge the gap between technical and business aspects.

P9 : "I acknowledge that the language barrier can pose challenges in involving certain actors in the process. However, I believe that conducting smaller focus groups with farmers themselves can still provide valuable insights and contribute to the creation of relevant personas for the overall focus group. While

it may be more difficult in certain regions, I think this method is particularly well-suited when language barriers are minimal or non-existent."

B.6 Responses online questionnaire

	Advantage	Concerns	Method Execution	Suggestions
P1	the SDBM radar, though wonderig how this can be related to/extracted from more commonly used models business model canvas/product vision/user journey concepts	Using this, alike other methods requires experience/knowledge to do well (and know when to stop). Also, the model can be made stronger by using metrics when a goal can be considered to be achieved. Developing this requires quite an investment at the initial stage and it may be hard to get all stakeholders together frequently and for considerable time.	Adding metrics, not needing a specific modeler, linking/integrating this to execution focused methods (e.g agile backlogs).	-
P2	I really like the two-dimensional representation of task and (inter)depedencies, as compared to the tradiotional, one-dimensional "timelines"	I think the diagrams can get pretty complex pretty quickly – then you will lose overview. How to keep it?	This would help business developers / analysts to define goals and tasks, and software developers to execute them.	Links to planning (how long does this take?), sizing (how big is this task?) and prioritizing (how important is this task?).
P3	Everything stays connected to the why, this is the starting point for everything. I like how it breaks down from why to different activities.	The visual representation (example) was a bit difficult to read/understand.The quality of the model can be improved if it can be applied in an easy visual representation (excel, PowerPoint). Did not fully understand (but can be me) how this related to other non-functional requirements. Can the approaches be separate from each other, do you need to create coherence in approach, set-up, and dependencies with the non-functional requirements?	Apply it as the framework you use in the requirements generation process and use it to shape the approach and steps.	
P4	The linkage/ dependencies, because that helps a lot on building the goal tree.	-	I am confident that the final work on this methodology will support our Lead ICT to get onboarded and up-to-speed.	
P5	I think it's very effective that you can see all the dependencies. I think that also gives the inspiration to think about all the dependencies who are initially forgotten.	The only thing I can think of are the boundries of the dependencies. You could go on endlessly.	I think it could work very well in the initial process but also during. It could figure as an iteration overview. So that if you finish a task you change the color. In the end, it works as a process map.	Maybe you could demonstrate the importance due the size of the 'balloon'. So besides the color you can also see the importance.

Table B.2: EFG Results Questionnaire

	Advantage	Concerns	Method Execution	Suggestions
P6	where we can describe tasks needed to achieve value proposition	the use of so many colors that can cause confuse about the meaning of each color.	There should be representative of each actor that discuss the big picture (sdbm/r) and then this representative will bring the result and facilitate another discussion with their unit on how to decide the tasks needed to achieve the value proposition.	Make sure that in each next model can be traced to the previous model.
P7	All actors are on the same level, from the model it doesn't seem that there is a more dominant actor. Success metrics are a great way to track if you are on track. The visual representation shows how everything connects which makes the process transparent and clear.	It can become more complex over time. Perhaps it would be nice to have a short summary with updates for the people that don't enjoy looking at the visual representation. The modal has different benefits per actor, it would be great to iterate on how they would like to keep track of their benefits to feed the modal again (feedback loop).	In practice, I would keep working with workshops because it literally brings people together to define the modal (starting phase). I would like to keep a quarterly meeting to check in to see if we need to adjust or iterate.	I like that you bring together all stakeholders. The method is very useful in a starting phase, curious to understand how this would work for existing products. The benefit of all actors should be clear. Sometimes it's difficult for actors to speak up, speak another language, or change current processes. It's oke to define the "restrisicos" or residual risks (or benefits!) to take into account. The method is not focused on implementation or short-term benefits but rather on the longer-term business/relationship goals. It would be great for more companies to shift their mindset every once in a while to understand what's actually going on.
P8	SDBM-r to identify the value proposition	Each step came with a new model, which required time grasp for the participants.	The method and outcome will be handed over to the ICT manager, who will use it for app development. The method is more reliable than an individual inside the company, as it represents various stakeholders.	There needs to be an in-company champion that can drive the process. The method needs more validation on activity and dependency level, as the most dominant persons in the process were mid and high level managers.
P9	It breaks down strategic goals into tasks which can be used to drive technical implementation. It is common that the translation from business goals to technical details does not go well, and this method actually forces business people to explain their end goals in such a way that technical details can be extracted.	The model's representation was a bit overloaded by the introduction of dependencies. Currently, the number of dependencies is quite high and does not bring that much value to the visualisation of the model except for explaining the order of implementation (e.g. if A is finished then B is finished as well).	Starting off, you should gather all actors, which requires the business to define their prospected actors. From there, the method can be executed and will create a consensus about the roadmap of the project. Additionally, metrics are defined upfront which allow the business to diverge from their first iteration of the model and pivot to a better direction, i.e. it facilitates the business to keep focus. Also, by specifying tasks the IT department can create clear user stories that should be developed, so it also allows IT to have an overview of what is needed and what the actual contribution of a new feature will be.	Diminish the importance of dependencies in the view of the model, as they are only needed if you focus on some activity. Emphasise metrics in the visualization if possible, as those metrics are important to steer the priorities of the entire project. Ensure that all actors adopt the model fully, if one actor does not adopt the model it will not work that well.

Table B.3: CFG Results Questionnaire