Contributions to Stakeholder Value-Oriented IT Service Management

The Development of the *its*VALUE Method

Dissertation

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Abstract

This dissertation introduces the development and evaluation of *its*VALUE, a comprehensive method, modeling notation, and ADOxx-based toolset for stakeholder value-oriented IT Service Management (ITSM). The method enables organizations to model, analyze, and redesign IT services with a strong emphasis on stakeholder perceptions of value, addressing a significant gap in many existing ITSM approaches that often overlook implicit or context-specific value aspects.

Following a rigorous Design Science Research (DSR) process, *its*VALUE integrates multiple established modeling methods (including VSM 4.0, VSA 4.0, DVD, 4EM, and VDML) into a coherent and extensible framework. Key components of the method include the Value Perception Model (VPM), Stakeholder Value Map (SVM), Value Stream Blueprint (VSB), and the Process Specification Model (PSM). These modeling artifacts help trace and operationalize the relationships between stakeholder expectations, value-creating activities, and service delivery components.

The method was developed iteratively and validated through a real-world case study in an industrial context, followed by an external evaluation by independent users. The results confirm the applicability, usability, and practical relevance of *its*VALUE, highlighting its potential for broader adoption in practice and research. This work contributes a novel, tool-supported approach to embedding Stakeholder Value (SV) into ITSM and provides a solid foundation for future extensions in service modeling, enterprise architecture, and digital transformation initiatives.

Keywords

*its*VALUE, Stakeholder Value (SV), Value Stream (VS), IT Service Management (ITSM), ITIL 4, Enterprise Modeling, Design Science Research (DSR), Method Integration Process (MIP), Agile Modelling Method Engineering (AMME), Iterative Development, Value Perception Model (VPM), Stakeholder Value Map (SVM), Value Stream Blueprint (VSB), Process Specification Model (PSM), ADOxx Modeler, OMiLAB

Kurzfassung

Diese Dissertation stellt die Entwicklung und Evaluation von *its*VALUE vor, einer umfassenden Methode, Modellierungsnotation und einem ADOxx-basierten Werkzeug zur stakeholderwertorientierten Gestaltung von IT Service Management (ITSM). Die Methode unterstützt Organisationen dabei, IT-Services gezielt auf Basis der individuellen Wertwahrnehmungen von Stakeholdern zu modellieren, zu analysieren und weiterzuentwickeln, und adressiert damit eine zentrale Lücke vieler bestehender ITSM-Ansätze, die implizite oder kontextspezifische Wertaspekte oft vernachlässigen.

Der methodische Rahmen basiert auf dem Design Science Research (DSR) und integriert verschiedene etablierte Modellierungsmethoden (darunter VSM 4.0, VSA 4.0, DVD, 4EM und VDML) in ein konsistentes und erweiterbares Framework. Zu den Kernkomponenten zählen das Value Perception Model (VPM), die Stakeholder Value Map (SVM), das Value Stream Blueprint (VSB) sowie das Process Specification Model (PSM). Diese Artefakte ermöglichen eine nachvollziehbare Verknüpfung zwischen Stakeholder-Erwartungen, wertschöpfenden Aktivitäten und Service-Elementen.

Die Entwicklung erfolgte iterativ und wurde im Rahmen einer praxisnahen Fallstudie sowie einer anschließenden externen Evaluation durch unabhängige Anwender evaluiert. Die Ergebnisse belegen die Anwendbarkeit, Benutzerfreundlichkeit und Praxisrelevanz von *its*VALUE und zeigen das Potenzial für eine breitere Anwendung in Forschung und Praxis. Diese Arbeit liefert damit einen neuartigen, werkzeuggestützten Beitrag zur Integration von Stakeholder Value (SV) in das ITSM und bietet eine belastbare Grundlage für weiterführende Arbeiten im Kontext von Servicemodellierung, Unternehmensarchitektur und digitaler Transformation.

Schlagwörter

*its*VALUE, Stakeholder Value (SV), Value Stream (VS), IT Service Management (ITSM), ITIL 4, Enterprise Modeling, Design Science Research (DSR), Method Integration Process (MIP), Agile Modelling Method Engineering (AMME), Iterative Development, Value Perception Model (VPM), Stakeholder Value Map (SVM), Value Stream Blueprint (VSB), Process Specification Model (PSM), ADOxx Modeler, OMiLAB

Nomenclature

4EM For Enterprise Modelling

AMME Agile Modelling Method Engineering

BPMN Business Process Model and Notation

BSC Balanced Scorecard

CPL Current Performance Level

CVS Current Value Stream

DA Data Availability

DR Digitization Rate

DU Data Usage

DSR Design Science Research

DVD Dynamic Value Description

DVSM Dynamic Value Stream Mapping

EVSM Extended Value Stream Method

EVSMN Extended Value Stream Model and Notation

FEDS Framework for Evaluation in Design Science Research

FM Flowthing Model

FVS Future Value Stream

GPM Goal & Problem Model

GI Guided Interview

H Score Hindering Score

IF	Impact Factor
ISB	Industrial Service Blueprint
ITIL	IT Infrastructure Library
ITSM	IT Service Management
IT S-SB	IT Self-Service Blueprint
KPI	Key Performance Indicator
MIP	Method Integration Process
OMiLAB	Open Models Initiative LABoratory
POA	Possession, Ownership, Availability
PSB	Product Service Blueprint
PSM	Process Specification Model
R	Requirement
RDF	Resource Description Framework
RDF-S	Resource Description Framework - Schema
RDR	Relation-Domain-Range
REA	Resources, Events, Agents
RF	Relevance Factor
RM	Risk Management
RQ	Research Question
RVSM	Risk Value Stream Mapping
SB	Service Blueprint
SD	System Dynamics

SDL	Service-Dominant Logic
SLA	Structured Literature Analysis
S Score	Supporting Score
SMS	Service Management System
SSG	Service System Graph
SV	Stakeholder Value
SVC	Service Value Chain
SVS	Service Value System
SVM	Stakeholder Value Map
UML	Unified Modelling Language
***its*VALUE**	”It’s a Value Added Language You Employ”
VDML	Value Delivery Modelling Language
VoPM	Value-oriented Process Modelling
VPM	Value Perception Model
VS	Value Stream
VSA 4.0	Value Stream Analysis 4.0
VSB	Value Stream Blueprint
VSD 4.0	Value Stream Design 4.0
VSM 4.0	Value Stream Method 4.0
VSM	Value Stream Mapping
VSMN	Value Stream Model and Notation
VW	Value Weight
WST	Work System Theory

Contents

List of Figures

List of Tables

List of Algorithms

1. Introduction

In today's fast-paced, technology-driven world, IT Service Management (ITSM) is vital for modern organizations. It enables them to design, deliver, manage, and continuously improve IT-enabled services that provide value to customers and stakeholders. According to ISO/IEC 20000-1:2018 [40], ITSM involves establishing and enhancing a Service Management System (SMS). Over time, ITSM has evolved from a reactive, operations-focused approach to a proactive, strategic function that fosters business innovation and agility.

The growing dependence on IT services has placed ITSM at the forefront of digital transformation efforts. As Johnson et al. [59] note, this shift reflects a move from technical service provision to a value-driven approach, where ITSM contributes to business success and competitive advantage. This transformation is supported by standardized frameworks like ITIL, COBIT, and ISO/IEC 20000, which aim to align IT capabilities with business outcomes and ensure consistent, efficient, and customer-focused service delivery.

Among these frameworks, the IT Infrastructure Library (ITIL) is the most prominent and widely adopted. Developed by the UK's Central Computer and Telecommunications Agency (CCTA) in the 1980s [96], ITIL has evolved through several iterations to stay relevant amid changing technological and organizational demands. ITIL 4, released in 2019, represents a significant paradigm shift [8–12]. It emphasizes value co-creation, adaptability, and integration with modern practices such as Agile, DevOps, and Lean. Instead of prescribing rigid processes, ITIL 4 introduces the Service Value System (SVS) and Service Value Chain (SVC) as flexible, holistic constructs that help organizations dynamically deliver and improve services.

From an academic perspective, ITSM is increasingly seen not only as a practical framework but also as a research discipline encompassing diverse conceptual and methodological traditions. Scholars have emphasized the need for models that go beyond efficiency metrics to incorporate stakeholder-centric views of value (Alter [4, 5]), aligning IT services with user expectations, contextual requirements, and evolving digital ecosystems. This aligns with Vargo and Lusch's Service-Dominant Logic (SDL) [138, 139], which views value as a co-created outcome rather than a provider-delivered product.

However, while ITIL 4 explicitly motivates concepts like Stakeholder Value (SV) and Value Stream (VS), it lacks formalized methods or tools for their modeling and operational integration. As Winkler and Wulf [151] argue, such a lack of conceptual and methodological infrastructure limits a framework's ability to trace and evaluate SV in practice. Therefore, there is a clear need for approaches that systematically embed value considerations into service design and improvement.

To address this gap, this dissertation presents *its*VALUE, a method, notation, and modeling tool for value-oriented ITSM. Although its development is illustrated using ITIL 4 terminology and structures, *its*VALUE is not tied to ITIL 4 as a product. Instead, it aims to advance scientific and methodological support for ITSM as a whole. ITIL 4 is used as a contemporary example due to its influence and conceptual alignment with value co-creation. By integrating stakeholder perceptions of value with concrete components of VSs, *its*VALUE enables organizations to model, analyze, and improve their services with a clear focus on what matters most to those involved. This work contributes a robust and adaptable approach for bridging theoretical value constructs with practical ITSM implementation, furthering the discipline's evolution toward more agile, transparent, and stakeholder-oriented service management.

1.1. Motivation, Challenge and Contribution

Despite advancements in ITSM, many methods still fail to systematically address SV in the manner required by ITIL 4. Existing approaches such as e3value [24, 58, 124, 135, 143, 148], DVD [124–126], and VSM [1, 2, 13, 31, 37, 38, 88, 94, 119, 143, 152] primarily focus on the exchange of explicit values, such as explicit elements like goods and monetary resources. However, they often overlook implicit values, such as user satisfaction, perceived simplicity, or trust; implicit but crucial aspects that ITIL 4 explicitly requires to consider for each relevant stakeholder.

As both Iden and Eikebrokk [56] and Marrone et al. [82] discuss common challenges faced during ITSM and ITIL implementations, especially the integration of SV into VSs may pose a significant challenge. Because "value" has a subjective and multi-dimensional nature: different stakeholders have diverse and dynamic perceptions of what they consider valuable, which are often context-specific and implicit. This complexity is rarely reflected in traditional process or service models, which tend to reduce value to performance metrics or cost efficiency. Although ITIL 4 emphasizes value co-creation and introduces the SVS and VSs as guiding constructs, it lacks concrete modeling guidance to operationalize the relationship between SV and VSs [12]. As Winkler and Wulf [151] note, this absence of formalized methods for value tracing within ITSM frameworks leads to blind spots in service design and delivery. Without clear connections between stakeholder perceptions and actual service processes, organizations risk designing services that are technically complete but misaligned with what stakeholders actually need or value.

Addressing this challenge requires not only conceptual clarification but also a practical solution; specifically, a structured and tool-supported approach for linking stakeholder demands to service execution. Therefore, the term method refers to more than a procedural guideline. According to Brinkkemper [21], a method is "an approach to performing systems development projects, based on a specific way of thinking, consisting of directions and rules, structured in a systematic way in development activities with corresponding development products". This definition highlights that a method encompasses both procedural steps and the underlying principles, models, and artifacts that guide its application.

To address the aforementioned gap, we developed *its*VALUE, an integrated framework for modeling and analyzing IT services from a value-oriented perspective. It considers both explicit and implicit forms of value relevant to various stakeholders. To support this, *its*VALUE introduces a foundational meta-model that explicitly connects SVs with VSs through transitive relationships: stakeholders value certain elements, and these elements can be directly influenced by VS components, which may also impact one another. This structure (also shown later in Chapter 3 by Figure 3.1) enables the identification of implicit value creation dependencies, fulfilling further ITIL 4 requirements. This conceptual link between SVs and VSs sets *its*VALUE apart from existing approaches, making it a unique contribution to both research and practice. By enabling a traceable, stakeholder-driven analysis of VSs, *its*VALUE helps bridge a fundamental gap in current ITSM practices and supports organizations in aligning service design with dynamic stakeholder needs.

1.2. Important Concepts in ITSM and ITIL 4

Building on the motivation and identified challenges, a detailed understanding of key ITSM and ITIL 4 concepts is crucial. ITIL 4 [12] defines "service" as an enabler for the collaborative creation of value among different actors or stakeholders. A service primarily supports a customer or user in achieving their goals and desires without the customer being responsible for specific costs or risks. Instead, a service provider assumes those costs and risks, with the service customer compensating the provider. Further, ITIL 4 [12] defines ”IT Service Management (ITSM)” as a sequence of specialized capabilities a company employs to generate value for its customers by providing services. To achieve this, companies must carefully understand the essence of value, the stakeholders involved, and how their services enable value creation. To support this understanding, the following terms, as defined by ITIL 4, are critical:

Stakeholder Value (SV): Defines what ”value” actually represents for stakeholders.

Value Streams (VSs): Illustrate how value is commonly and generally created.

Service Blueprints (SBs): Provide a methodological approach to designing services, addressing emerging challenges in ITSM

1.2.1. Stakeholder Value (SV)

According to ITIL 4 [8, 12], the term value is defined as a set of perceived usefulness, importance, and benefits of something. Moreover, value is highly dependent on each relevant stakeholder individually. Value is defined by what each relevant stakeholder actually values, not what the service provider assumes the stakeholders might value. ITIL 4 specifies that value is created through active collaboration between the service provider, the service consumer, and other stakeholders. Each of them can have one or more different and unique points of view on what they actually value.

Further, ITIL 4 [12] describes that a service provider produces output that can be either a material or immaterial delivery object. This output results from an activity assisting the service consumer in achieving specific objectives. One or more outputs can become an outcome for a stakeholder. For example, a marriage photo would be the output created by a photographer, while the objective of receiving and maintaining memories is an outcome for the stakeholders who hired the photographer.

In the field of IT services, the following groups can be stakeholders according to ITIL 4 [12]: service customers (who define requirements and take responsibility for the service consumption), service consumers (who actually use the service), sponsors (who manage the budget available for purchasing the service), sub-parts of the service provider (e.g., employees), suppliers or partners to the service provider, shareholders, governments, and other groups. Each of them can have one or more different and unique points of view on what they actually value.

Moreover, value can be material (e.g., money, saving costs, materials, or products) or immaterial (e.g., good user experience) or optimized risks. In the past, value analysis was mostly focused on saving costs [8]. However, companies currently define speed and flexibility as crucially valuable for setting themselves apart. In the future, this scope may shift to areas like IT security, human centrality, or increased automation. As the perception of value continually changes, its meaning should be periodically revised and clarified for each relevant stakeholder.

Additionally, ITIL 4 uses the term value co-creation to emphasize that SV is mostly not generated by a single actor. Instead, multiple actors (e.g., suppliers, customers, users, sourcing partners, etc.) are often part of a VS and thus contribute to the creation of SV for that particular service. Hence, ITIL 4 does not differentiate between the terms value co-creation and value creation.

1.2.2. Value Stream (VS)

A VS is a series of steps carried out by a company to create and deliver products or services to their consumers [8, 12]. Structuring activities as VSs provides a clear overview of what the company actually delivers. This overview can help identify elements hindering the workflow and activities that do not add value, commonly referred to as waste, which should be eliminated. According to ITIL 4 [8, 12], VSs focus on the end-to-end flow of activity from demand to value. While VSs are not processes, processes can be referenced within a VS as units of work at different granularities or contexts. VSs use information provided by stakeholders or other VSs and utilize resources from service providers and service consumers to generate outputs required to create outcomes demanded by the stakeholders. The key objectives are maximizing value generation and minimizing waste.

To enhance a company's performance, its various VSs must be identified and understood. Structuring activities as VSs provides a clear overview that can enhance service delivery. Thus, companies should carefully investigate how they perform their tasks and assign all identified VSs. They can then analyze their current state to detect elements hindering the workflow and activities not adding value. Such activities, referred to as waste, should be eliminated. Additionally, any section of the VS offers potential for enhancing value-creating activities, such as adding new activities or adapting existing ones to increase productivity. To optimize VSs, companies can automate processes or introduce new technologies and working styles to increase efficiency or improve user experience. They should define VSs for each product or service they offer. Depending on the company's strategy, VSs can either remain the same or be adapted to changing demands or circumstances. Anyway, VSs should be continually maintained to meet the company's objectives.

According to ITIL 4 [8, 12], VSs are not processes. Processes are sequences of activities that turn inputs into outputs and describe in detail the actions performed to achieve a specific objective. Processes can be referenced in a VS as they can add value. Instead, VSs focus on the end-to-end flow of activities from the initial demand to the final delivery of value. Through the VS model, a company processes units of work, which may change depending on the level of granularity or context. A VS is initiated by a demand and ends in the creation or restoration of value. VSs use information provided by stakeholders or other VSs as inputs and utilize resources from service providers and service consumers to generate outputs required to create outcomes demanded by the stakeholders. A VS step should be described by its name, input triggers, important information, practice contributions, actions, tasks, constraints, outputs, and an estimated or target lead time.

ITIL 4 [9] briefly introduces Value Stream Mapping (VSM) as a method for visualizing VSs, including the flow of work, information, and resources. Its key objectives are maximizing value generation and minimizing waste. Considering the entire VS is crucially important, as local optimizations might create bottlenecks further down the VS, worsening its overall performance. Moreover, balanced complexity is very important. Too little information can make a VS too unspecific, while too much can make it too confusing to understand. Physical and information flows should be clearly distinguished. Typical mistakes in VSM include using it solely as a work design, making it look too complicated, taking no action as a result, not having an appropriate team for modeling, or not using any metrics that could be used for better analysis, understanding, or comparison.

1.2.3. Service Blueprint (SB)

According to [10], ITIL 4 recommends Service Blueprints (SBs) to model and understand the customer journey. A customer journey is the complete end-to-end experience customers have with service providers and their products offered through touch points and service interactions. A touch point of a customer journey is any event where a (potential) service consumer interacts with the service provider's products or resources. A service interaction, on the other hand, is a reciprocal action between a service consumer and service provider that facilitates the co-creation of value.

SBs can help understand these touch points and interactions by visualizing them. SBs are architectural drawings depicting how the service should look and what is required for service provision. The key elements of SBs are:

The Line of Interaction: Pinpointing the direct interactions between the consumer and provider.

The Line of Visibility: Separating visible and invisible activities from the consumer's perspective.

The Line of Internal Interaction: Separating employees who are (in)directly supporting customer interactions.

SBs support linking the customer journey to products and services, highlighting user touch points and service interactions, discovering weaknesses, identifying opportunities for optimization, and bridging cross-department efforts to avoid double workloads. They assist companies in understanding how customers use their services, identifying pain points, optimizing complex interactions, and exploring possibilities for improving service design, the customer journey, or reducing costs. By investigating all touch points customers encounter with the service, SBs help understand what stakeholders might value.

Each step of the customer journey should contribute more SV than it deducts. Personas can be defined to describe typical or target customers, enhancing the understanding of different customer needs and expectations. According to ITIL 4, each section of the VS provides potential for enhancing value-creating activities, such as adding new activities or adapting existing ones to increase productivity. By optimizing VSs, companies can automate processes or introduce new technologies and working styles to increase efficiency or improve user experience.

In conclusion, SBs are valuable tools for visualizing and improving the customer journey, ensuring that each interaction adds value and aligns with stakeholder expectations.

1.3. Outlook and Chapter Synopsis

This dissertation guides the reader through the entire research journey, from problem identification to solution development, application, and evaluation. Each chapter contributes to building and validating the *its*VALUE method, ensuring its relevance and effectiveness in the context of ITSM and ITIL 4.

Chapter 2 introduces this work's methodological foundation. It presents the Design Science Research (DSR) process as the overarching framework and explains complementary methodologies like Method Integration Process (MIP), Agile Modelling Method Engineering (AMME), and the Framework for Evaluation in Design Science Research (FEDS). These methodologies collectively guided the iterative development and assessment of *its*VALUE, ensuring a robust and comprehensive approach to method design.

Chapter 3 provides a comprehensive contextualization of this work's research. It traces the evolution and principles of IT Service Management (ITSM) and ITIL, analyzes current scientific perspectives, and identifies the research gap that *its*VALUE aims to address, particularly the explicit integration of Stakeholder Value (SV) into Value Streams (VSs). This chapter sets the stage for understanding the significance and necessity of the *its*VALUE method within the broader ITSM landscape.

Chapter 4 presents a Structured Literature Analysis (SLA) that systematically reviews existing methods and notations relevant to modeling SV, VSs, and Service Blueprints (SBs). This chapter defines the research questions, identifies open challenges, and derives requirements that inform the design of *its*VALUE. The SLA ensures that the method is grounded in existing knowledge while addressing identified gaps.

Chapter 5 details the development of the initial version of *its*VALUE. It outlines the method's conceptual structure, meta-model, visual notation, and the implementation of a supporting ADOxx modeling tool. Further, it demonstrates how *its*VALUE integrates SV into VS modeling and analysis, providing practical examples and applications.

Chapter 6 reports on a real-world case study conducted with the initial version of *its*VALUE. It describes the research design, execution, and evaluation results across multiple dimensions, including the method, notation, tool, and modeling process. The findings reveal both strengths and areas for improvement, offering valuable insights for further refinement.

Chapter 7 presents the development of the updated version of *its*VALUE, driven by insights from the case study and additional theoretical requirements. This refined version includes enhanced method guidance, updated meta-models, revised visual representations, and an improved modeling tool, along with a practical application manual. These enhancements aim to address identified limitations and improve the method's usability and effectiveness.

Chapter 8 describes a second, independent evaluation of the updated *its*VALUE method. Conducted by external users in a laboratory setting on a real-world case, this evaluation investigates its applicability, usability, comprehensibility, and efficiency. The results validate *its*VALUE's maturity and confirm its relevance for both academic and practical use, demonstrating its potential for widespread adoption.

Chapter 9 concludes this work with a reflective discussion on the research journey. It highlights the overall contributions and limitations of *its*VALUE, summarizes the key findings, and outlines implications for future research and practice in the field of ITSM. This chapter provides a comprehensive overview of the dissertation's impact and suggests directions for ongoing exploration and development.

1.4. Overview of Publications and Author Contributions

Several sections of this dissertation have been previously published in academic venues. This section details which parts were published, where they appeared, and the contributions of the respective authors to each publication. This ensures full transparency regarding authorship and contribution throughout the development of this work.

Significant portions of Section 2.5 are included in the works by Richter [107] and Richter and Sandkuhl [108], as both venues required a comprehensive overview of related work.

The contents of Chapter 4 were partially published in *Business Information Systems Workshops (BIS 2021)* by Richter and Lantow [110]. Due to page constraints, only the most pertinent results were included in that paper, while the full scope of the research is presented in this dissertation. The research process and chapter writing were conducted entirely by Richter. Lantow contributed through academic supervision and by supporting the publication process, particularly in selecting results that matched page constraints and reviewer expectations. Additionally, an updated literature query (conducted later by Sandkuhl due to time constraints on Richter's side) was incorporated in the extended journal article by Richter and Sandkuhl [108].

Chapter 5 resulted in two publications: one by Richter and Lantow [109] at *Business Informatics Research (BIR 2021)*, and another by Richter et al. [111] in the edited volume *Domain-Specific Conceptual Modeling (2022).* The former introduced the *its*VALUE method in a condensed format due to space limitations. The latter provided a more detailed presentation of the method, enabled by a broader scope and higher page allowance.

In both cases, Richter was responsible for the entire research process and manuscript writing. Lantow provided supervision and publication guidance. In the second publication, Pröpper acted as an industry partner from Drägerwerk AG & Co. KGaA, contributing feedback during the early stages of method development before the company exited the project in mid-2021.

Chapter 6 contributed to Richter and Lantow [109] and the sole-author work by Richter [107], both presented at the *Business Informatics Research (BIR)* conference in consecutive years. The first publication included selected empirical findings as per reviewer requests, while the remaining results were later published in full by Richter alone.

Chapter 7 forms the basis of a submission (still under review) to the *Enterprise Modelling and Information Systems Architectures (EMISAJ) – International Journal of Conceptual Modeling*, authored by Richter and Sandkuhl [108]. Richter led the research and writing process, with Sandkuhl offering conceptual guidance and publication support.

To aid practitioners in applying the updated *its*VALUE method, a supplementary application manual was published on the OMiLAB platform[1] and on ResearchGate[2] [112].

The evaluation study presented in Chapter 8 is based on work published in the *Practice of Enterprise Modeling Forum (PoEM 2024)* by Wilken et al. [149]. Unlike earlier chapters, Richter did not carry out the full research or author the main body of this paper. Instead, Richter initiated the study by identifying the need for an external evaluation of *its*VALUE by new users and coordinated a student research group (Wilken, Guckenberger, Löser) to conduct the work. The group was supervised by Rittelmeyer, who also led the publication effort. Sandkuhl supported the group with academic guidance. During this phase, Richter took a meta-perspective (supporting and advising as necessary) and later re-evaluated the results in the context of this dissertation to analyze the learning experience and usability of *its*VALUE.

[1] `www.omilab.org/activities/omilab-book-series/volume2/details/?id=42`
[2] `http://dx.doi.org/10.13140/RG.2.2.14851.07208/1`

2. Methodology

This chapter outlines the methodologies we utilized to create this work. First, we introduce the Design Science Research (DSR) process by Peffers et al. [99, 100] which we followed for the overall *its*VALUE project. Next, we also present important further subsequent methodologies we followed for different steps during the development process, including the Method Integration Process (MIP) by Goldkuhl et al. [48] and the Agile Modelling Method Engineering (AMME) methodology by Buchmann and Karagiannis [22, 62–64]. Then, we outline our proposed evaluation strategy throughout our entire project, adhering to the Framework for Evaluation in Design Science Research (FEDS) by Venable et al. [141]. Lastly, we finish with a curation of related work in artifact evaluation.

2.1. The Design Science Research (DSR) Process

The Design Science Research (DSR) process by Peffers et al. [99, 100] is designed to guide researchers in conducting and presenting design science research in information systems. It aims to provide a structured approach consistent with prior literature, offering a nominal process for conducting research, and serving as a mental model for presenting design science. Figure 2.1 shows the DSR process' six sequential steps, each contributing to the development and validation of a research artifact. As we intent to address a research gap by developing an artifact on our own, this methodology suits the purpose of our work.

1. **Problem Identification and Motivation:**

   This initial step involves defining the specific research problem and justifying the need for a solution. The problem should be clearly articulated to capture its complexity and significance. This step requires a thorough understanding of the current state of the problem and its importance. We addressed this by conducting a thorough SLA presented in Chapter 4 and considering the requirements of ITIL 4, identifying a research gap and need for a new method, prior outlined in Section 1.1.

2. **Objectives of a Solution:**

   In this section, the researcher infers the objectives of a solution from the problem definition. These objectives can be quantitative (e.g., measurable improvements) or

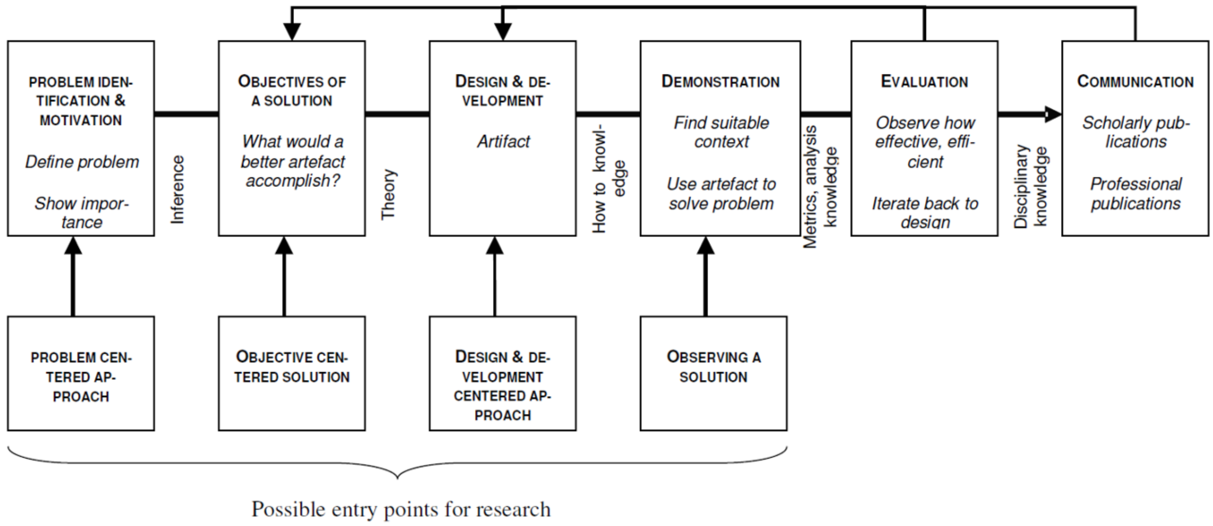


Figure 2.1.: The DSR Process from Peffers et al. [99]

qualitative (e.g., new capabilities). The objectives should be logically derived from the problem specification, requiring a thorough understanding of existing solutions and their limitations. We addressed this step in the conclusion of our SLA in Section 4.3.2 and in Section 5.1. Here, we explicitly defined the requirements for *its*VALUE, precisely targeting the research gap identified and motivated in Section 1.1, as well as incorporating promising findings from our SLA presented in Section 4.2.2.

3. **Design and Development:**

   This step involves creating the artifactual solution, which can be constructs, models, methods, or instantiations. The researcher determines the desired functionality and architecture of the artifact and then proceeds to develop it. This step requires theoretical knowledge that can be applied to create an effective solution. We addressed this step in Chapter 5 and again in Chapter 7 for an evaluation-based refinement.

4. **Demonstration:**

   The efficacy of the artifact is demonstrated in this step. The researcher uses the artifact in a suitable context, such as experimentation, simulation, case studies, or other appropriate activities, to show that it can solve the identified problem. This step requires practical knowledge of how to use the artifact effectively. We covered this step in Chapter 5 and Chapter 7 by providing a proof-of-concept and through a case study presented in Chapter 6 and a further evaluation in Chapter 8.

5. **Evaluation:**

   In this step, the researcher observes and measures how well the artifact supports a solution to the problem. The evaluation involves comparing the objectives of the solution with the actual results obtained from using the artifact. This may include metrics, performance measures, satisfaction surveys, client feedback, or simulations. Based on the evaluation, the researcher decides whether to iterate back to the design step to improve the artifact or to proceed to communication. We addressed this step by conducting different forms of evaluations, adhering to FEDS by Venable et al. [141], as outlined in Section 2.4. Firstly, we considered the results from Chapter 6 to iterate back to step 2 of the DSR process by concluding new Requirements (Rs), as presented in Chapter 7. After implementing and demonstrating those, we carried out an additional evaluation on the updated version of *its*VALUE.

6. **Communication:**

   The final step involves communicating the problem, the artifact, its utility and novelty, the rigor of its design, and its effectiveness to relevant audiences, including researchers and practitioners. To adhere to this step, we published and submitted every content part of this work to a variety of scientific workshops, conferences, and journals. Furthermore, we have published the *its*VALUE ADOxx Modeler along with an application manual for free download at OMiLAB[1] and ResearchGate[2] [112].

The DSR process is flexible and allows researchers to enter the process at different points, depending on their starting conditions and the nature of their research. The first possible entry point is the problem-centered approach. Here, researchers start with identifying a specific problem that needs solving. This approach is typical when the research idea originates from observing a problem or from suggestions for future research in prior studies. The process begins with problem identification and motivation. For this work, we used this entry point by focusing on the needs regarding the consideration of SV in VSs defined by ITIL 4 [8–12], which were not satisfyingly met by any existing method, as motivated by our SLA in Chapter 4.

The second entry point is an objective-centered solution. It starts with explicitly defining the objectives of a solution, often derived from consulting experiences or system development activities that did not meet expectations. Researchers focus on what a better

[1] `www.omilab.org/activities/omilab-book-series/volume2/details/?id=42`
[2] `http://dx.doi.org/10.13140/RG.2.2.14851.07208/1`

artifact would accomplish and proceed to design and development. The third entry point is the design and development-centered approach. Here, researchers may begin with an existing artifact that has not yet been formally considered as a solution for a specific problem domain. This artifact might come from another research domain, have been used to solve a different problem, or emerged as an analogical idea. Lastly, observing a solution serves as the final possible entry point. In this approach, researchers observe a practical solution that already works and then apply rigor to the process retroactively. In other words, they work backwards to formalize the solution, starting with demonstration and evaluation, and then move to problem identification and objectives of a solution.

In conclusion, the DSR process by Peffers et al. [99, 100] provides a comprehensive and flexible framework for conducting design science research in information systems. By following its structure, researchers can systematically address complex problems, develop innovative artifacts, and rigorously evaluate their effectiveness. Hence, we followed it. The resulting artifact, known as the *its*VALUE method, consists of several interrelated components, including a formal meta-model, visual modeling notation, procedural guidance, and a supporting modeling tool. These components were developed iteratively and evaluated both individually and in combination.

2.2. The Method Integration Process (MIP)

According to Goldkuhl et al. [48], the motivation for integrating different methods in information systems development stems from the diverse and evolving nature of development circumstances. Technological and organizational changes create situations where a single, universal method may not be sufficient. Considering our results from Chapter 4 in combination with the needs and requirements defined by ITIL 4 [8–12], this description suits our, and thus, this work's purpose. Further, differences in knowledge, competence, experience, and expectations of method users can also necessitate the combination and integration of various methods. Such integration can be temporary for specific development situations or, as in our case with the initial development of *its*VALUE, permanent to create a new, comprehensive method suitable for multiple scenarios.

The MIP involves combining various methods to create a comprehensive approach that addresses specific needs and challenges. The following steps outline the MIP, emphasizing the importance of communication, practical application, and continuous learning:

1. **Identify the Need for Integration:**

   First, recognize the necessity to combine different methods due to diverse development circumstances and evolving technological and organizational contexts. Understand that a single, universal method may not be sufficient to address all defined problems, necessitating the integration of multiple methods. For this purpose, we conducted the SLA presented in Chapter 4, highlighting the lack of any method besides *its*VALUE that fully meets the ITIL 4 requirements.

2. **Address Communication Issues:**

   The second step focuses on initial communication problems that often arise due to different emphases and understandings of the methods' components and their application. To resolve these issues, it is crucial to shift to a meta-level discussion (discourse) to establish a common understanding of what constitutes a method. This involves investigating, reconstructing, and evaluating the grounds for different method components, ensuring a shared understanding among all participants. To address this issue, we distinguished between different relevant terms and categorized several method candidates. We outlined these terms in Chapter 1 and followed them for the query of our SLA in Chapter 4.

3. **Utilize Method Theory:**

   The third step involves applying an explicit method theory to classify and reconstruct different parts of the methods. This theory includes components such as perspective, framework, method components, and cooperation/collection forms. The method theory provides a structured approach to understanding and integrating various method components, ensuring consistency and coherence in the integrated method. To address this step, we differentiated between several aspects of a method, including the step-by-step method framework, the method's conceptualization (further including different perspectives on the value creation), its notation, and a usable modeling tool instantiating the method. Our structure for both Chapter 5 and Chapter 7 reflects these considerations.

4. **Reconstruct and Classify Method Candidates:**

   The fourth step advises using the method theory to identify and articulate tacit knowledge, classify method parts, and understand the contributions of each method to the new integrated method. This classification involves breaking down method parts into meaningful units and reconstructing them to fit into the new method framework. Address any gaps or inconsistencies in the original methods by articulating and reconstructing tacit knowledge, making it explicit and usable in the integration process. To address this issue, we investigated all results discovered by our SLA based on their potential for suiting the requirements of ITIL 4, specifically highlighted in Section 4.2.2. Based on those outcomes, we later reconstructed the meaningful units into the initial version of *its*VALUE, as presented in Chapter 5.

5. **Formulate Method Hypothesis:**

   The fifth step involves developing a method hypothesis that outlines the framework and phases of the integrated method. It serves as a proposal to be tested and refined. Therefore, determining prerequisites, initial business diagnosis, focused business diagnosis, and generating and evaluating measures should be considered. Each phase has specific purposes and method components to be used, allowing for situation adaptability and ensuring that the integrated method meets the project's goals. To address this step, we formulated a method hypothesis covering all these aspects for *its*VALUE in Section 5.2. Especially during the case study from Chapter 6, we investigated how well *its*VALUE actually meets its defined hypothesis.

6. **Apply the Integrated Method in Practice:**

   The sixth step suggests implementing the integrated method in real-life projects to gain practical experience and validate its applicability. It helps in further reconstructing tacit knowledge and refining the method. Joint practical experiences are crucial for understanding the positive and negative effects of the method's usage and for identifying improvement areas. To address this, we applied the initial version of *its*VALUE in a real-life situation, as described in Chapter 6. Moreover, we also applied its updated version in a further real-life context, as described in Chapter C.

7. **Reflect and Learn:**

   The seventh step involves continuously reflecting on the practical application of the method to identify discrepancies between espoused knowledge (articulated) and knowledge-in-use (applied). These insights should be used to improve the method, ensuring that it evolves based on practical experiences and feedback from its application. To address this issue, we evaluated the initial version of *its*VALUE deeply in Chapter 6 and utilized these conclusions to refine it, as described in Chapter 7. Moreover, we investigated the updated version again, as described in Chapter 8.

8. **Meta Learning:**

   The final step recommends engaging in meta learning (learning about how to learn) to enhance the overall MIP. This involves understanding the process itself and making necessary adjustments. Meta learning helps in developing a deeper understanding of the methods and the integration process, ensuring continuous improvement and adaptation. To adhere to this step, we changed our evaluation approach for another evaluation (cf. Chapter 8) compared to the first one (cf. Chapter 6). Based on our discoveries and conclusions from that case study, we identified the necessity to gain insights from a completely independent evaluation where the conductors did not have prior experiences with *its*VALUE. This approach aimed to minimize potential bias and gain insights into how *its*VALUE is perceived by someone who has to learn and apply it for the first time on their own, as this also constitutes a requirement of its method hypothesis.

To summarize, the key components of the MIP by Goldkuhl et al. [48] include the perspective, framework, method components, and cooperation and collection forms. The perspective provides the conceptual and value basis of the method, guiding its overall direction and principles. The framework outlines the structure and phase sequence of the method, ensuring a coherent and organized approach. Method components combine procedures, notations, and concepts to form the building blocks of the method. Finally, cooperation and collection forms define how different people interact and cooperate during method-guided work, ensuring effective collaboration and data collection. For the creation and refinement of *its*VALUE, we adhered to these key components of the MIP by carefully considering them throughout the entire development and evaluation process.

2.3. The Agile Modelling Method Engineering (AMME) Methodology

The Agile Modelling Method Engineering (AMME) methodology, proposed by Buchmann and Karagiannis [22, 62–64], is designed to support the development of modeling methods and tools, particularly focusing on the requirements specific to these methods. It empha-

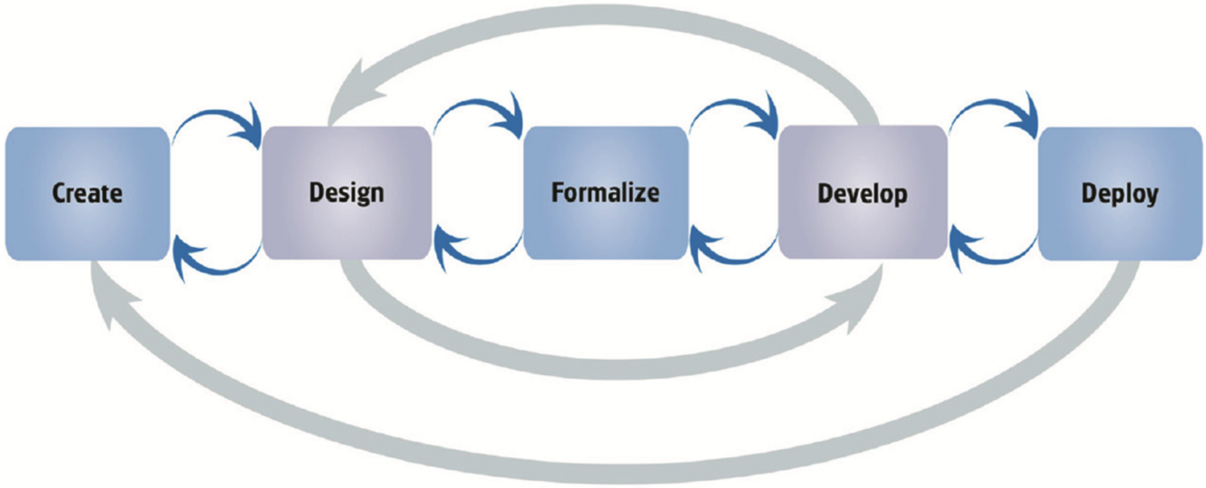


Figure 2.2.: The AMME Life-Cycle from Karagiannis [62]

sizes the importance of modeling method Requirements (Rs), which are often overlooked in traditional requirements engineering frameworks. As this scope also suits this work's scope, we adhered to the AMME methodology, especially for the revision of the initial version of *its*VALUE leading to its updated version. The AMME life-cycle contains of five phases, as illustrated by Figure 2.2.

1. **Create:** It begins with the initial knowledge acquisition and requirements elicitation. This involves identifying the opportunity for a new modeling method, understanding the domain, and gathering input from stakeholders to define the goals and scenarios for the modeling method. To address this issue, we derived the potential for *its*VALUE based on the requirements of ITIL 4, which were not satisfyingly met by any other existing modeling method, as indicated by our SLA's results. For the refinement, we followed a similar approach by considering new requirements derived from a first evaluation, motivating these changes with specific and precise goals.

2. **Design:** Next, the modeling language, mechanisms, and procedures are specified. The modeling language encompasses notation, syntax, and semantics. It may also be partitioned into multiple viewpoints if it becomes too complex. For *its*VALUE, we applied this by introducing different model types, each serving a different purpose or view on the same value creation. The mechanisms cover functionalities operating on model contents, such as code generation, report generation, and model transformation. For *its*VALUE, we also included such mechanisms in our ADOxx modeler

to support users in utilizing the method. Lastly, the overall modeling procedure outlines the usage of the method, considering its purpose, use cases, and specific steps. With our *its*VALUE method framework, we addressed this aspect as well.

3. **Formalize:** Here, the method design is refined using appropriate formalism to ensure clarity and remove ambiguities. This phase aims to support implementations across various platforms by providing a precise and unambiguous method specification. We addressed this issue particularly by carefully developing the conceptualization of *its*VALUE, which serves as its foundation.

4. **Develop:** Next, a usable modeling tool is created based on the refined method design. This phase often leverages rapid prototyping environments to quickly develop and test the tool, ensuring it meets the specified requirements and functionalities. By developing the initial version of *its*VALUE and testing it with exemplary models as a proof-of-concept, we addressed this issue.

5. **Deploy:** Finally, this phase involves packaging and deploying the modeling tool for use. During this stage, the tool is evaluated in real-world scenarios, and user feedback is collected. This feedback is crucial for identifying any issues or areas for improvement. We addressed this step by publishing our ADOxx Modeler, along with an application manual, for free download at OMiLAB[3] and ResearchGate[4] [112].. Further, we tested its initial version in a case study (see Chapter 6) and had its updated version tested by independent users in another evaluation (see Chapter 8).

The life-cycle includes a feedback loop that feeds back into the Create phase, ensuring the modeling method continuously evolves in response to new requirements and user feedback. This process maintains its relevance and effectiveness over time. Requirements are decomposed into manageable units, which are then addressed through agile engineering efforts. This decomposition helps isolate evolving requirements and makes change propagation traceable. For the refinement of *its*VALUE, we paid particular attention to this feature of the AMME methodology and followed it precisely. Based on the feedback and results of the case study from Chapter 6, we derived concrete Requirements (Rs) specifically targeted at certain aspects of *its*VALUE, as described in Chapter 7. This approach

[3] www.omilab.org/activities/omilab-book-series/volume2/details/?id=42
[4] http://dx.doi.org/10.13140/RG.2.2.14851.07208/1

allowed us to leverage the agile nature of the AMME methodology and its community-oriented approach. The AMME methodology encourages collaboration and knowledge sharing within the modeling community. This is facilitated through platforms like Open Models Initiative LABoratory (OMiLAB), where researchers and practitioners can share their experiences and developments.

2.4. The Evaluation Strategy Based on FEDS

For our overall evaluation strategy for this project, we adhered to the Framework for Evaluation in Design Science Research (FEDS) by Venable et al. [141]. This framework provides a comprehensive approach to evaluating design artifacts and theories within Design Science Research (DSR). Given that we follow the DSR process by Peffers et al. [99, 100], FEDS aligns well with our research objectives. It addresses the need for rigorous evaluation to ensure the utility, quality, and efficacy of design artifacts.

FEDS is structured around four key dimensions: *Why*, *When*, *How*, and *What* to evaluate. These dimensions guide the evaluation process, ensuring a thorough and systematic approach. Figure 2.3 illustrates the overall FEDS framework by Venable et al. [141], highlighting the dimensions of *Why* and *How*, and outlining several possible evaluation strategies. Additionally, Figure 2.4 illustrates the dimension of *When*, providing further clarity on the timing of evaluations.

Why (Formative vs. Summative Evaluation): *Formative Evaluation* is conducted during the development of the artifact. Its primary goal is to provide feedback that can be used to improve the artifact. This type of evaluation focuses on identifying strengths and weaknesses, allowing researchers to make iterative improvements. For example, formative evaluation might involve user testing of a prototype to gather insights on usability and functionality. For the development of *its*VALUE, we conducted formative evaluations particularly during the initial development phase, as well as during subsequent refinements. For instance, in the early stages of testing our prototype, we did not yet have the Value Stream Blueprint (VSB) as a conceptual model type. Instead, it was divided into two separate model types: a Service Blueprint (SB) and a Value Stream (VS) model type. Based on these initial evaluations, we decided to merge these two early conceptual model types into the initial version of the VSB, which later underwent further modifications (see Chapter 5).

However, these formative evaluations primarily resulted in minor changes, such as adjustments in visualizations. Thus, this work does not detail these specific changes.

On the other hand, *Summative Evaluation* is performed after the artifact has been developed. Its purpose is to assess the overall effectiveness and utility of the artifact. Summative evaluation involves comparing the artifact against predefined criteria to determine if it meets the intended goals. This type of evaluation is crucial for validating the final product and ensuring it delivers the expected outcomes. For the development of *its*VALUE, we conducted three summative evaluations in total, two of which were significantly more extensive than the remaining one. After finalizing the initial version of *its*VALUE, we carried out a comprehensive case study (see Chapter 6). This evaluation involved comparing *its*VALUE against its method hypothesis, the physics of notation by Moody [90], and our overall requirements for *its*VALUE that were defined to address the research gap. These served as our predefined criteria for assessment. The intermediate updated version, resulting from those findings, underwent another minor summative evaluation before integrating those results into *its*VALUE and conducting a final third evaluation. This final evaluation involved external evaluators to minimize potential bias. For both of these summative evaluations, we used the same predefined criteria, extended with the requirements derived from the conclusions of our case study. As the second summative evaluation was significantly less extensive than the first and third, we solely integrated its conclusions into Chapter 7 in Section 7.1.2.

When (Ex Ante vs. Ex Post Evaluation): *Ex Ante* evaluation occurs before the artifact is fully developed. This type of evaluation is predictive, aiming to estimate the potential impact and utility of the artifact. It helps in making decisions about whether to proceed with the development and can guide the design process by highlighting potential issues early on. For the development of *its*VALUE, we conducted minimal ex ante evaluation. Our discussion of the SLA in Section 4.3 could be considered as a form of early ex ante evaluation, as we deliberated on how to integrate several promising aspects together. Also, all minor modifications during the development process itself can be considered as ex ante evaluations, as they aimed to predict and enhance the potential impact and utility of *its*VALUE.

In contrast, *Ex Post* evaluation takes place after the artifact has been implemented. This retrospective evaluation assesses the actual impact and performance of the artifact in its real-world context. Ex post evaluation provides valuable insights into how well the artifact works in practice and whether it achieves the desired outcomes. For the development of *its*VALUE, we conducted three ex post evaluations in total, two of which were significantly more extensive than the remaining one. As the second evaluation was less extensive than the first and third, we solely integrated its conclusions into Chapter 7 in Section 7.1.2.

How (Artificial vs. Naturalistic Evaluation): *Artificial Evaluation* is carried out in controlled environments, such as laboratories. This type of evaluation allows researchers to isolate specific variables and test hypotheses under controlled conditions. Methods used in artificial evaluation include simulations, laboratory experiments, and theoretical analysis. Artificial evaluations allow gathering precise and reliable data, though it may lack real-world applicability. For all of our *ex ante* and normative evaluations, we followed this artificial approach. Further, we applied this method for our second *ex post* and summative evaluation, whose conclusions are solely integrated into Chapter 7 in Section 7.1.2. By doing so, we aimed to achieve a promising proof-of-concept before testing *its*VALUE under real-world conditions.

Naturalistic Evaluation, on the other hand, is conducted in real-world settings. It involves evaluating the artifact in its intended environment, with real users and real tasks. This type of evaluation embraces the complexities of real-life situations and provides insights into how the artifact performs in practice. While naturalistic evaluation offers high external validity, it can be more challenging and resource-intensive. For the development of *its*VALUE, we conducted a pure naturalistic evaluation through a case study on the initial version of *its*VALUE. Moreover, we performed an independent assessment, conducted by external evaluators. Although these evaluators utilized *its*VALUE in a real-world scenario, they were not directly part of this real-world case themselves. Thus, this additional evaluation may exhibit both artificial and naturalistic features, due to its laboratory nature.

What (Properties of the Artifact): Finally, the specific properties of the artifact that are evaluated are crucial. These properties can include a wide range of attributes such as functionality, usability, reliability, performance, and more. The choice of properties to evaluate depends on the goals of the DSR project and the nature of the artifact. For instance, if the artifact is a software tool, properties like usability, efficiency, and user satisfaction might be important. For the assessment of our

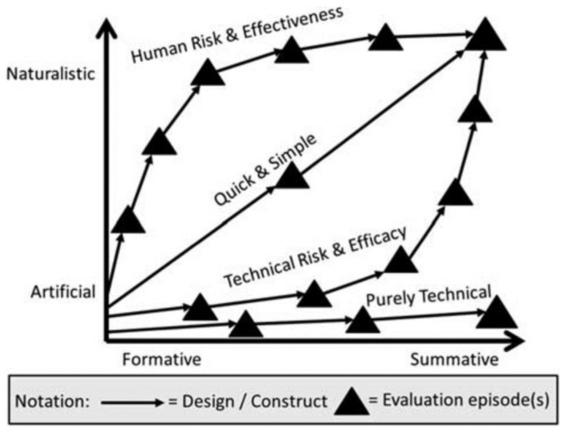


Figure 2.3.: The FEDS Framework from Venable et al. [141]

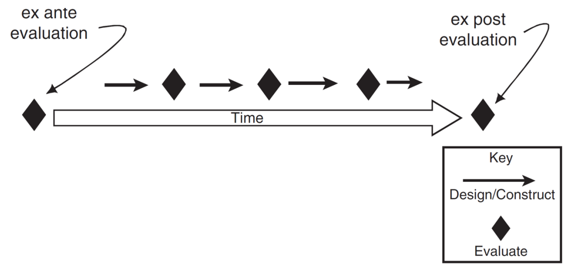


Figure 2.4.: The Ex Ante/Ex Post Evaluation Time Continuum from Venable et al. [141]

*its*VALUE ADOxx modeler, we considered these dimensions to ensure a comprehensive evaluation. For the *its*VALUE method, we referred to its purpose and method hypothesis, ensuring it aligns with the intended goals and addresses the identified research gap. For the *its*VALUE notation, we referred to the physics of notation by Moody [90] to ensure clarity and effectiveness in visual representation. Evaluating these properties helps ensure that the artifact not only works as intended but also meets the needs and expectations of its users, ultimately contributing to its overall success and utility.

Given the unique and novel nature of *its*VALUE, which conceptually links SV and VSs, it was crucial to adopt a strategy that could handle the technical complexities and demands of the ADOxx development environment. This approach was essential to ensure the system's safe operation and to quickly obtain meaningful results. By considering the four dimensions outlined in FEDS, we followed a structured approach to evaluation strategies. The *Purely Technical Artifact Strategy* was not suitable for *its*VALUE as it is designed for artifacts without human users. Similarly, the *Human Risk & Effectiveness Strategy* was not applicable since real users were not involved in formative evaluations. Although our formative evaluations were minimally documented, we did not strictly adhere to the *Technical Risk & Efficacy Strategy.* Instead, our approach was a hybrid of this strategy and the *Quick & Simple Strategy.* This hybrid approach allowed us to rapidly progress to summative and naturalistic evaluations while capturing artificial formative results for iterative refinements. This chosen strategy was reasonable because it effectively addressed the unique challenges and technical demands of developing *its*VALUE, ensuring safe operation and quick, meaningful results. This hybrid approach provided a balanced and thorough evaluation process, aligning with our project's objectives.

In this context, it is important to clarify the nature of the artifact developed throughout this research. The overarching artifact presented and evaluated is the *its*VALUE method, which consists of a structured, multi-step framework for integrating SV into VSs within ITSM. Consistent with DSR and method engineering practices, several sub-artifacts were created and evaluated separately during the development process. These include the *its*VALUE meta-model, visual notation, model types (e.g., VPM, SVM, VSB, and PSM), and the ADOxx-based modeling tool. Each sub-artifact contributes to the instantiation of the *its*VALUE method as a whole, with their individual development and evaluation documented in Chapters 5 to 8. This modular structure enabled a more focused and iterative evaluation strategy, as outlined in this section.

2.5. Related Work in Artifact Evaluation

In their respective chapters, we detail the specific methodologies chosen for evaluating our artifacts. Chapter 6 covers the case study on the initial version of *its*VALUE, while Chapter 8 addresses the evaluation on its updated version. To provide a comprehensive overview of the diverse approaches in artifact evaluation, we also present a curated selection of related work in this domain.

To begin with, Koç [69] describes the application of the Framework for Evaluation in Design Science Research (FEDS) by Venable et al. [141], specifically to evaluate the developed method "deCOM". FEDS was employed to structure the evaluation episodes and define their objectives, including efficiency, effectiveness, and usability. This involved both formative evaluations in artificial environments and summative evaluations in realistic, natural settings. The "Human Risk & Effectiveness" evaluation strategy was chosen because the greatest design risk was perceived to be user-oriented, and the evaluation resources allowed for the inclusion of real users in their context. This approach enabled iterative improvement of the artifact's properties and provided a solid foundation for its application in various contexts.

Additionally, Prat et al. [105] introduced a taxonomy of evaluation criteria for information systems artifacts in design-oriented research. Our strategy aligns with almost every dimension and evaluation criterion of this taxonomy, as we aimed for a broad scope in our initial evaluation of *its*VALUE described in Chapter 6. However, the ”generality” evaluation criterion and the entire dimension of ”evolution” are not covered. For evolving *its*VALUE, the dimensions of ”structure” (to achieve better comprehensibility) and ”evolution” (to ensure high robustness of the ADOxx modeler) were particularly important, as discussed in Chapter 7.

Next, Bork and Roelens [19] introduced a technique for evaluating and improving the semantic transparency of modeling notations. They suggest splitting this evaluation process into two phases: evaluating the initial notation and revising it, including gathering participants' feedback on the intuitiveness of the notation. Although we did not follow this process exactly, we also asked our participants in Chapter 6 about the intuitiveness of the visual elements in Chapter 6. Since the feedback was positive, changing the visual representations of objects was only a minor part of refining *its*VALUE during Chapter 7. However, we investigated this even further by our additional evaluation from Chapter 8.

Further, Buchmann and Karagiannis [23] conducted an evaluation for an ADOxx-based tool aimed at supporting the definition and elicitation of requirements for mobile apps. Their evaluation primarily focused on comprehensibility, which we also addressed, along with perceived usefulness, during our case study in Chapter 6. We asked our participants about both aspects during the GIs. Moreover, the overall comprehensibility of *its*VALUE was majorly investigated with our additional evaluation from Chapter 8.

Lastly, Petrusel and Mendling [103] presented BPMN-based comprehension evaluation techniques. They used eye-tracking to predict if a model was comprehended or not.

3. Contextualization of this Work

To provide a thorough understanding of the domain in which the *its*VALUE method has been developed and evaluated, this chapter delves into the conceptual and scientific foundations of IT Service Management (ITSM). While the introduction of this dissertation has addressed some core concepts defined by ITIL 4, this chapter positions ITSM within the broader scope of business and management sciences, offering an in-depth exploration of relevant research trajectories. Further, it outlines the evolution of ITIL, highlighting both its conceptual core and key criticisms from the academic community. Additionally, this chapter outlines how *its*VALUE precisely addresses the research gap, detailing its specific contributions to the field. This contextualization ensure that the subsequent chapters are grounded in an informed and theoretically sound perspective, preparing the reader to better understand the motivation and novelty of the *its*VALUE method.

3.1. Principles and Evolution of IT Service Management (ITSM)

According to Galup et al. [42], ITSM is defined as a strategic approach to designing, delivering, managing, and improving the way IT is used within an organization. It emphasizes the importance of aligning IT services with the needs of the business. As defined by ISO/IEC 20000-1:2018 [40], ITSM includes the establishment, implementation, maintenance, and continuous improvement of a Service Management System (SMS) to ensure the effective delivery of IT services in alignment with business requirements.

The origins of ITSM can be traced back to the need to professionalize IT service delivery, moving from ad hoc, reactive problem-solving to proactive service design and continuous improvement. According to Johnson et al. [59], this shift was significantly influenced by the creation of the IT Infrastructure Library (ITIL) in the 1980s by the UK's Central Computer and Telecommunications Agency (CCTA), which provided standardized best practices for IT service management. Over time, ITSM has evolved into a strategic function, playing a crucial role in enabling digital transformation and enhancing organizational agility. This evolution reflects the growing recognition of IT services as critical enablers of business success and innovation.

Frameworks like ITIL, COBIT, and ISO/IEC 20000 offer standardized guidelines for organizing, monitoring, and improving IT service delivery. According to Böhmann et al. [25], these frameworks help organizations manage complexity, align IT outputs with business outcomes, and ensure continuous value creation in increasingly dynamic environments. By adopting these frameworks, organizations can achieve greater efficiency, reduce risks, and improve customer satisfaction through consistent and reliable IT service delivery.

The impact of these frameworks has also spurred significant interest within the academic community. Researchers have explored the theoretical foundations of ITSM, questioned its underlying assumptions, and examined its intersections with other fields such as systems theory, enterprise modeling, organizational change, and service science. This academic inquiry has led to a deeper understanding of ITSM as not only a practical management framework but also a field deserving of critical, theoretical, and methodological scrutiny. Scholars have contributed to the development of new models and approaches that enhance the effectiveness and adaptability of ITSM practices.

To gain a deeper understanding of the evolution and current state of ITSM as a scientific domain, Section 3.1.1 reviews key research trajectories and conceptual perspectives that have emerged. It emphasizes how scholars have approached ITSM not only as a practical management framework but also as a field deserving of critical, theoretical, and methodological examination. Subsequently, Section 3.1.2 presents our interpretation of value, particularly implicit, stakeholder-centered value, and traces the scientific lineage behind our conceptual choices.

3.1.1. Scientific Perspectives on ITSM

The scientific literature on ITSM spans various disciplines, including information systems, operations research, and management science. Research in this domain has focused on formalizing service management practices and critically reflecting on their limitations.

From a theoretical standpoint, ITSM can be situated within broader service and management frameworks. Vargo and Lusch's [138, 139] Service-Dominant Logic (SDL) reframed the concept of value by asserting that it is not embedded in products but co-created dynamically through interactions between providers and consumers. This perspective aligns closely with modern ITSM frameworks, especially ITIL 4, which emphasize co-creation, shared responsibility, and holistic stakeholder engagement.

One major research stream in this regard examines value-oriented ITSM approaches. Influenced by the value co-creation paradigm, this stream emphasizes the active role of users, customers, and other stakeholders in defining and shaping service value. Researchers like Alter [4] have called for more stakeholder-centric methods that go beyond efficiency and cost control to address user satisfaction, contextual needs, and perceived usefulness. Additionally, Alter [5] highlights the importance of work systems in achieving organizational goals and integrating new technologies.

Further, the role of the Chief Information Officer (CIO) in optimizing IT's value and driving business transformation is crucial. Peppard [101] discusses how CIOs are encouraged to become drivers of business transformation and innovation, emphasizing the need for leadership skills to enhance IT performance and value. Moreover, Baines et al. [14] emphasize the concept of product-centric servitization, which involves integrating services with products to create value, as essential for developing comprehensive ITSM strategies.

Another stream centers on the processual and structural design of service systems. This includes modeling techniques for IT service processes, performance metrics for service quality, and frameworks for aligning IT and business objectives. Studies like Hochstein et al. [55] have outlined the organizational and technical complexities involved in implementing ITSM frameworks.

Recent academic research increasingly approaches ITSM through interdisciplinary lenses like systems thinking, enterprise modeling, and agile organizational design. In particular, the integration of agile principles (like iterative development, adaptability, and continuous feedback) into ITSM has become a critical focus. Verlaine [142] proposed a hybrid framework that aligns Agile values with ITSM principles, demonstrating how flexibility and customer orientation can be reconciled with structured service delivery.

Other notable research trends in ITSM include:

Cloud-Native Service Management: The shift toward cloud computing has necessitated adaptations in ITSM practices to manage cloud-based services effectively. According to Müller et al. [91], this includes developing strategies for service integration, scalability, and maintaining service quality in cloud environments.

Automating ITSM through Artificial Intelligence and Machine Learning: The application of AI assistants in managing the incident lifecycle within microservice environments is examined by Zhou and Fokaefs [154]. Their SLA highlights the role of

AI and machine learning in automating various ITSM processes, thereby enhancing incident response times and overall service management efficiency.

Collaborative Modeling of Service Ecosystems: Advances in enterprise modeling like Riss et al. [113] have introduced the concept of Digital Twins of an Organization (DTO), enabling virtual representations of business processes and service systems. DTOs serve as powerful analytical tools to simulate service performance, explore stakeholder impacts, and test continuous improvement initiatives before implementation. They use graph-based, machine-readable knowledge representations to improve agility and facilitate collaborative planning.

Context-Sensitive Service Management in SMEs: Ungureanu et al. [134] explore the integration of Agile principles in ITSM processes within small and medium enterprises (SMEs). Their study from Romania highlights how context-sensitive approaches can enhance service management by adapting to the specific needs and constraints of SMEs, thereby improving efficiency and responsiveness.

These developments indicate a shift from static, process-heavy frameworks toward more flexible, adaptive, and co-creative approaches in ITSM. Building upon these developments, the following section presents the theoretical foundation for how SV is understood in this work and how it informs the conceptual design of the *its*VALUE method.

3.1.2. Theoretical Foundations of SV in ITSM

The understanding of Stakeholder Value (SV) in this study is based on established theories from service science and information systems. Specifically, Vargo and Lusch's [139] Service-Dominant Logic (SDL) provides a foundational perspective of value as co-created through interactions between providers and consumers, rather than produced and delivered independently. Value is considered inherently contextual, experiential, and determined by the beneficiary in use, rather than delivered as a predefined output. This perspective directly supports the view adopted in *its*VALUE, where value is treated as a dynamic, context-sensitive construct shaped by stakeholder perceptions and evolving service interactions.

In addition to this perspective, Alter's [5] Work System Theory (WST) offers a conceptual framework for understanding how value emerges from configurations of people, information, technology, and processes that interact to produce outcomes for internal and external stakeholders. The concept of a "work system" aligns with the notion of a VS in ITSM, and WST emphasizes the importance of considering both technical and human dimensions of service systems. The modeling approach in *its*VALUE reflects these principles by enabling users to explicitly capture the relationships between service components and SV.

While traditional ITSM approaches often prioritize efficiency, standardization, or compliance, the approach in this work places perceived Stakeholder Value (SV) at the center of service design and analysis. Together, SDL and WST provide the theoretical foundation for the design decisions made in *its*VALUE. They support a shift in ITSM thinking from process- and product-centered management to value-centered service systems that prioritize stakeholder perspectives and collaborative value realization. This theoretical grounding reinforces the applicability of *its*VALUE beyond a single framework such as ITIL 4, positioning it as a conceptual contribution to the broader evolution of ITSM methodologies.

Finally, value creation mechanisms discussed in Stabell and Fjeldstad's [128] typology of value configurations offer additional perspectives that could guide the extension of *its*VALUE to various business and service domains.

3.2. The IT Infrastructure Library (ITIL): Evolution and Core Concepts

The IT Infrastructure Library (ITIL) is widely recognized as the most influential and widely adopted framework for structuring and managing IT services. Auth [6] notes that ITIL was initially developed in the 1980s by the UK's Central Computer and Telecommunications Agency (CCTA) [96] to address the growing need for standardized IT management practices across government functions. Over time, ITIL has evolved through multiple versions to adapt to changing technological trends and service philosophies [7]. Each iteration has aimed to enhance the framework's relevance and usability in diverse organizational contexts, reflecting its increasing strategic importance in ITSM, as highlighted by Iden and Eikebrokk [35].

ITIL v1 (1989): Cater-Steel et al. [26] describe the original version of ITIL as consisting of over 30 volumes, documenting best practices intended to standardize IT operations. These practices were largely process-based and focused on improving service quality by aligning IT services with business needs.

ITIL v2 (early 2000s): Iden and Eikebrokk [56] characterize ITIL v2 as a more streamlined and widely adopted version, consolidating the framework into a few core volumes focused on incident, problem, and change management. While it significantly contributed to unifying ITSM terminology, it was often criticized for lacking a holistic view of service value delivery.

ITIL v3 (2007–2011): Sánchez Casanova [115] explains that ITIL v3 introduced a lifecycle-based approach to service management, promoting long-term strategic alignment between IT and the organization. The five stages (Service Strategy, Service Design, Service Transition, Service Operation, and Continual Service Improvement) shifted the focus from isolated processes to continuous value delivery.

ITIL 4 (2019): ITIL 4 marks a paradigm shift in ITSM by embedding value co-creation and incorporating modern methodologies such as Agile, DevOps, and Lean. Auth [6] emphasizes that this version introduces the Service Value Chain (SVC) and redefines ITSM as a flexible, adaptive discipline aimed at fostering innovation and stakeholder-centric value realization.

3.2.1. Key Components and Constructs of ITIL 4

The central concept of ITIL 4 is the Service Value System (SVS), which frames how all components and activities within an organization interact to facilitate value creation. The SVS comprises several key elements

Guiding Principles: These are high-level recommendations derived from earlier ITIL versions and modern practices such as Agile and Lean. Examples include ”Focus on Value”, ”Collaborate and Promote Visibility”, and ”Keep it Simple and Practical.” These principles provide a foundation for decision-making and actions, ensuring that the organization remains focused on delivering value to stakeholders.

Governance: This component defines how policies and oversight mechanisms ensure strategic alignment and accountability in service provision. Effective governance ensures that IT services are delivered in accordance with organizational goals and regulatory requirements, maintaining transparency and control over service management activities.

Service Value Chain (SVC): The SVC is a flexible operating model comprising six core activities (Plan, Improve, Engage, Design & Transition, Obtain/Build, and Deliver & Support). These activities are interconnected and enable the creation of VSs that deliver outcomes. The SVC allows organizations to adapt and respond to changing business needs, ensuring that services are continuously optimized and aligned with strategic objectives.

Practices: Replacing the term ”processes”, ITIL 4 includes 34 practices grouped into three categories: general management, service management, and technical management. These practices offer adaptable, principle-driven guidance that organizations can tailor to their specific contexts. By focusing on practices rather than rigid processes, ITIL 4 promotes flexibility and innovation in service management.

Continual Improvement: This is a cyclical approach to enhancing services, performance, and alignment with stakeholder expectations. It emphasizes an iterative mindset embedded throughout all practices and VSs. Continual improvement encourages organizations to regularly assess and refine their service management practices, fostering a culture of ongoing development and excellence.

Additionally, ITIL 4 [12] places significant focus on the concept of value co-creation, defining service as ”a means of enabling value co-creation by facilitating outcomes that customers want to achieve”. Importantly, value is no longer viewed as unidirectionally delivered from provider to consumer, but rather as an emergent outcome of collaborative interactions among stakeholders.

According to Sun and Chen [131], effective IT service provision requires aligning the goals of clients and providers through co-creative mechanisms embedded in governance structures. Their findings underscore the need for shared understanding and flexible contractual arrangements that support iterative value realization. This alignment ensures that both parties are working towards common objectives, enhancing the overall effectiveness and satisfaction of the service provided.

In a broader service context, Hilton et al. [54] emphasize that value realization in co-created environments often depends on mutual role clarity and effective touchpoints between actors. This is particularly relevant for ITIL 4’s emphasis on stakeholder-specific outcomes and interaction-driven service architecture. Clear roles and well-defined interactions help prevent misunderstandings and ensure that all stakeholders are engaged in the value creation process.

This notion is operationalized in ITIL 4 through the following concepts:

Stakeholders: Not limited to customers but encompassing users, sponsors, service providers, partners, and regulators; each with unique value perceptions and expectations. Recognizing the diverse needs and contributions of various stakeholders is crucial for effective service management.

Value Streams (VSs): End-to-end sequences of activities that transform demand into value. VSs combine different SVC activities and practices tailored to specific services or products. By mapping out these streams, organizations can identify opportunities for optimization and ensure that each step contributes to the desired outcomes.

Outcomes vs. Outputs: Outcomes are the results desired by stakeholders (e.g., enhanced decision-making), whereas outputs are the deliverables produced by the service (e.g., a dashboard report). Focusing on outcomes ensures that services are designed and delivered to meet the actual needs and expectations of stakeholders.

Service Interactions and Touchpoints: The moments in which stakeholders interact with the service provider are emphasized as crucial value-defining experiences. These are often modeled using Service Blueprints, as described by Bitner et al. [18], a recommended tool in ITIL 4, to map out the customer journey. By analyzing these interactions, organizations can enhance the quality and impact of their services, ensuring that each touchpoint adds value.

3.2.2. Implications for Practice and Limitations of ITIL 4

ITIL 4 provides a flexible structure that allows for scalable and iterative improvement of ITSM practices. It supports integration with digital strategies and emerging technologies, encouraging organizations to adapt practices to their own service ecosystems. The framework's emphasis on the Service Value System (SVS) and the Service Value Chain (SVC) facilitates a holistic approach to service delivery and continual improvement. Still, ITIL 4 presents several limitations that practitioners and organizations must consider:

Complexity and Resource Intensiveness: The implementation of ITIL 4 can consume many resources, requiring significant investment in training, process redesign, and cultural change. Lucio-Nieto and González-Bañales [77] identify that significant time investment from IT staff and a thorough understanding of ITIL purposes are critical challenges during implementation, especially in mid-sized and resource-constrained organizations. Winkler and Wulf [151] similarly note that ITSM frameworks often lack the mechanisms to dynamically respond to shifting stakeholder expectations, which increases the operational burden during implementation phases. This complexity can be a barrier to adoption, particularly for organizations with limited resources.

Integration Challenges with Agile and DevOps Practices: Although ITIL 4 acknowledges the relevance of Agile and DevOps, integrating these practices can be challenging. Serrano et al. [122] argue that there are structural and cultural incompatibilities between the control-oriented processes of ITIL and the decentralized, iterative workflows in Agile environments. This tension may cause friction in hybrid adoption scenarios and dilute the benefits of agility. Organizations must navigate these differences to effectively combine ITIL with Agile and DevOps methodologies.

Overemphasis on Processes Over People: Serrano et al. [122] point out that ITSM efforts often ignore change management and soft skills, which are critical for Agile-compatible service environments. However, cultural resistance may become a persistent barrier in ITIL 4 adoption. The framework's strong focus on procedural standardization may overlook the need for employee empowerment, continuous learning, and cross-functional collaboration. Addressing these human factors is essential for successful ITIL implementation.

Ambiguities in Value Realization and Measurement: While ITIL 4 introduces the notion of value co-creation, it offers limited guidance on how value should be defined, assessed, or monitored over time. Considering Winkler and Wulf [151], this abstraction can be criticized, noting that without concrete tools for tracing stakeholder value perceptions and linking them to service activities, ITSM strategies risk being misaligned with actual business impact. Clear metrics and evaluation methods are needed to ensure that value co-creation is effectively realized.

Structural vs. Dynamic Value Co-Creation: Finally, ITIL 4 continues to emphasize structural value facilitation through predefined practices and roles. However, as Winkler and Wulf [151] explain, this perspective does not capture the dynamic and evolving nature of value in digital service ecosystems. There is a lack of modeling support to link value perceptions to operational workflows, leaving a gap in enabling adaptive, stakeholder-centric service designs. Organizations must develop flexible approaches to value creation that can adapt to changing stakeholder needs and technological advancements.

These limitations underscore the need for approaches that extend beyond ITIL 4's conceptual boundaries by offering explicit mechanisms to model, evaluate, and continuously adapt SV within service ecosystems. While ITIL 4 emphasizes the importance of value co-creation, it lacks the conceptual infrastructure and methodological tooling to systematically translate stakeholder perceptions into actionable and traceable design elements within service architectures.

3.3. Closing the Gap: The Contributions of *its*VALUE

The *its*VALUE method, as introduced in this dissertation, tackles these shortcomings of current ITSM frameworks, especially ITIL 4. It presents a groundbreaking, model-based strategy for embedding Stakeholder Value (SV) into the design and analysis of Value Streams (VSs). This is achieved through a formalized process that integrates stakeholder value perceptions with the components of VSs, ensuring that the design and operational aspects of services are closely aligned with stakeholder expectations and needs.

3.3.1. Bridging Stakeholder Value (SV) and Value Streams (VSs)

While ITIL 4 encourages the consideration of SV, it does not provide specific guidance on how to model, quantify, and link this value to the service delivery architecture. The *its*VALUE method addresses these gaps by offering a comprehensive modeling language and methodology that enables:

Explicit Modeling of Stakeholder Value Perceptions: Utilizing the Value Perception Model (VPM) and Stakeholder Value Map (SVM), *its*VALUE allows for clear representation of how stakeholders perceive value.

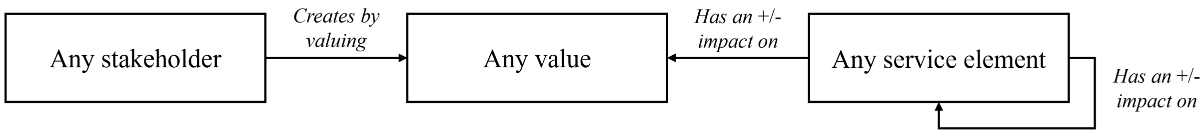


Figure 3.1.: The Novel Conceptual Contribution of *its*VALUE

Identification and Quantification of Value Influence: *its*VALUE helps to identify and measure the impact of various service activities or components on SV and among each other. All of this is achieved by Value Perception Models (VPMs), Value Stream Blueprints (VSBs) and Process Specification Models (PSMs).

Tracing Impact Relationships: The method uses transitive, model-based links to trace the relationships between VS components and stakeholder value perceptions, ensuring that these connections are explicitly modeled and maintained.

This approach is supported by *its*VALUE's meta model, which formally defines the relationships between SVs and service activities or components. As illustrated in Figure 3.1, these links are not assumed or abstractly referenced but are explicitly modeled and maintained, providing a clear and structured way to understand and optimize value creation.

3.3.2. A Formalized, Tool-Supported Approach

The *its*VALUE method brings these concepts to life through a custom ADOxx-based modeling tool. This tool provides several key capabilities:

Traceability Across Models: It ensures traceability across different models and model types, allowing users to follow the connections and dependencies throughout the value creation process.

Analytical Capabilities: The tool includes analytical features to identify "waste" in the VS, such as components that contribute little, no, or even negative value.

Support for Current and Future State Modeling: Via a Future Value Stream (FVS) and Current Value Stream (CVS), it supports both current state and future state modeling, enabling organizations to plan and visualize improvements over time.

Automation of Value-Weight Calculations: The tool automates complex value-weight calculations based on stakeholder-defined priorities and other relevant factors.

By providing a consistent and structured modeling process, rather than just static best practices, *its*VALUE offers a rigorous approach to integrating SV into IT service design. This approach effectively bridges the gap between understanding what needs to be done and how to do it.

3.3.3. Research Contribution

The *its*VALUE framework makes three significant contributions to IT Service Management (ITSM) research and practice:

Methodological Innovation: It introduces a novel approach by directly linking stakeholder value perceptions to the operational components of service delivery. This transformation turns value modeling from a passive activity into an active design task. By actively engaging with stakeholders and integrating their perceptions, *its*VALUE ensures that the design and delivery of services are closely aligned with the actual value expectations of those involved.

Formal Modeling Support: It provides robust support for formal modeling through meta modeling techniques and specialized tools. This enables users to visualize, document, and analyze the pathways of value creation effectively. By leveraging these tools, organizations can gain deeper insights into how value is generated and identify opportunities for optimization and improvement.

Theory-Practice Bridging: It is based on the principles of both enterprise modeling and Service-Dominant Logic (SDL), as proposed by Vargo and Lusch [138, 139]. It is specifically designed to be practically applicable, utilizing the ADOxx Modeler for creating models and conducting evaluations in real-world scenarios. This approach ensures that theoretical concepts are effectively translated into practical applications, making them useful and relevant in real-world contexts

These aspects position *its*VALUE as a unique contribution in a landscape where ITSM frameworks like ITIL serve as a high-level guide, but concrete, stakeholder-centered modeling methods remain scarce.

4. A Structured Literature Analysis

This chapter investigates the state of research on modeling and analyzing SV for IT services based on a SLA. Given that only a few studies have addressed the issues raised by ITIL 4, we focused on how to model SV, VSs, and SBs. To guide our investigation, we followed the guidelines recommended by Webster and Watson [146] and Kitchenham [68]. Therefore, we defined multiple RQs:

RQ 1: From an ITIL 4 perspective, which potential methods and notations for IT service value modeling and analysis are defined in the scientific literature?

This first RQ gathers existing methods in the area. These methods can be described at various levels of granularity. Since ITIL 4 already outlines a value-oriented approach to ITSM, future implementers benefit from approaches that are operationalized to a level that allows tool support for modeling and analysis. SBs, SV modeling, and VS modeling have been selected as foundational modeling concepts because they are explicitly mentioned in the ITIL 4 standard [12].

RQ 2: What is the potential of the identified notations to serve value modeling for IT services from an ITIL 4 perspective?

The second RQ focuses on the suitability of the identified notations (whether part of a method or not) to meet the requirements of ITSM or ITIL 4, respectively.

RQ 3: What general information can be gathered about the investigated literature?

The third RQ aims to collect general information about the literature to provide contextual information useful for discussing our SLA results. This includes:

RQ 3.1: How much activity has there been over time? *(Investigating the publication timeline to understand the level of activity over time)*

RQ 3.2: What research topics are being investigated? *(Identifying the general research topics to see the focus areas within the field)*

RQ 3.3: Who is active in this research area? *(Determining key contributors and institutions in this research area)*

RQ 3.4: What research approaches were used by the authors? *(Analyzing the methodologies and frameworks applied in the studies)*

RQ 4: According to the authors, which challenges still need to be tackled?

The fourth RQ aims to collect open challenges and questions that remain unanswered according to the literature. This helps in identifying gaps in the current research and areas that need further investigation.

First, we describe the design and process of our SLA in Section 4.1. The important concepts related to value and service management from the ITIL 4 perspective, defined in Section 1.2, provide a structure for analyzing the literature. The answers to the RQs are presented in Section 4.2. This leads to a collection of modeling requirements for IT service value modeling as intended by ITIL 4, summarized and discussed in Section 4.3.

4.1. Paper Selection for Analysis

We conducted a SLA to assess the state of research on methods for IT-Service Value Modeling. Therefore, we followed the guidelines recommended by Webster and Watson [146] and Kitchenham [68]. Moreover, Figure 4.1 presents the steps suggested by Ivarsson and Gorschek [57] that we followed for the review process.

Firstly, we identified conference series, journals, and catalogs likely to represent the state of the art in our topic of interest. We extracted a base set of papers for our review by performing a keyword search on Scopus, a well-known portal for high-quality scientific literature indexing. The process of paper identification starts with defining the overall search space, which involves determining the literature sources to consider in light of the research questions. Our query is based on the main concepts described in Section 1.2 and contains four parts:

1. *((TITLE ("value" W/1 ("modeling" OR "modelling" OR "designing")) AND ALL("notation"))*
2. *TITLE ("value stream" AND ("modeling" OR "modelling" OR "designing" OR ("design*" W/3 "method"))*
3. *((TITLE ("service blueprinting") OR (TITLE ("service blueprint*" AND ("modeling" OR "modeling" OR "designing")))) AND ALL("value"))*
4. *PUBYEAR > 1999 AND (LIMIT-TO (SUBJAREA, "ENGI") OR LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI"))*

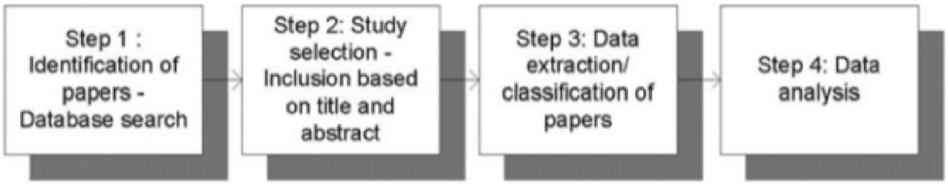


Figure 4.1.: The SLA Process from Ivarsson and Gorschek [57].

Next, we excluded and included papers based on their title and abstract. We classified the remaining papers based on the concepts described in Section 1.2. From these, we extracted data relevant to our research questions and analyzed it. The first two steps are described in this section, while the data extraction and analysis are covered in the following sections that address the RQs.

Generally, we searched for ”designing” instead of ”design” to avoid including documents that use ”design” in contexts other than modeling (e.g., ”design of a study”). This approach helped us prevent irrelevant documents from flooding our review set.

To get an idea of how to model SV properly, we searched for modeling *value* generally. We used the terms ”model(l)ing” and ”designing” to exclude literature dealing with general models and focus on literature explicitly dealing with modeling value. We ensured that one of these terms is very close to the term ”value.” If they appear in a document's title, both terms should not be separated by more than one other word. This approach helped us find important literature like Scheller and Hruby [118], which includes titles such as ”value delivery modeling.” We also searched for these terms in the abstracts and keywords but with the restriction of them appearing side by side. Using the *W/n* operator ensured finding documents with both phrases like ”value model(l)ing” and ”model(l)ing value” while keeping the query short and comprehensible. To get information about possible notations, all documents found by the first part should contain the term ”notation” somewhere.

To get information on how to model VSs, we used the terms ”model(l)ing” and ”designing” as well, although we knew about the synonymous and common term *Value Stream Mapping* (VSM). While exploring this second part of our query, we found that the term VSM describes a general methodological approach rather than an actual modeling method with a specific notation. Thus, we stuck to documents explicitly mentioning ”value stream” and either ”model(l)ing” or ”designing” in their title. Additionally, we considered documents introducing a design method where both terms are not separated by more than three words. Important documents like Hartmann et al. [51] were found as well. Due to low results when tuning our query, we did not exclude literature not mentioning the term ”notation” somewhere.

To get documents presenting information on how to model SBs, we considered documents explicitly using the term ”service blueprinting”, as it is a commonly known term for such activities. We also considered documents using the terms ”model(l)ing” and ”designing” in combination with ”service blueprint.” We excluded any document not mentioning the term ”value” somewhere to focus on literature dealing with SV.

Our SLA draws a sample of scientific literature. Therefore, missing some sources reduces the sample size and the potential significance of the study. Out of the remaining 36 papers, nine were classified as not relevant to the topic, and two were not available in English. We carefully investigated the title and abstract of each accessible document. If the title and abstract showed that the document was in a different domain (e.g., focusing on modeling chemical expressions or just focusing on business processes instead of an entire VS), we classified it as not relevant. Furthermore, we scanned the remaining documents for their potential contributions to the RQs. Any document suitable for this purpose was assumed to be relevant. In the end, 25 papers were considered relevant and used for data extraction and analysis.

4.2. Results of the Structured Literature Analysis (SLA)

The results of our query were first collected in April 2021 and verified in January 2024. In total, 52 possibly relevant papers were identified. Table 4.1 provides an overview of all documents found, distinguishing them by their accessibility and relevance. Only 13 of these 52 documents were behind a paywall or otherwise inaccessible to us. Of the remaining 39 documents, we classified 31 as relevant and 8 as not relevant.

Accessible	**Relevant**	**Literature Found**	$\sum$
Yes	*Yes*	[1–3, 13, 17, 18, 20, 24, 31, 37, 38, 46, 50, 51, 58, 70, 73, 74, 86, 88, 94, 118–120, 124, 132, 135, 143, 148, 150, 152]	31
	No	[41, 66, 67, 79, 80, 130, 136, 147]	8
No		[16, 29, 32, 34, 53, 60, 71, 75, 76, 104, 129, 133, 145]	13

Table 4.1.: Overview of the literature found at Scopus

To determine relevance, we carefully examined the title and abstract of each accessible document. If the title and abstract indicated that the document was in an unrelated domain, we classified it as not relevant (e.g., Stadtherr et al. [130] focused on modeling chemical expressions, or Weiss et al. [147] focused solely on business processes rather than an entire VS). Furthermore, we scanned the remaining documents for their potential contributions to our second or third RQ. We classified any document that addressed methods or notations in the field of modeling SV, VSs, or SBs as relevant. However, documents that merely mentioned but did not describe a modeling approach were classified as not relevant (e.g., Machado et al. [79] described how VSs can enhance company performance but did not present a specific modeling approach).

Additionally, an error occurred in Scopus: it listed the paper by van Eck et al. [135] twice [136]. Hence, we classified only one of these as relevant and the other as not. Lastly, we encountered a promising document by Heger et al. [52] on ResearchGate while setting up our query. We included this document in our research as it provides valuable contributions to our RQs.

As a result of re-running our query over time, we found seven additional papers. Two are our own publications: Richter et al. [111], Richter and Lantow [109]. The remaining five address value stream simulation modeling (Reda and Dvivedi [106]), service blueprinting in the context of human-centric artificial intelligence (Magyari and Secomandi [81]), service blueprinting for product-service systems (García Lechuga and Cortés [43]), value modeling in legal risk management (Muthuri et al. [92]), and VS techniques in industrial manufacturing (Rudnitckaia et al. [114]).

4.2.1. RQ 1: Modeling Methods and Notations

As mentioned earlier, the identified modeling methods and notations from the different parts of the query are mapped to the concepts defined in Section 1.2. Table 4.2 provides an overview. The *Value Stream Mapping* method is the most frequently presented one for modeling VSs compared to the others. However, as stated in Section 4.1, *Value Stream Mapping* is a very general approach that encompasses a variety of methods and notations.

In the following, we focus on the expressiveness of the notations connected to the identified methods. We used a classification based on the concepts presented in Section 1.2. For brevity, the visual notations are not shown. Instead, we refer to the abstract notation, meaning the concepts available in the different approaches and their semantics.

Domain	Method	Literature
Stakeholder Value (SV) modeling	e3value	[24, 58, 124, 135, 143, 148]
	DVD	[124]
	REA	[20, 143]
	POA	[118]
	VoPM	[143]
	SSG	[74]
	VDML	[95, 143]
Value Stream (VS) modeling	VSM	[1, 2, 13, 31, 37, 38, 88, 94, 119, 143, 152]
	RVSM	[150]
	DVSM	[94]
	VSMN	[52]
	VSD 4.0/VSM 4.0	[50, 51]
	EVSM	[73]
Service Blueprint (SB) modeling	"traditional" SB	[18, 70, 86]
	IT S-SB	[120, 132]
	ISB	[17]
	PSB	[46]
	FM	[3]

Table 4.2.: Overview on the method classification and the literature associated

As this section contains a substantial amount of varied information, the notations for the different modeling approaches are grouped by their domain in separate subsections.

4.2.1.1. Notations for Stakeholder Value (SV) Modeling

Notations for SV modeling, as identified in the first part of the query, primarily focus on the exchange of value between different stakeholders. Thus, the provision and receipt of value are modeled for each stakeholder. Generally, value is considered as economic value, which can be measured in monetary terms.

e3value: In the *e3value* notation, economically independent actors transfer value through value ports and interfaces by performing activities. Value interfaces group value ports that provide or request value objects to or from actors or market segments. As per Souza et al. [124], a market segment is a group of actors sharing a set of common properties. Several authors reference *e3value* in their approaches. Johannesson and Bergholz [58] extended the *e3value* notation, allowing modeling rights, claims, or custody in addition to exchangeable tangibles.

Dynamic Value Description (DVD): Souza et al. [124] define in their *DVD* method a special view presenting value exchange from a stakeholder-centric perspective using the same concepts as *e3value*. Souza et al. claim that this approach performs better than *e3value* in terms of effectiveness, efficiency, perceived ease of use, usefulness, and intention to use. Another important addition is the introduction of value level agreements, which emphasize the immaterial value attributed to quality rather than the exchange of goods. However, there is no special concept for these quality aspects; they are described by comments in the model.

Possession, Ownership, Availability (POA): The *POA* model by Scheller and Hruby [118] is similar to the approach by Johannesson and Bergholz [58]. It offers more expressiveness regarding the nature of exchange compared to *e3value*. Furthermore, concepts for modeling processes, resources, and events are added. Consequently, more information on how value is created and consumed can be provided in a model. Still, the focus remains on the value exchange.

Value Delivery Modelling Language (VDML): The *VDML*[1] is a standard defined by the Open Management Group (OMG). As Scheller and Hruby [118] only mention it, we used the official standard documents for analysis. *VDML* integrates several approaches to value modeling and connected domains, such as *e3value* and business models. It also addresses VS modeling and provides a general framework intended for a high level of abstraction. Thus, non-economic value is supported by providing a general measure concept for value, but its concrete definition and measurement is left open. Consequently, *VDML* can be used for an integrated model that addresses SV and VS modeling. Still, it is less specific in terms of the modeling concepts and views used than most of the analyzed approaches. An important addition of *VDML*, stemming from the integrated Structured Metrics Metamodel[2], is the possibility for different measures to influence each other positively or negatively. Thus, different value propositions can also influence each other positively or negatively.

Resources, Events, Agents (REA): In the *REA* method, resources, agents, and events are the main concepts. Resources are controlled by agents and exchanged in events (i.e., business activities). Agents exchange value objects (e.g., services, products, money, or even consumer experiences). Such objects are valued by one or more

[1] `https://www.omg.org/spec/VDML/About-VDML/`
[2] `https://www.omg.org/spec/SMM/1.2`

agents. While von Rosing et al. [143] listed it as one of many options for modeling value, Boubaker et al. [20] extracted REA models from Business Process Model and Notation (BPMN) models using patterns. They distinguish between structural and behavioral patterns. A structural pattern can be a conversion, exchange, outsourcing, insourcing, or renting pattern. A behavioral pattern can be an independent branch, resource dependency, resource provision, or internal responsibility pattern.

Value-oriented Process Modelling (VoPM): The VoPM method was created by von Rosing et al. [143]. It aims at connecting value drivers, performance drivers, organizational components, responsible persons, relevant tiers (strategic, tactical, or operational), specifications of innovative or transformational aspects, and the related processes linked to all previous points. Although VoPM does not explicitly model value as a resource that can be exchanged or transferred, it shows how different business components or processes actually affect valuable objectives. It understands value also as an immaterial good.

Service System Graph (SSG): Modeling value co-creation with a SSG was introduced by Li et al. [74]. According to Li et al. [74], a service system for a specific value proposition requires both actors and related resources. A pair of an actor and a required resource is called a *service object*. Li et al. [74] conducted several mathematical definitions to describe the SSG and its requirements. It includes both data and process views. According to Li et al. [74], SSG also enables novel ways to mathematically analyze service systems holistically. Its notation completely consists of mathematical expressions and visualizations.

4.2.1.2. Notations for Value Stream (VS) Modeling

Notations for VS modeling, as identified in the second part of the query, primarily focus on visualizing and optimizing the steps required from product creation to delivery. Over time, various extensions and adaptations of the traditional VSM method have been developed to address specific needs and incorporate additional elements such as risk management, digital environments, and IT infrastructure. This section provides an overview of several VSM methods and their unique contributions to the field.

Value Stream Mapping (VSM): The VSM method assists in visualizing all required steps from product creation to product delivery to the end-customer, aiming at optimization. Value relates to the economic value of making something lean. To perform VSM, Mohammed et al. [88] and Faisal [37, 38] recommend constructing a current state mapping first, followed by constructing and then analyzing a future state mapping. Still, many authors apply the framework slightly differently in terms of visualizations. While von Rosing et al. [143] listed VSM as one of many options for modeling VSs, Mohammed et al. [88], Faisal [37, 38], Azizi et al. [13], Dotoli et al. [31], Agyapong-Kodua et al. [1, 2], and Xie et al. [152] used it for their own purposes. Dotoli et al. [31] also used Unified Modelling Language (UML) models for specifying single steps inside the VS. Moreover, Schönemann et al. [119] proposed an extended modeling approach for VSM by considering the linkage between products and processes, although they do not explicitly show their models. This approach should not be confused with the EVSM presented by Lewin et al. [73].

Risk Value Stream Mapping (RVSM): The RVSM framework was created by Willumsen et al. [150]. It shows how VSs can be modeled in Risk Management (RM). According to Willumsen et al. [150], RM adds value to processes requiring risk information. The central aspect of RVSM is the information flow regarding risk and uncertainty, which can be technical, organizational, or market-dependent. This information flow can be manifested through dialogue or items like reports, logs, and matrices. The purpose of the framework is to map key decision points, formal RM process steps, product development process steps serving RM, risk-related information flows, categorize process steps, identify waste, and evaluate the value added by each process step for stakeholders and other processes. Additionally, the framework provides a legend explaining all visual elements.

Dynamic Value Stream Mapping (DVSM): The DVSM method was created by Noto et al. [94] and combines VSM with System Dynamics (SD) modeling. Generally, DVSM models still use VSM schema but with SD representation, which is highly intuitive according to Noto et al. [94]. The graphical syntax of SD models contains flow (rate) and stock (level) variables that can be distinguished and combined into stock-and-flow diagrams. It supports VSM due to its characteristics, enabling simulation, a systemic view, explicit linking between system structure and behavior, and effective visual representation. DVSM aims to overcome the static perspective of common VSM and its lack of a systemic view, addressing the gap between operations and organizational strategy while remaining visually simple.

Value Stream Model and Notation (VSMN): The VSMN was developed by Heger et al. [52]. It is based on an existing VS method but improved with additional elements from BPMN and *"Notation 2.0"*. Heger et al. [52] defined domain-specific requirements: enabling the flow of information to be viewed while considering time, analyzing the VS regarding waste of time due to lack of information availability or flows, and creating the VS design by considering suitable information availability and flows. VSMN considers information flows, information-dependent elements, digital environments, and time in addition to traditional VS modeling concepts. It is more like a language and not a whole methodology, providing an intuitive overview.

Value Stream Design 4.0 (VSD 4.0) and Value Stream Method 4.0 (VSM 4.0): The holistic method VSM 4.0 for analyzing and designing VSs in Industry 4.0 was developed by Hartmann et al. [50, 51]. Firstly, SV and how it is created must be defined. Secondly, the current state needs to be analyzed, where Hartmann et al. [50,51] refer to the Value Stream Analysis 4.0 (VSA 4.0) by Meudt et al. [84,85]. Lastly, the desired future state must be designed. To design this future state, Hartmann et al. [50,51] introduced VSD 4.0. Its purposes are making VSs flow, enhancing product flows and processes digitally, and integrating product and process information flows. Hartmann et al. [50,51] recommend identifying causes hindering product flow, installing digital solutions, reducing complexity by combining several process steps into one where reasonable, and using slim pull systems if digital connections between processes are not possible. VSM 4.0 supports quantification of waste in information logistics by specific KPIs, such as the Digitization Rate (DR), Data Availability (DA), and Data Usage (DU). It is a typical VSM approach but extended with IT systems and information flows.

Extended Value Stream Method (EVSM): The EVSM was developed by Lewin et al. [73]. It contains everything of the traditional VSM but is extended with new concepts dealing with IT infrastructure. The fundamental extensions are swimlanes assigned to different storage media or types of data usage, arrows showing flow direction, and data boxes with frequency or type of data acquisition. Additionally, it supports the concepts of raw data (e.g., data detected by a sensor), information (i.e., data that has been processed and has higher value), and implications (i.e., information that requires a response in the system).

4.2.1.3. Notations for Service Blueprint (SB) Modeling

Notations for SB modeling, as identified in the third part of the query, primarily focus on visualizing and optimizing the sequence of interactions between stakeholders during service delivery. These methods help pinpoint problems with perceived service quality and their causes. Over time, various adaptations and extensions of traditional SB methods have been developed to address specific needs, such as IT self-services, industrial services, and product-service systems. This section provides an overview of several SB methods and their unique contributions to the field.

"Traditional" Service Blueprints (SBs): The key features of SBs are customer actions and the physical evidence seen by the customer during the stages of the service delivery. People or even technology can be the actors interacting with the service. SBs allow everyone in the organization to visualize an entire service process and its underlying business processes. It makes all points of customer contact and physical evidence explicit. There are customer actions, onstage/visible contact employee actions, backstage/invisible contact employee actions, support processes, and the physical evidence. Bitner et al. [18] summarized SBs, Milton et al. [86] compared SBs with BPMN, and Kostotopoulos et al. [70] elaborated the advantages of SBs.

IT Self-Service Blueprints (IT S-SBs): Although Suzianti et al. [132] used SBs for IT self-services, they did not show any models or notation. Thus, we considered IT S-SB developed by Bär et al. [120], also having IT self-services as an objective. As the meta model of IT S-SBs includes all of the concepts and relationships from common SBs, they are very similar. However, the additional concepts and relationships of IT S-SBs are relevant for designing IT self-services. These new concepts and relationships are the classification of IT self-services by purpose, the integration of physical or IT systems, resources or license terms, the sub-models for describing actors and actions' capabilities, the classification of fail points and behavioral patterns, and a sub-model for depicting the solution to a fail point.

Industrial Service Blueprints (ISBs): The concept of ISBs is introduced by Biege et al. [17]. ISBs are different from usual SBs, as ISBs are generally more process-focused and able to have more than just one starting or ending point. In ISBs, actors are spatially focused on the y-axis instead of the five layers in SBs. In ISBs, activities are the basic elements of a process. They are represented by a rectangular shape and are connected with arrows that indicate their chronological sequence. Whereas "AND" connections are shown by two correlating arrows, "AND" branches are represented by an arrow splitting up. Further, "OR" and "XOR" symbols can be used to depict alternative or exclusive alternative relations of activities.

Product Service Blueprints (PSBs): The PSB approach was developed by Geum et al. [46] and is an expansion of the common SB method. PSBs consist of three parts: a product area, a service area, and a supporting area. The product area provides the flow of product-consumed activities, the service area describes the flow of service provision activities, and the supporting area provides the underlying activities required to provide the product-service system. Whereas the line of integration just separates the product from the service area, the line of operation keeps both of them from the supporting area apart. Further, all three areas are divided into two sub-areas. For the product area, the line of use separates the use area (providing the flow of usage) from the management area (describing the flow of management of products). For the service area, the line of interaction separates the front office and the back office (following the common SBs). For the supporting area, the line of design keeps the production area and design area apart.

Flowthing Model (FM): The FM method was introduced by Al-Fedaghi et al. [3] as an alternative approach to SBs. However, FM extends the SB approach by concepts of BPMN. Such a model is a map of conceptual movement and states of things. These things are so-called *"flow things"* and can be goods, money, information, or data. These things flow in a so-called *"flow system"* consisting of specific sub-areas dependent on the use case. The term *flow* refers to the exclusive transformation of a flow thing passing among six states (also called stages) in a flow system. These stages are creating, transferring (input/output), processing, releasing, arriving, and accepting. Inside the flow system, dashed arrows represent triggering and solid arrows represent flows. The FM approach has a more process-oriented scope compared to common SBs, which focus more on interactions and lines of visibility.

4.2.2. RQ2: Potential for IT-Service Value Modeling

The overall goal of this examination is to explore the potential for ITIL 4. By analyzing various approaches and their suitability for ITIL 4, we aim to identify the most effective methods for optimizing IT services and aligning them with modern industry standards. This section provides a comprehensive overview of different methodologies, highlighting their strengths and limitations in the context of ITIL 4.

Stakeholder Value (SV) Methods: Although *e3value* is a well-known and commonly used method for modeling value, it does not perfectly meet the requirements of ITIL 4. In *e3value*, value is interpreted as a material good that can be transferred from one actor to another. However, ITIL 4 requires value to also encompass immaterial goods (e.g., customer satisfaction). Moreover, *e3value* does not highlight the perspectives of each relevant stakeholder involved, which is also required by ITIL 4.

Conversely, *DVD* provides these perspectives through stakeholder-specific views. Still, the only ways to model immaterial value in *DVD* are through value level agreements and comments. Consequently, not all requirements of ITIL 4 are met.

As mentioned in Section 4.2.1, *VDML* supports the required concepts and introduces the modeling of conflicts in value delivery through the possibility of negative influences between value propositions. However, the concrete concepts and stakeholder-specific views need to be defined in addition to *VDML*. In general, it is too abstract for analyzing the value delivery of a concrete IT service.

The REA method shares the same issues as *e3value* for suiting ITIL 4, as it views value as material resources and considers value generation from one central perspective. However, the patterns proposed by Boubaker et al. [20] could provide useful hints when trying to extract valuable information from BPMN models.

As the POA model is an extension of the REA method, it shares its issues regarding ITIL 4. Especially the concepts of possession and ownership seem unsuitable, as they highly refer to material exchanges of valuable resources. However, ITIL 4 requires mainly immaterial values (e.g., customer satisfaction) for IT services.

Therefore, VoPM describes the term of value as material and immaterial resources. Its connection between value and performance drivers, as well as categorizing value drivers into innovation and transformation drivers, could be a good incentive for defining improvements regarding generating value. Especially, as VoPM also links several business components that could be improved to these drivers.

Furthermore, the visual representation of SSG is very hard to understand due to just using mathematical formalisms. Thus, SSG does not comply with the principles for cognitively effective visual notations suggested by Moody [90]. Consequently, SSG seems to be an unattractive option for modeling SV.

Further, VDML provides promising ideas with considering multiple scenarios and assigning levels of satisfaction to a value proposition. It also introduces modeling conflicts in value delivery by the possibility of negative influences between value propositions. However, the concrete concepts and stakeholder-specific views must be defined elsewhere, as VDML is generally too abstract for analyzing the value delivery of a concrete IT service.

Value Stream (VS) Methods: Although the VSM method seems to be the most common one for modeling VS, it slightly differs in terms of minor visual representations. This reveals when comparing the figures by Xie et al. [152], Mohammed et al. [88], Agyapong-Kodua et al. [1], and Dotoli et al. [31]. However, all these approaches share the features proposed by the VSM framework from Noto et al. [94]. They provide an overview for the end-to-end creation of value from demand to delivery. However, VSM does not provide any concepts of IT systems or informational flows. Thus, it does not suit modeling VSs for IT services in compliance with ITIL 4.

Instead, the RVSM method introduces very specific information flows for the field of RM. It provides a framework for modeling VSs in RM where single steps explicitly require risk information flows. However, it does not explain how to add RM as a beneficial step inside providing value creation in other VSs. Still, the concept of RM and its beneficial features seem to be important for ITIL 4, as service consumers aim for decreasing their risk when purchasing IT services.

The DVSM method provides a very simplified visual representation with very few concepts. Although this makes models very slim and easy to understand, it also causes a lack of other information (e.g., distinguishing material and information flows, which is actually required by ITIL 4). Instead, VSMN provides such a distinguishing. Additionally, it also introduces concepts of IT systems and considers time as well as availability throughout the entire VS. Moreover, it seems to have a well-comprehensible visual representation due to using some features of BPMN. Thus, VSMN seems to be a good fit when modeling VSs for IT services.

However, the example provided by Heger et al. [52] seems to reveal that it is slightly inflexible for cases where a VS could take several turns between different environments instead of flowing straight. Further, VSM 4.0 and VSD 4.0 also provide an integration of concepts for IT systems and information flows. However, they do not provide a concept for measuring time visually. Moreover, the visual VSD 4.0 seems to be a bit overwhelming when viewing the entire VS alongside all assigned information flows and IT systems. Still, the framework of VSM 4.0, its improvement matrix, and their proposed KPIs seem to be a good reference when actually modeling VSs for IT services.

Lastly, the EVSM shares tremendous similarities with the visual representation of VSD 4.0. EVSM describes all the concepts for IT systems and their links to the other components of the VS by using swimlanes. The same concepts are part of VSD 4.0 as well. Consequently, EVSM seems to suit modeling VSs for IT services not perfectly as well.

Interestingly, Hartmann et al. [50, 51] did not reference Lewin et al. [73] at all, although Hartmann et al. [50, 51] clearly used the visual representation by Lewin et al. [73]. Moreover, Heger et al. [52], Willumsen et al. [150], Lewin et al. [73], and Hartmann et al. [50, 51] used the exact same visual representation for waste (a kaizen lightning or box) in VSs.

Service Blueprint (SB) Methods: The "traditional" SB approach already seems to be a helpful tool to understand the relationships between the customers and the service components. It complies with the definition of a SB by ITIL 4.

However, the IT S-SB method seems to be an even better fit for ITIL 4, as it was explicitly developed for IT (self)services. Thus, it already contains important concepts required for IT services and thus also for ITIL 4 (e.g., concepts for IT systems, actor capabilities, or fail point solutions).

Instead, the ISB approach focuses on the industrial domain explicitly. Thus, it does not provide concepts for IT. Moreover, ISBs are presented visually more like a process and not like a traditional blueprint. Thus, they do not provide a compact overview of the relationships between the customer and the service components. Consequently, ISBs do not seem to suit ITIL 4 as well as previous approaches.

The PSB approach seems to have similar issues as well, as it primarily focuses on connecting products with services. Further, PSBs seem to be not as comprehensive as usual SBs are due to the additional product area. However, in IT services, the service itself is mostly the product sold. Thus, a section solely for the products offered seems to be unnecessary for IT services.

Lastly, the FM method clearly focuses on providing a more procedural view than usual SBs. Therefore, many new concepts were introduced to visualize the flow of things. However, these new concepts drastically increased the complexity of the FM method, as it provided new and alternative control flows.

However, any SB approach investigated seems to be very static, as much information is bound to contextual areas and not to specific relations explicitly drawn.

4.2.3. RQ3: General Information on the Literature

To answer sub RQ 3.1, most documents were published in the late 2010s, with a peak of 8 publications in 2018. In 2020, Scopus found 5 documents published that year.

This trend aligns with the topics investigated in the literature (sub RQ 3.2). Among the relevant documents, Scheller et al. [118] was the first to address integrating informational flows into modeling SV. In 2017, Lewin et al. [73] explored extending the VS method to suit Industry 4.0. By 2018, the focus of the documents had shifted significantly from industrial to informational domains. Conversely, earlier works primarily focused on industrial domains and did not systematically consider informational flows until the late 2010s. SBs were also extensively investigated during this period. Bär et al. [120] is the latest document found that deals with SBs and their application for IT self-services. This shift in scope for SBs mirrors the changes observed in modeling SV and VSs. In 2012, Milton et al. [86] and in 2015, Al-Fedaghi et al. [3] explored extending SBs with concepts from BPMN, a method that already includes informational flows. Previously, SBs were primarily aimed at Industry 3.0. A document can be assigned to more than one subject area, and our query excluded documents not assigned to *computer science*, *engineering*, or *business management*. These subject areas encompass the majority of relevant documents.

For RQ 3.3, Germany contributed the most documents (11), followed by the USA (7) and the UK (6). We did not present a visual separation by each author, as only J. Gordin contributed to 3 papers, the maximum among all authors, which would not add significant value. Over 92% of the documents were published in conferences or as scientific articles, with the remainder being parts of books or literature reviews.

Among all relevant documents, most authors conducted case studies to validate their proposals, ideas, methods, or notations (sub RQ 3.4). They also performed brief research or literature analyses to support their assumptions. In some cases, simulations (Li et al. [74]) or questionnaires (Suzianti et al. [132]) were used to validate the authors' assumptions. Additionally, some authors implemented prototypes (Boubaker et al. [20]) or developed new methods (Hartmann et al. [51]), frameworks (Scheller et al. [118]), or methodologies (Al-Fedaghi et al. [3]).

As a result of re-running our query over time, we found seven additional papers. Two are our own publications: Richter et al. [111], and Richter and Lantow [109]. The remaining five address value stream simulation modeling (Reda and Dvivedi [106]), service blueprinting in the context of human-centric artificial intelligence (Magyari and Secomandi [81]), service blueprinting for product-service systems (García Lechuga and Cortés [43]), value modeling in legal risk management (Muthuri et al. [92]), and VS techniques in industrial manufacturing (Rudnitckaia et al. [114]).

4.2.4. RQ4: The Open Challenges of the Literature

In total, von Rosing et al. [143], Suzianti et al. [132], Azizi et al. [13], and Xie et al. [152] did not provide an outlook or pose open questions. Additionally, we have excluded information about a document's outlook if the authors defined open questions unrelated to the methods and notations they addressed. Generally, Noto et al. [94], Willumsen et al. [150], Souza et al. [124], Mohammed et al. [88], Faisal [37, 38], Hartmann et al. [50, 51], Bär et al. [120], Li et al. [74], Lewin et al. [73], Bukhsh et al. [24], Boubaker et al. [20], Schönemann et al. [119], Dotoli et al. [31], Agyapong-Kodua et al. [1, 2], Kostotopoulos et al. [70], Biege et al. [17], van Eck et al. [135], Wieringa et al. [148], and Heger et al. [52] stated that further research is needed to achieve their specific objectives. This includes conducting more extensive case studies, applications, experiments, or exploring broader domains.

For e3value, Johannesson et al. [58] suggest investigating how rights created in value exchanges are affected by the type of resource exchange. According to Souza et al. [124], DVD requires visual improvements, particularly regarding its icons and the elicitation of value level agreements. Scheller et al. [118] emphasize the need for modeling policies and contracts for POA. Li et al. [74] call for the development of a software-aided modeling tool for SSG.

Willumsen et al. [150] highlight the need for developing support for conceptualizing the future state of RM in RVSM. For DVSM, Noto et al. [94] recommend defining performance indicators consistent with the proposed strategy. Heger et al. [52] suggest improving the usability and comprehensibility of VSMN to enhance its practical application. Hartmann et al. [50, 51] propose that each phase of VSM 4.0 / VSD 4.0 should be detailed further, identifying relevant tools and methods. Lewin et al. [73] pose several open questions for EVSM: adding design principles for lean and efficient Industry 4.0, investigating what a waste-free Industry 4.0 looks like, discussing which systems or logic add value, and evaluating current systems for their suitability for Industry 4.0.

Al-Fedaghi et al. [3] suggest examining possible extensions for SBs from other methods like BPMN. Milton et al. [86] call for exploring how SBs can improve the design of inter-unit processes. Geum et al. [46] recommend integrating scenario-based representation into PSBs. For REA, VoPM, IT S-SB, ISB, and FM, no author provided any outlook.

4.3. Discusison of the SLA

Generally, the VSM 4.0 framework seems to be a good starting point for modeling SV and VSs in the field of IT services, as it holistically enhances VSs by detecting and reducing waste. However, the scope of VSM 4.0 does not seem to fit ITSM and ITIL 4 perfectly, as it primarily focuses on optimizing VSs in manufacturing. VSM 4.0 understands value as a material good that is desired, transferred, and created. Thus, it does not support the possibility to acknowledge immaterial value assumptions like the VoPM approach by von Rosing et al. [143] does.

Moreover, the first step of VSM 4.0 misses one major requirement of ITIL 4: The SV must be understood before it can be defined. Therefore, stakeholders affected by the service should be invited to share what they actually value. Each value perception could be explicitly defined using a combination of DVD and VoPM. It is crucial to define each relevant stakeholder's value perceptions separately. DVD is a good starting point, as it provides an actor (or more specifically stakeholder) centric view. Instead of other actors in the actual DVD model, their value perceptions are drawn around each relevant stakeholder. Similarly to VDML, these defined value propositions could be even defined as positive or negative.

In a later step, their relationships to the service components that are part of the VS can be added. Before that, a global value map could be drawn showing the relationships between all value perceptions of the stakeholders. These relationships could be investigated to identify supporting or contradictory relations between the value perceptions of different stakeholders. Sometimes, the same output of a process might mean a different outcome for different stakeholders, as they value differently. Additionally, these different values can be categorized and receive assigned symbols like in VoPM (e.g., indicating that there is still a potential for an increase in value creation). Moreover, value should be understood as an immaterial good as well, like VoPM proposes.

Once each SV is understood and explicitly defined, a VS for the service can be modeled using a hybrid of VSMN and IT S-SB. Both show a flow for an entire service from demand to delivery while acknowledging concepts that are relevant for IT. These concepts can be combined. The environments from VSMN could replace the layers from IT S-SB. This could ensure high flexibility for each case, as only important layers are used. Moreover, a VS could take several turns between all environments very easily instead of being forced to flow straight. Additional operators like *"and"*, *"or"*, or *"xor"* might be helpful to address possible branches caused by conditions inside a VS.

Once a VS is modeled, its components can be mapped with each relevant stakeholder's value perception model by explicitly showing the relationships between each particular SV and how it is affected by service components that are part of the VS. With this being done, wasteful activities and key service components or activities can be identified. With the global value map earlier created as a foundation and the improvement matrix of VSM 4.0 as an assistance, possible improvements can be analyzed and ranked according to their perceived importance by the stakeholders. This analysis could be considered for the design of a future VS which is also modeled using the hybrid of VSMN and IT S-SB.

4.3.1. Limitations of the SLA

Unfortunately, we could not consider the 13 documents found with the query used in the SLA of this work, as they were either behind a paywall or inaccessible. Additionally, our query was performed solely on Scopus and not on other scientific search engines. Despite these limitations, the accessible literature still provided a wide range of promising considerations for modeling SV, VSs, and SBs. In total, we considered 39 documents for our research, which offered valuable approaches.

However, we noticed that we missed documents dealing more specifically with VDML, as we did not include papers with the term *model(l)ing "language"*. While we believe our query was well-defined overall, we cannot be completely certain about the completeness of our search, as we may have missed other promising documents. Another point of criticism might be that we included Heger et al. [52], even though it was not found via Scopus. We discovered it on ResearchGate while gathering inspirations for defining our query. As Heger et al. [52] appeared to be a well-suited document, we included it to serve the purpose of this work. Furthermore, since we did not find documents explicitly dealing with VDML, we had to consider [95] by the Object Management Group.

4.3.2. Summary and Conclusions

This SLA reviewed the literature on modeling SV, VSs, and SBs. Based on the analyzed literature, no single approach completely meets the requirements for IT-Service Value modeling. Each approach provides well-justified concepts based on modeling requirements. Summarizing, the following requirements, apart from the "baseline" of modeling, can be identified:

Value for Different Stakeholders: *DVD* &*IT S-SB* provide stakeholder-specific models.

Quality Dependent Value: This concept is introduced by *DVD*. *SB*, with their focus on interactions and physical evidence, also support this aspect by considering the perceived quality of service.

Conflicting Value Propositions: Emphasizing the optimization of a certain value or value category might diminish other values (e.g., this effect is considered in *VDML*).

Value based on Information Flows: While *RVSM* emphasizes risk-related information flows, *VSM 4.0* and *EVSM* generally introduce information flows.

Risk Dependent Value: *RVSM* allows the explicit modeling of risks and the analysis of value with regard to risk-targeted information flows and activities.

Alternatives in the Control Flow: Approaches like *ISBs* and *Flowthing* use control flow gateways known from BPMN.

Value Creation through Multiple Processes and Resources: *"Traditional" SB* define five standard layers that describe different actors and their processes involved in service delivery. *ISBs* extend this concept to an arbitrary number of actors. The *POA* approach includes resources as well. *VSM 4.0* and *EVSM* use swim lanes to identify different actors.

IT Resources: *VSM 4.0*, *EVSM*, and *IT S-SB* provide concepts to include IT resources in VS and IT-Service modeling.

Considering all these aspects, IT-Service Value models tend to be complex. Mechanisms for complexity management, such as those suggested by Moody [90], or the definition of modeling methods that adapt to the specific context by selecting appropriate method components and hence a subset of modeling concepts, should be investigated.

To conclude, the literature provided many considerable aspects suiting the requirements and concepts of ITIL 4. However, no method suits ITIL 4 entirely or perfectly. Generally, investigating how IT systems, information flows, or immaterial value perceptions has just started in the recent past and seems to continue in the near future. Consequently, IT concepts are new in the domain of value modeling, VSs, and SBs. Further, some investigated documents introduced alternative control flows commonly known from other domains (e.g., BPMN). Lastly, value in an immaterial sense, quality-dependent value, conflicting value propositions, and risk-dependent value should be considered.

5. Developing the Initial Version

Considering the literature reviewed in the previous Chapter 4, various challenges and questions remain unanswered. The precise definition of value and how it can be appropriately defined for each relevant stakeholder is still undetermined. Additionally, the dependencies and relationships between different value perceptions are important to consider. Furthermore, how the perceived value of each stakeholder is influenced by the service offered and its components requires investigation. Moreover, the methods for drawing conclusions regarding the VS itself should be addressed.

As no approach we discovered with our SLA satisfactorily meets the requirements of ITIL 4, and thus, the purpose of this work, we addressed these open issues by developing *its*VALUE, a new method, notation, and ADOxx Modeler based on our findings from Chapter 4. This chapter outlines and motivates the results of our first development iteration. First, Section 5.1 outlines the requirements for *its*VALUE, which we derived from the requirements of ITIL 4 and the corresponding research gap outlined in Section 1.1. The process of *its*VALUE application is described in Section 5.2. The meta-model, which describes the complete notation and forms the basis for the *its*VALUE Modeler implementation, is presented in Section 5.3. An exemplary view and more detailed knowledge on modeling and analyzing value delivery using the *its*VALUE Modeler can be found in Section 5.4. The final Section 5.5 discusses the first state of development and provides an outlook on the next steps to foster *its*VALUE application.

5.1. Towards the Initial Version of *its*VALUE

Based on the identified research gap in Section 1.1 and the requirements outlined by ITIL 4, it became evident that a new approach was necessary to address the complexities and demands of modern IT services. The existing methodologies often fell short in systematically integrating SV into VSs, particularly in capturing both explicit and implicit elements that stakeholders perceive as valuable. To bridge this gap, we developed *its*VALUE, an integrated framework designed to provide a comprehensive solution.

Our goal was to create a method that not only aligns with the principles of ITIL 4 but also offers practical tools and clear methodological guidance for users. This involved identifying and defining SV perceptions, understanding existing VSs, and addressing factors that affect these values and generate waste. Additionally, we aimed to ensure that *its*VALUE encompasses all necessary concepts typically considered in other established methods within the realm of ITSM. Thus, any VS components involved in value creation, such as IT resources or information, are effectively integrated. By doing so, *its*VALUE supports the holistic enhancement of existing VSs or the creation of new VSs, ultimately leading to more efficient and effective ITSM.

To achieve these objectives, we derived the following key Requirements (Rs) for our initial development of *its*VALUE:

R1: Offer a clear method framework and notation

itsVALUE should provide a clear method framework, including a comprehensive notation for the comprehensive creation of itsVALUE models.

R2: Understand and define SV perceptions

itsVALUE should help users understand and explicitly define their stakeholders' value perceptions, both material (explicit) and immaterial (implicit), such as ease of use or employee satisfaction.

R3: Understand and define existing VSs

itsVALUE should help users understand and define existing VSs, ensuring a clear conceptual connection between VSs and SVs.

R4: Identify factors affecting SVs and waste generation

itsVALUE should help users identify and define what affects their SVs and what generates waste, addressing inefficiencies and missed opportunities for value creation.

R5: Enable identification of implicit value creation dependencies

itsVALUE should enable the consideration of implicit value creation dependencies through transitive relationships, fulfilling further requirements outlined by ITIL 4.

R6: Identify further VS components part of the value creation

itsVALUE should help users identify where IT systems, IT resources, physical evidence, or information appear in the value creation process, ensuring alignment with stakeholder needs.

R7: Enhance existing VSs or create new VSs

itsVALUE should help users define and perform enhancements for existing VSs or draft entirely new VSs to support SVs as effectively as possible, such as by reducing or avoiding waiting times.

R8: Provide practical modeling tools

itsVALUE should include practical tools to support the systematic application of its key features, supporting comprehensive management of itsVALUE models.

To start the development of *its*VALUE, we followed the Method Integration Process (MIP) by Goldkuhl et al. [48], which supports the integration of several existing methods into a new method. Goldkuhl et al. [48] advise comparing and classifying all original methods first to detect valuable contributions to the new method. Therefore, we classified and compared several methods from our SLA in Section 4.2.2 and concluded valuable contributions in Section 4.3.2 (R1). From our SLA, we used parts of VSM 4.0, VSA 4.0, VSD 4.0, VSMN, IT S-SB, DVD, VoPM, and VDML. Additionally, we incorporated the For Enterprise Modelling (4EM) method by Sandkuhl et al. [117], which adds valuable contributions that the methods from the SLA lacked.

4EM consists of seven model types, each representing a different view on enterprise modeling: *Goal & Problem Model (GPM)*, *Concept Model*, *Business Process Model*, *Business Rule Model*, *Actor & Resource Model*, *Technical Components & Requirements Model*, and *Inter-model Relations Model*. The implementation of inter-model relations is a significant benefit 4EM contributes to *its*VALUE, as we aim to link different instances of the same object in various models (R4, R5). Additionally, 4EM provides techniques for decomposing objects into sub-models, reducing complexity and increasing comprehensibility. Generally, 4EM is designed for participatory modeling sessions. We derived our concept of value from the *Goal* concept in the GPM of 4EM. According to ITIL 4, a company should achieve the highest possible value for its stakeholders, similar to the definition of goals by Sandkuhl et al. [117]. Further, Engelsmann et al. [36] mapped a value to a goal when transforming e3value models into ArchiMate diagrams. Thus, we understand a SV as a specification of a business goal. When determining SV as a business goal, both material and immaterial value assumptions can be defined, assisted by the SMART principles by Drucker [33] (R2). An adaptation of the GPM by Sandkuhl et al. [117] helps model the relations and dependencies between different SVs. We also used visualizations of BPMN for *its*VALUE, as it is familiar to many practitioners (R1).

Once each original method candidate is analyzed for its beneficial contributions, Goldkuhl et al. [48] advise defining a method hypothesis for the new resulting one. They underline the importance of making the method adaptable to different situations as demanded by the user. Hence, we defined the scope of *its*VALUE as follows (R1-7):

> *itsVALUE should help users understand and explicitly define their stakeholders' value perceptions (both material and immaterial), understand and define existing VSs, understand what (implicitly) affects their SVs and what generates waste, and identify where IT systems, IT resources, physical evidence, or information appear in the value creation. Further, itsVALUE should help define and perform enhancements for existing VSs or draft entirely new VS to support SVs as effectively as possible (e.g., by reducing or avoiding waiting times).*

In other words, *its*VALUE addresses known problems (modeling and optimizing VSs, reducing waste, showing links between processes and systems) and new problems proposed by ITIL 4 (explicitly detecting and showing what value is and how it is created or negatively affected). This broader approach distinguishes *its*VALUE from other methods used for its derivation. For example, DVD focuses on modeling value through value exchanges for each actor, while VoPM aims to model value more broadly and assign it to different processes. Although VDML provides concepts for positive and negative influence of value propositions, it is generally too abstract for analyzing the value delivery of a concrete IT service. VSM 4.0, VSA 4.0, and VSD 4.0 focus on optimizing industrial VSs by reducing waste and using digital solutions, while VSMN focuses on modeling such VSs. IT S-SB focuses on modeling IT self-services from demand to delivery. 4EM provides a holistic view on an enterprise by considering processes, business goals, actors, resources, and more. Its GPM focuses on modeling business goals, their dependencies, and relations, alongside possibilities, problems, constraints, and causes to understand what the company should strive for. We combined valuable contributions from these methods into *its*VALUE.

5.2. The *its*VALUE Method

To cover these purposes, Figure 5.1 shows our *its*VALUE framework (R1). Initially derived from the VSM 4.0 framework by [50, 51], it is extended by the ideas of ITIL 4 and

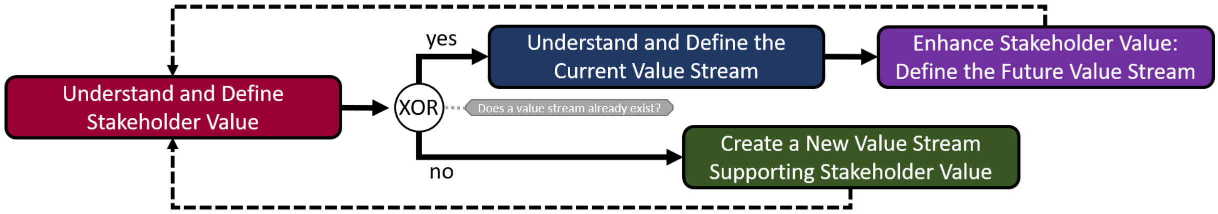


Figure 5.1.: *its*VALUE Framework

components of other methods considered for *its*VALUE. Depending on whether there is an existing service and VS that needs enhancement, *its*VALUE proposes two paths. We extended the *its*VALUE framework to include several iterations, derived from the *Delphi* method, which aims to reach a high consensus among group members according to Geist [44]. Geist executed four iterations, delivering promising results in gathering required information from stakeholders. Thus, we recommend performing approximately four iterations of *its*VALUE, especially for a new service and VS. The following sections 5.2.1, 5.2.2, 5.2.3, and 5.2.4 introduce each phase of *its*VALUE in detail.

5.2.1. Understand Stakeholder Value (SV)

The first phase of our *its*VALUE framework focuses on understanding and explicitly defining what each relevant stakeholder values (see Figure 5.2, R2). While Hartmann et al. [50, 51] acknowledge the value perception by the customer, ITIL 4 [10, 12] emphasizes the importance of pleasing all stakeholders. Besides customers, ITIL 4 lists employees, managers, suppliers, partners, the media, the public, and many more as important and considerable stakeholders. ITIL 4 recommends exploring and understanding the needs of each relevant stakeholder to define what they value. Therefore, a company should gather information from each relevant stakeholder. Different approaches for assessing this information seem reasonable, depending on the relationship with the stakeholder. For instance, close customers or employees can be directly interviewed, whereas the public or media should be monitored continuously to understand the company's image. ITIL 4 underlines that the closer the collaboration with a stakeholder, the more affected they are, and thus, the more attention they should receive in tracking their value perceptions.

Once the results of these investigations have been gathered, each relevant stakeholder's value perceptions should be defined explicitly and separately. This conclusion is derived from the key idea of the DVD method introduced and evaluated by Souza et al. [124–126],

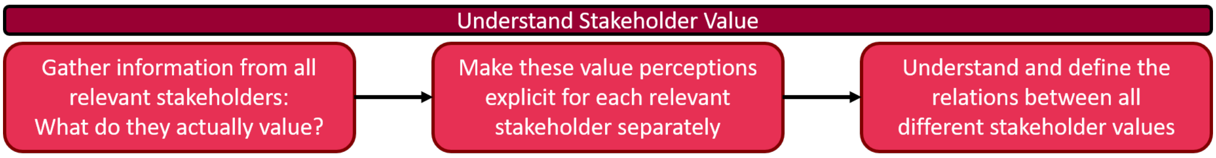


Figure 5.2.: *its*VALUE Component: Understand SV

as discussed in Section 4.2.2. Our VPM (detailed in Section 5.4.1) serves this purpose. An example can be found in Section 5.4.1, Fig 5.13. Each relevant stakeholder receives their own VPM, representing the core of that model, with their value assumptions placed around them. We designed the explicit value perceptions by combining the *goal* concept of 4EM and the value representation of VoPM. Each modeled SV should be classified regarding its Relevance Factor (RF) and Current Performance Level (CPL):

Relevance Factor (RF): For the RF, we defined four rating values: *Mandatory*, *Moderate*, *High*, and *Outstanding*. We adopted the idea of distinguishing between hygiene and success factors from Nerdinger [93]. A *Mandatory* SV is considered a hygiene factor if it causes dissatisfaction when missing while not significantly increasing satisfaction when delivered. Conversely, *Moderate*, *High*, and *Outstanding* SVs are different levels of relevance for success factors: If success factors are provided, they increase satisfaction (depending on relevance) while causing little dissatisfaction when missing.

Current Performance Level (CPL): CPLs reflect the perceived performance of value delivery. They can only be reasonably assessed if a service and thus VS already exists. For calculation reasons presented in Section 5.2.2.2, our method always requires a CPL for each SV, even for new VSs or VS components like processes, IT systems, etc. In such cases, a default CPL should be defined. For the CPL, we define the following rating values: *Poor*, *Moderate*, *High*, and *Outstanding*. A *Poor* CPL indicates that a SV is not well delivered. Conversely, *Moderate*, *High*, and *Outstanding* cover better-delivered SVs. We recommend using *Moderate* as the default CPL, as this setting does not affect further calculations (cf. Section 5.2.2.2).

Depending on the RF of a SV, its CPL provides different conclusions (e.g., a *Moderate* relevant SV does not fundamentally require an *Outstanding* performance as much as a *Mandatory* relevant SV does).

Once each relevant stakeholder's value perception is explicitly defined, the dependencies and relations among all SVs should be investigated. We understand SVs as a specialization of business goals in the sense of Sandkuhl et al. [117]. Thus, delivering different values may cause mutual support, obstruction, or even contradiction. For example, an extra validation activity may reduce risk within a VS and thus provide value, but it may also negatively influence value delivery in terms of short processing times. The results are reflected in the SVM. The GPM of 4EM by Sandkuhl et al. [117] provides a tool to investigate and define these dependencies and relations explicitly. Our corresponding adaptation, the SVM, is detailed in Section 5.4.2. Understanding how different SVs affect each other can assist companies in detecting which SVs are beneficial or problematic to other SVs. Combined with the RF and CPL of a value, such an understanding can be useful for deciding which SVs is more important when defining development actions. Considering the results presented by Geist [44], the possibility to perform iterations seems very beneficial in this phase to adapt flexible to dynamic stakeholder demands, motivating frequent repetitions of this step.

5.2.2. Understand and Model the Current Value Stream (CVS)

According to ITIL 4 [8, 12], VSs focus on the end-to-end flow of activity from demand to value. VSs are not processes, but they can reference them. Processes are units of work at different levels of granularity or contexts. VSs use information provided by stakeholders as inputs, or other VSs, and utilize resources from service providers and service consumers to generate outputs required to create outcomes demanded by the stakeholders. The key objectives are maximizing value generation and minimizing waste.

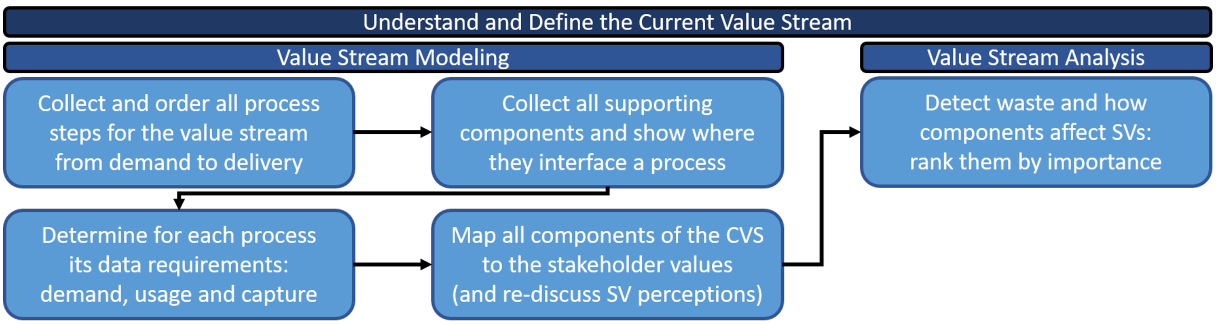


Figure 5.3.: *its*VALUE Approach Model: Define the CVS

If a VS already exists, it must be modeled, understood, and analyzed before it can be improved. The second phase of our *its*VALUE method (see Figure 5.3) addresses these issues (R3). We roughly follow the approach model of VSA 4.0 by Meudt et al. [85], as recommended by Hartmann et al. [50, 51] for VSM 4.0, which we also adopt for our *its*VALUE framework. This second method phase is divided into two sub-components: VS modeling, described in Section 5.2.2.1, and analysis, described in Section 5.2.2.2. Although these components are distinct, both provide new insights into VS performance.

5.2.2.1. Modeling and Connecting the CVS with the SVs

In the first step of VSA 4.0, any process, action, or activity that is part of the CVS should be collected and ordered from the initial demand to the final delivery (cf. Hartmann et al. [50,51]). Instead of using the visual representation of VSD 4.0 proposed by Hartmann et al. [50,51], we developed the VSB for the visual representation of the VS. It is described more precisely in Section 5.4.3. Basically, it is a combination of IT S-SB and VSMN that can be used to model VSs. If any records already exist on the VS investigated (e.g., process models of any other language, Microsoft Excel files, etc.), they should be used and considered for the collection of all activities that are actually part of the VS.

After all processes, activities, and actions have been collected, we combined the 2$^{\text{nd}}$ and 3$^{\text{rd}}$ steps of VSA 4.0 into a single step. At this stage, all additional components (e.g., storage media, IT systems, physical evidence, information, waiting times, etc.) should be collected and connected to the processes, activities, and actions they are used or required at (R6). This step can also be carried out using a VSB. It combines steps 2 and 3 known from VSA 4.0 by Hartmann et al. [50, 51].

Afterwards, the required data for each process or activity should be defined (step 4 of VSA 4.0). The following information for each desired or captured data should be specified: *desired (yes/no)*, *captured (yes/no)*, *used (yes/no)*, and *acquisition (automatically/manually)*. Collecting this information for each data point of each process or action allows for the calculation of KPIs for VS analysis (cf. Section 5.2.2.2). According to Meudt et al. [85] and Hartmann et al. [51], these KPIs (DR, DA, and DU) assist detect waste.

Next, we advise mapping all components of the CVS to the VPMs created earlier (R4, R5). The VPMs describe SVs belonging to their stakeholders. To map these VPMs with all components that are part of the CVS, each component should be analyzed with regard to its actual effects on any SV. This identification provides awareness and understanding of the CVS and SVs. It is possible to detect hidden, indirect effects of components in the VS on the value perceptions as well as new value perceptions (e.g., if a customer demands shipments within 24 hours and a process, which is hidden to the customer, of the VS requires more than 30 hours, that particular process affects that SV negatively, as it crucially prevents shipments being carried out in under 24 hours). While new value perceptions should be added to the respective VPM, an indirect effect will be further investigated in the analysis step. Additionally, it may be reasonable to re-discuss what close stakeholders value, as they may not have considered each aspect of the CVS and its components to define what they desire in the beginning (i.e., in the phase illustrated by Figure 5.2). We derived this step from the key idea of the DVD method, as it provides an overview of how an actor is influenced by other model components. Moreover, positive and negative value propositions can be defined (like in VDML).

5.2.2.2. Analyzing the CVS: Detection of Waste and Ranking

In this step, waste inside the CVS and potential improvement spots are detected (steps 5 and 6 from VSA 4.0 by Hartmann et al. [50, 51], R4, R7). Besides cycle time analysis from "traditional" VS analysis, we distinguish between the analysis of data processing and the analysis of stakeholder perspectives. Generally, the analysis concentrates on VS components that cause poor performance in value delivery (e.g., long idle times, increased effort, or general obstacles) and are thus considered wasteful or as producing "Waste". *its*VALUE provides different mechanisms of waste detection. With regard to data processing, the VSB allows identifying missed digitization potentials and mismatches between information demand and provision. Furthermore, waste can be detected and analyzed based on the mapping to SVMs. Both analysis mechanisms are explained in the following. A third implemented mechanism for waste detection uses timing information to identify, for example, idle times. For reasons of brevity, it is not further described.

Data Processing: Meudt et al. [84] conducted a SLA on how the term "waste" is understood in the literature regarding VSs. They concluded that data is the key aspect for investigating waste in a VS and that data can generate waste regarding its usage, acquisition, processing, and storage. They originated the DR, DA, and DU KPIs to indicate waste in data. According to Meudt et al. [85] and Hartmann et al. [51], these KPIs are calculated as shown in Figure 5.4. To calculate these KPIs for each process, gathering the relevant information is required (already addressed in Section

$$DR = \frac{\sum automatically\ acquired\ (and\ digitally\ captured)\ data}{\sum captured\ data}$$

$$DA = \frac{\sum captured\ data}{\sum desired\ data} \qquad DU = \frac{\sum used\ data}{\sum captured\ data}$$

Figure 5.4.: Calculating the DR, DA & DU, based on Hartmann and Meudt et al. [51,85]

$$RF: \begin{cases} 3 & \textbf{if} \ \text{"} Mandatory \text{"} \\ 1 & \textbf{if} \ \text{"} Moderate \text{"} \\ 2 & \textbf{if} \ \text{"} High \text{"} \\ 3 & \textbf{if} \ \text{"} Outstanding \text{"} \end{cases} \qquad CPL: \begin{cases} -3 & \textbf{if} \ \text{"} Poor \text{"} \\ 1 & \textbf{if} \ \text{"} Moderate \text{"} \\ 2 & \textbf{if} \ \text{"} High \text{"} \\ 3 & \textbf{if} \ \text{"} Outstanding \text{"} \end{cases}$$

$$IF: \begin{cases} \frac{1}{2} & \textbf{if} \ \text{"} Low \text{"} \\ 1 & \textbf{if} \ \text{"} Moderate \text{"} \\ \frac{3}{2} & \textbf{if} \ \text{"} High \text{"} \end{cases}$$

$$VW = RF \times CPL$$

Figure 5.5.: Variable Assignments & Calculating the VW of a SV

5.2.2.1). If the DR is lower than 1, the process has the potential to become more automated and thus effective. If the DA is not equal to 1, the process receives either not enough required or too much unnecessary data. If the DU is lower than 1, the process captures unnecessary data. To conclude, with every KPI close to or even equal to 1, a process produces very low or even no waste.

According to Meudt et al. [85], Hartmann et al. [50, 51], and Heger et al. [52], waste in transferring data or information can be caused by media breaks. This is critical for information flows, as a media break causes manual processing of data from one media type to another. Therefore, we designed a way to visualize media breaks inside a VSB introduced in Section 5.4.3 (the DR can detect hidden media breaks). Moreover, if a process is decomposed, that major process must contain all data information of its sub-processes. If a sub-process of another decomposed process requires such data, this guarantees it receives those data. However, if such a decomposed process is optimized, it does not mean that the major VS is optimized as well. Hence, the entire VS should receive the highest attention.

Stakeholder perspectives: ITIL 4 demands that each VS activity generates more value than it consumes, as consumed value means costs that can be calculated for value

Algorithm 1: Calculating the S Score & H Score of a VS component

set $S,\ H : 0$
foreach *affectedObject* **do**
    if $(\mathit{affectedObject} \in \mathit{Value})$ **then**
        set $\mathit{eachResult} : VW_{\mathit{affectedObject}}$
    if $(\mathit{relationType} \in \mathit{Supports})$ **then**
        if $(\mathit{affectedObject} \notin \mathit{Value})$ **then**
            set $\mathit{eachResult} : S_{\mathit{affectedObject}} \times \frac{1}{2}$
        if $(\mathit{eachResult} < 0)$ **then**
            set $\mathit{eachResult} : \mathit{eachResult} \times -\frac{1}{3}$
        set $S : S + (\mathit{eachResult} \times IF_{\mathit{relationType}})$
    else if $(\mathit{relationType} \in \mathit{Hinders})$ **then**
        if $(\mathit{affectedObject} \notin \mathit{Value})$ **then**
            set $\mathit{eachResult} : H_{\mathit{affectedObject}} \times \frac{1}{2}$
        if $(\mathit{eachResult} > 0)$ **then**
            set $\mathit{eachResult} : \mathit{eachResult} \times -\frac{2}{3}$
        set $H : H + (\mathit{eachResult} \times IF_{\mathit{relationType}})$
end
return S, H

delivery activities (waste is negative revenue from an activity). But in the service domain, implicit non-economic values are also possible and deliverable. Thus, these values are generally not quantifiable in terms of costs and revenues. The VPM mostly describes this unquantifiable type of value. Thus, *its*VALUE does not focus on the detection of negative revenues. Instead, we concentrate on the identification and analysis of waste based on the RF, CPL, and dependencies inside the VPMs.

Therefore, we developed an algorithm to detect how each component of a VS supports and hinders SVs (see Algorithm 1). With the Supporting Score (S Score) and Hindering Score (H Score) of such a component, we defined two new KPIs addressing this issue. As we do not consider economic values, we are not dealing with a metric scale. A direct calculation of created value against detected waste or negative influences on the delivery of certain SVs is problematic. Hence, the interpretation of both is left to human analysis. Whereas the S Score provides the created SV attributed to a VS component, the H Score provides the waste attributed to that component. Consequently, it is possible to identify components that create substantial value, components creating no value at all, and components creating waste by nonperformance or hindering the creation of value. The default S Score and H Score of a component should always be *0*, as this calculation requires every component to (at least implicitly) affect one SV, which may not always be the case. The calculation is based on the VW (see Figure 5.5). As we do not have any further empirical evidence than our derivation from the classification of Nerdinger [93] (see Section 5.2.1), we keep the calculation as simple as possible. For this purpose, we assigned only the values *1*, *2*, and *3* to the RF, indicating different relevance. Further, we assign *Outstanding* success SVs as relevant as *Mandatory* hygienic SVs, as the *Mandatory* hygienic ones are fundamentally required for the *Outstanding* ones to fully activate their potential. Moreover, we retained these values for the CPL, with the exception of *Poor*, which we changed to the value of *-3*. Thereby, we want to highlight poor-performing SVs and thus waste through the value consumption in the sense of ITIL 4. In addition to the ratings of the VPM, an Impact Factor (IF) of a component affecting service delivery can be specified for fine-tuning (see Figure 5.5 and Algorithm 1, lines 10 & 16). For the IF, we consider a *Low* influence by halving, a *Moderate* by remaining, and *High* influence by adding the half. Thereby, the IF influences the S Score or H Score of a component equally, just linearly.

Based on the VW, the S Score and H Score are calculated considering direct and indirect support and hinder relations in the model. If a component directly affects a SV, the calculation of its S Score and H Score requires the VW of that SV (see Algorithm 1, lines 3-4). Conversely, if a component directly affects another component, the calculation of its S Score and H Score requires half of the already calculated S Score or H Score of that other component (see Algorithm 1, lines 6-7 & 12-13).

Moreover, we want to ensure that a supporting component always receives a positive S Score and a hindering one a negative H Score. Thus, we calculate the intermediate result times a negative factor if it is negative itself with a supporting relation or if it is positive but with a hindering relation. For the first case (see Algorithm 1, lines 8-9), this negative factor is only half of the factor for the second case (see lines 14-15). If a process supports a SV whose CPL is still assigned as *Poor*, that process still receives $+\frac{1}{3}$ of the VW to its S Score, as that process still contributes value to it. Conversely, if a process hinders a SV whose CPL is still assigned as *High*, that process still receives $-\frac{2}{3}$ of the VW to its H Score, as that process consumes value from it. As this is a form of waste in the sense of ITIL 4 [12], we want to highlight any hindering components more crucially than supporting components that still do not deliver enough satisfaction. Generally, considering the S Score and H Score separately for each stakeholder may be reasonable to get a broader understanding of how SV is specifically created for whom.

Ranking of Potential Improvement Spots: Once waste in a CVS is detected, Meudt et al. [85] recommend ranking all identified spots that could be enhanced to identify the most crucial or relevant problems and solve them first. They advise either starting with so-called *bottleneck processes* or those processes having the lowest KPIs. Bottleneck processes are processes that limit the performance of the entire VS, as they are limited themselves but also key to the flow of the VS. Consequently, such bottleneck processes can also be considered as waste. However, according to Sengupta et al. [121], bottleneck processes are primarily considered in manufacturing sectors, as they appear where actual machines have a limited amount of resources for processing materials. Moreover, Meudt et al. [85] do not advise any technique to systematically identify them in the field of IT. Thus, we do not investigate any bottleneck processes in this work and primarily follow the KPIs previously described.

The KPIs previously described are used to identify potential improvement spots. Further, key SVs can be identified, showing which SVs or key components require enhancements the most. Those SVs having a low CPL and high RF also embody a high potential for improvement. Therefore, the S Score and H Score of all affecting components can be considered as well. If they do not support those SVs or even hinder them, they embody a high potential for improvement. This could reveal which specific development actions are required to directly enhance any SV.

We also recommend to consider the created SVMs (see Sections 5.2.1 and 5.4.2), as it helps to avoid missing any problematic dependencies or relations between several SVs. Understanding those relations might assist in identifying the best development actions to enhance as many SVs as possible. Furthermore, the data processing KPIs can be used to identify media breaches and other problems in the data supply.

5.2.3. Enhance SV: Define the Future Value Stream (FVS)

Once a CVS is understood and explicitly defined, that particular CVS should be enhanced (R7). The result of this is a Future Value Stream (FVS) supporting SV better than the

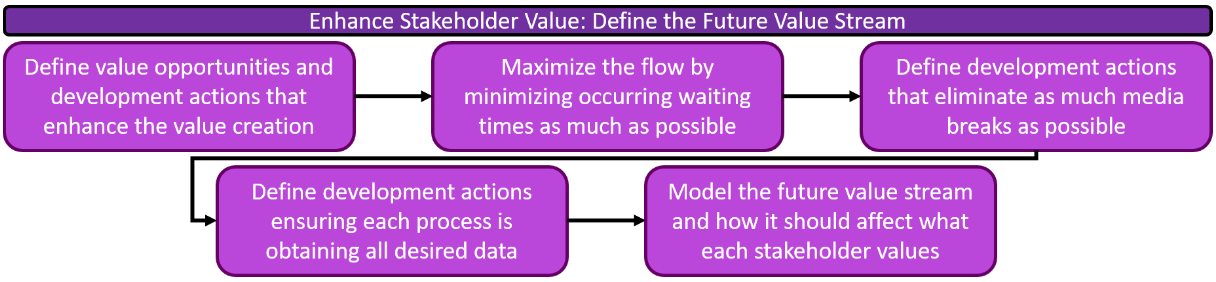


Figure 5.6.: *its*VALUE Approach Model: Define the FVS

CVS. This originates from 4EM by Sandkuhl et al. [117], VSM 4.0 (in particular the VSD 4.0 by Hartmann et al. [50,51] and the VSA 4.0 by Meudt et al. [84,85]). Figure 5.6 shows the corresponding sub-framework.

After analyzing the selected current state (previously addressed in Section 5.2.2), 4EM advises defining development actions followed by modeling a future state satisfying these demands for change, which is also recommended by VSM 4.0. The already created SVM can be used to define further information like opportunities, problems, constraints, or causes to sharpen the general scope of improvement to be planned, as 4EM also provides this possibility for its GPM from which we derived our SVM. Thus, opportunities regarding poorly performing SVs should be defined in the SVM. Development actions explicitly affecting components that impact SV could be defined in the VPMs.

Additionally, VSD 4.0 by Meudt et al. [84, 85] provides more specific recommendations a company should follow to enhance their VSs. It recommends maximizing the flow of the VS, especially by avoiding as much waiting time as possible. Moreover, VSD 4.0 advises performing this activity early, as this enhancement technique already provides the potential of eliminating "wasteful" processes before wasting extra efforts in improving them with further enhancement techniques. According to Hartmann et al. [50, 51], the major scope of this step is material flows. Material goods should "flow" as much as possible through the VS to avoid unnecessarily filling any inventory. Although material flows are not as important as information flows in IT services, this first enhancement technique should be considered when dealing with material goods. Moreover, even information flows can be hindered from continuous flow. For instance, processes that have a huge buffer may limit the VS by creating unnecessary waiting times. Further, investigating the importance of those processes or other VS having a negative H Score or S Score equal to 0 might be considerable and to be discussed by the particluar modelers.

As VSD 4.0 primarily focuses on industrial VSs in the field of manufacturing, its next enhancement technique also focuses primarily on material flows. At this stage, it advises enhancing the material flows with digital solutions. Its first recommendation is identifying root causes hindering continuous flow. For this purpose, it provides an improvement matrix consisting of recommendations for both material and information flows with both digital and analog approaches.

For information flows, avoiding media breaks seems to be the most important aspect. As media breaks require manual processing of the information from one media to another, they immediately prevent a continuous and uninterrupted flow of information. If media breaks are not preventable (e.g., when transferring data from a web service to an ERP system), this originally manual task could be performed automatically by interfaces between those different systems. However, this requires a high level of standardization of the information that needs to be transferred. Otherwise, an interface is hard to develop and very prone to failures.

For material flows, VSD 4.0 also recommends using a high level of standardization to enable digital systems to process material goods automatically and with minimal failure. Moreover, VSD 4.0 advises visually combining smaller processes that are already improved and achieve a continuous flow into greater processes. These greater processes then embody all previous smaller processes that are now continuously and automatically performed. 4EM addresses this domain by introducing a *decomposition* of processes, which we adapted to *its*VALUE as well. Such a decomposition enables creating a sub-VS of a single process of the original VS. The resulting sub-VS contains all processes and activities that are part of the single process in the original VS. Moreover, VSD 4.0 recommends installing pull systems instead of push systems wherever a continuous flow is not possible at all.

Next, VSD 4.0 advises integrating the *product information flow* and *process information flow* as much as possible. VSD 4.0 understands product information flows as information flows directly affecting the outcome of a product (e.g., drawing data, design data, or machine programs). Conversely, process information flows are those flows not bound to but independent from a specific product (e.g., monitoring KPIs or status data).

For integrating product information flows and process information flows, VSD 4.0 recommends addressing the requirements of each process separately to underline their importance for a continuous flow. For each process, development actions should be defined to satisfy all needs of each process regarding DR, DA, and DU, as better KPIs indicate a successful reduction of waste. This also includes considering the requirements of all supporting functions a process requires. Consequently, this implicitly determines the information that should be provided by a process to satisfy the requirements of its following processes. Moreover, how required data and information are stored and accessed by those processes should be explicitly defined.

Lastly, the FVS is modeled. For *its*VALUE, this implies not just modeling the VSB but also future versions of all VPMs and the SVM. After modeling the FVS, a new iteration of the *its*VALUE method is recommended to find unwanted side effects and iteratively refine them. However, we advise revising each service modeled with *its*VALUE on a regular basis, as ITIL 4 [12] underlines the importance of achieving high business flexibility to be able to adapt to rapidly changing demands and requirements and to sustainably satisfy all stakeholders' needs and desires.

One should explicitly determine a future state to define how the analyzed case should be after performing all decided enhancements. For *its*VALUE, this implies not just modeling a FVS using a VSB but also future versions of all VPMs and the SVM. Depending on the planned enhancements, the FVS should differ from the CVS regarding its flow and components. These changes should be applied to the new versions of the VPMs and SVM to explicitly define how each SV should be affected and perform after the enhancements. After these enhancements have been applied, this needs to be checked, possibly resulting in a new iteration of the *its*VALUE method. However, we advise revising each service modeled with *its*VALUE on a regular basis, as ITIL 4 [12] underlines the importance of achieving high business flexibility to adapt to rapidly changing demands and requirements and to sustainably satisfy all important stakeholders' needs and desires.

5.2.4. Create an Initial Value Stream (VS) Supporting SV

In service design, it might be necessary to develop a new service. This includes modeling a new VS that immediately supports SV with as little waste as possible (see Figure 5.7, R7). In such a case, this step follows the contents of Section 5.2.1. Moreover, this step involves interweaving the design and analysis of the new VS to minimize the effort required to find solutions for problems identified later. In contrast to all previously introduced phases (see Sections 5.2.1, 5.2.2, and 5.2.3), this current section 5.2.4 has no already proposed source we derived it from. Instead, we drafted it by integrating the techniques previously introduced in Sections 5.2.2 and 5.2.3, which we originated from VSM 4.0 by Hartmann et al. [51]. Hence, we refer in this section to the respective parts of these sections instead of introducing them again.

The first step of this phase is a combination of the first steps of Section 5.2.2 (the definition of value opportunities) and Section 5.2.3 (the collection of all processes required for the VS). Each potential process of the new VS should be immediately evaluated regarding its effects on the defined SVs and its reasonability for value creation in the sense of achieving a continuous flow as proposed by Hartmann et al. [50, 51] (see Section 5.2.3). If a process is already considered not beneficial to any SV or as hindering the continuous flow of the VS, a company should leave that process out directly from the beginning.

Each process should be carefully considered, as the VS should become as lean as possible. For this purpose, the second step of this phase focuses on a similar domain as the second step of Section 5.2.3 (minimizing waiting times). Potential waiting times should be eliminated or at least minimized, as they embody waste by decreasing the efficiency and potentially the effectiveness of a VS in the sense of Meudt et al. [84]. The leaner and smarter a VS is, the more efficiently it performs.

The third step of this phase is a combination of the third step of Section 5.2.2 (define data requirements) and the fourth step of Section 5.2.3 (development actions for data requirements). Once each necessary process has been identified, the data and information requirements for each one of them should be defined to directly aim for good KPIs (see Section 5.2.2.2) by considering and delivering each requirement from the beginning.

To assist this, the fourth step of this phase is a combination of the second step of Section 5.2.2 (identifying supporting components) and the third step of Section 5.2.3 (development actions to avoid media breaks). Reasonable and effective (i.e., providing a supporting influence on SVs) supporting components should be identified and connected to all processes

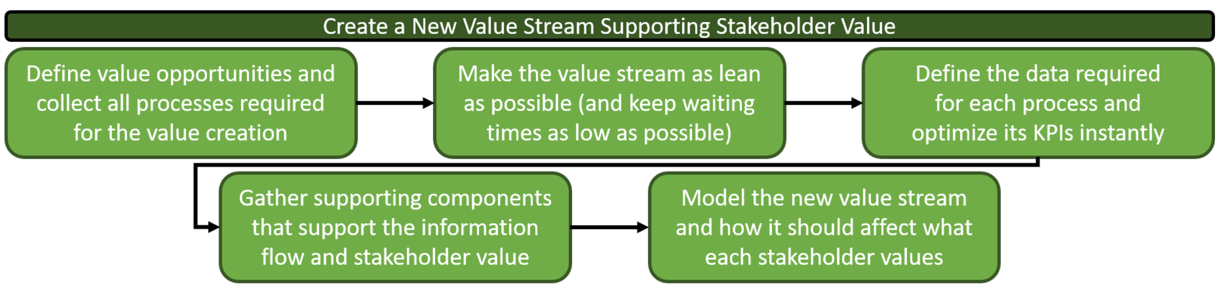


Figure 5.7.: *its*VALUE Approach Model: Define a new VS

requiring or dealing with data. If multiple different systems are required, the elimination of potential media breaks should be addressed as best as possible by considering providing interfaces between different IT systems and avoiding analog information.

Lastly, a combination of the fifth steps of Section 5.2.2 (mapping of the VS components and SVs) and Section 5.2.3 (modeling the future state) should be performed to explicitly define how each SV should be affected and perform with this new VS. As argued at the end of Section 5.2.3, this initial FVS should be checked by entering and performing a new iteration of *its*VALUE (leading to following the steps of Sections 5.2.2 and 5.2.3).

Especially, a reconsideration of what close stakeholders value should be performed to ensure not missing out any forgotten or even new value perceptions important for the service and its value creation (as argued at the end of Section 5.2.2). In combination with considering the findings of Geist [44], this underlines the reasonability of performing further *its*VALUE iterations before actually launching the service.

5.3. Conceptualizing *its*VALUE

This section introduces the *its*VALUE meta-model, designed to facilitate the adoption and use of the method (R1-7). The meta-models, represented using the UML standard, serve as conceptual frameworks for the *its*VALUE modeling language. We utilized class and object diagrams in UML, as they provide all necessary concepts and relations (e.g., inheritance, associations, abstract classes, properties, etc.). Additionally, we aimed to model our meta-models similarly to ontologies.

According to Staab et al. [127], an ontology formally describes concepts and their relationships. Unlike object-oriented approaches that provide procedural knowledge (e.g., the operational properties of a class), an ontology delivers declarative knowledge (e.g., the structural properties of a class). Since the concepts we derived from our sources do not explicitly require operational properties, we primarily focus on explaining these structural properties in our notation. Therefore, we follow the ontological approach. However, we have included some operational procedures in our prototype to enhance usability and value for the users of *its*VALUE (addressed in Section 5.4, R8).

By incorporating established concepts from approaches like 4EM and VSD 4.0, the method ensures comprehensibility and reduces the learning effort. Consequently, not all concepts will be described in detail.

Section 5.3.1 presents the abstract notation of our method based on the meta-model, followed by the visual notation of the meta-model's concepts in Section 5.3.2.

5.3.1. The *its*VALUE Meta-Model

Figure 5.8 provides an overview of all *its*VALUE concepts. The most general concept is the abstract class *itsVALUE Object*, which provides each concept with a name. Besides the decomposition concepts, every concept carries a Description attribute.

Decomposition Objects provide special semantics for decompositions within a visual model, while *Decomposable Objects* can be decomposed into linked sub-models. These sub-models implement Decomposition Objects among other concepts to specify the de-

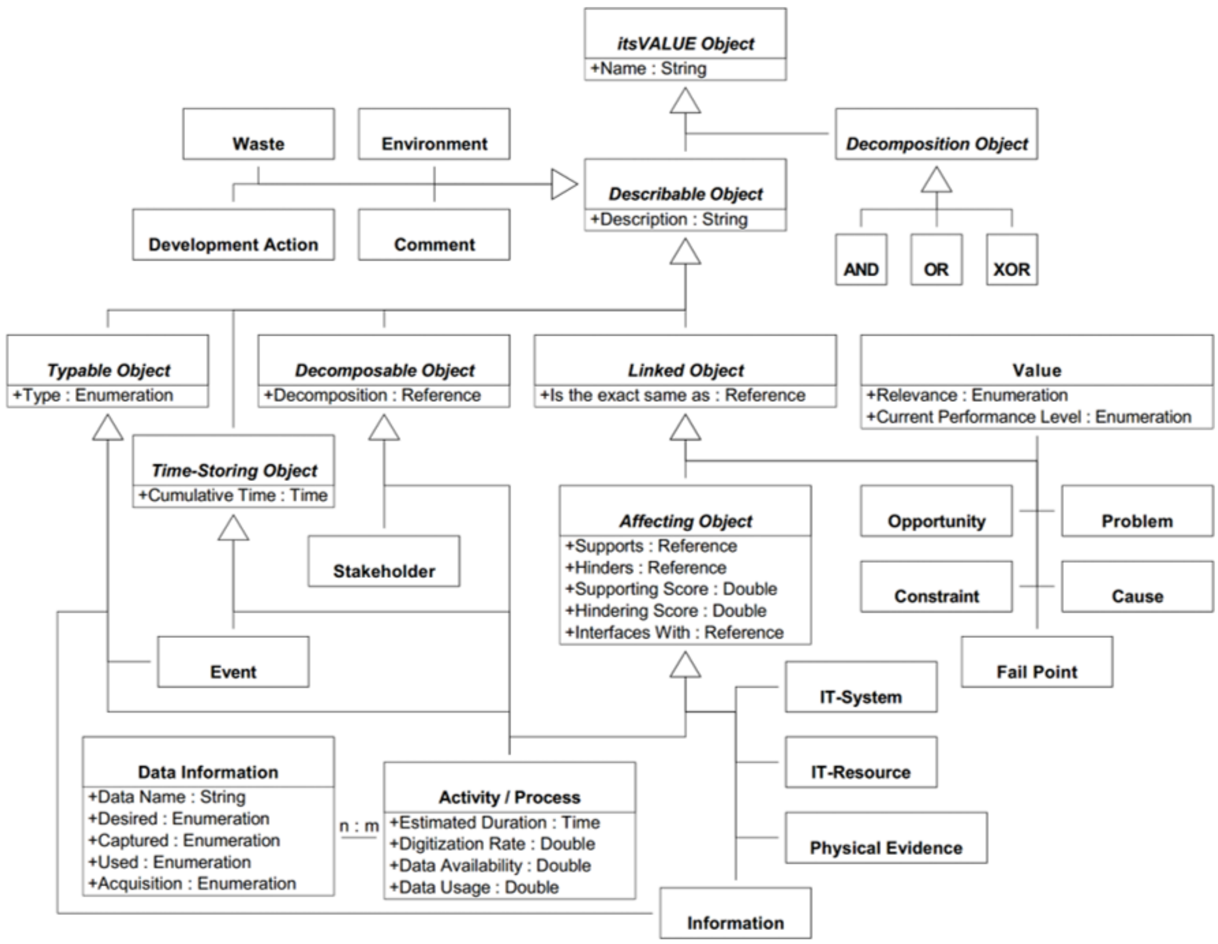


Figure 5.8.: *its*VALUE Meta-model: Concepts

composition. Concepts inheriting from Linked Object can be linked to identical instances in different models.

Affecting Objects (VS Components) can influence SVs and receive a S Score and H Score. They can also be related to other Affecting Objects, allowing processes to connect with supporting components of a VS. Activity / Processes objects can be assigned to multiple Data Information objects, providing all required data to calculate the DR, DA, and DU for a process. Moreover, Processes and Events are *Time-Storing Objects*, explicitly tracking the time consumption of a VS in the sense of Heger et al. [52].

Additionally, *Typable Objects* can be further specified: Activity / Process (not specified, information-related, or material-related), Information (analog, digital input, or digital output), and Events (start, common, or end). Instances of the Value concept receive a RF and CPL.

Figure 5.9 shows the *its*VALUE relation concepts. The most general relation concept is the abstract *itsVALUE Relation*, which provides each relation with a name and description attribute. *Time-Containing Relations* provide explicit tracking of the time consumption of a VS. Unlike *Time-Storing Objects*, we understand the Estimated Duration of a relation as a time buffer in the sense of Heger et al. [52]. By applying this property to relations, we avoid introducing a separate buffer concept, thereby increasing comprehensibility and decreasing the complexity of *its*VALUE.

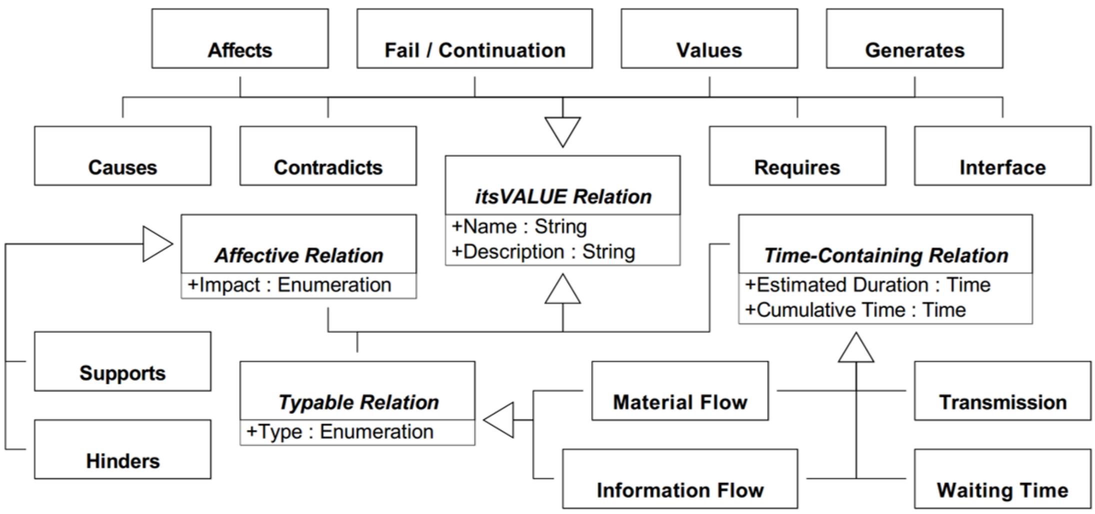


Figure 5.9.: *its*VALUE Meta-model: Relations

Some relation concepts inherit from *Typable Relation*, providing them with more precise specifications: Material Flow (Push or Pull) and Information Flow (Product Information Flow or Process Information Flow). Further, relation concepts inheriting from *Affective Relation* receive an IF indicating the strength of their influence. However, the relation concept Affects is not an Affective Relation, as it represents a neutral affection. In contrast, both Supports and Hinders have clear characters of influence: Supports embodies positive affection on a SV, while Hinders embodies negative affection, representing waste in the sense of ITIL 4. Since Affects does not have a specific connotation, its positive and negative affections can be considered as 0, and it does not require any IF, as their product would always be 0.

Figure 5.10 shows the constraints for relation usage by specifying domains and ranges. For instance, any *itsVALUE Object* can be connected with any other *itsVALUE Object* with a relation of the class Affects. Conversely, only Activity / Processes objects can require specific Information.

We adhered to the ontological approach previously followed, using a visual representation similar to Resource Description Framework - Schema (RDF-S) in the sense of Decker et al. [27, 28]. According to them, Resource Description Framework (RDF) is a method for storing information in the form of statements. An RDF statement is a triplet consisting

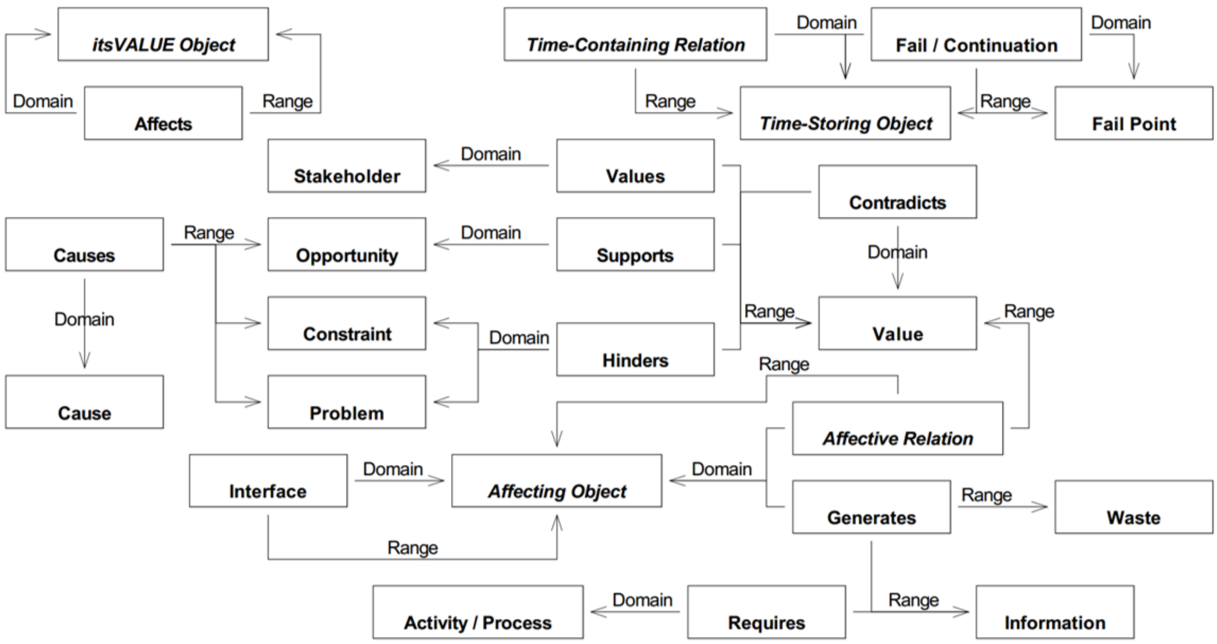


Figure 5.10.: *its*VALUE Meta-model: Relation Domains and Ranges

of a *subject*, *predicate*, and *object*, determining the connection between the subject and the object by the predicate.

For Figure 5.10, we consider each instance of an object concept from Figure 5.8 as an RDF subject or object and each instance of a relation concept from Figure 5.9 as an RDF predicate. To define this properly, RDF-S is required. According to Decker et al. [27,28], RDF-S specifies a data model for defining such RDF statements. RDF-S allows defining the domain (the object the relation is outgoing from) and range (the object the relation is incoming to) of a predicate. Adapted to our meta-models and especially Figure 5.10, this results in every single relation concept receiving at least one domain and range. These RDF-S-like statements finitely define all possible connections between instances of object concepts from Figure 5.8 with instances of relation concepts from Figure 5.9. For instance, any *itsVALUE Object* can be connected with any other *itsVALUE Object* with a relation of the class Affects. Conversely, only Processes can require specific Information.

Figure 5.11 presents an overview of *its*VALUE model types, illustrating the concepts and relations they encompass. Many concepts and relations appear in multiple model types (e.g., Value is part of both SVM and VPM), highlighting the importance of inter-model relations, especially for identical instances of the same object across different models. Consequently, our meta-models for *its*VALUE are not segregated by individual model

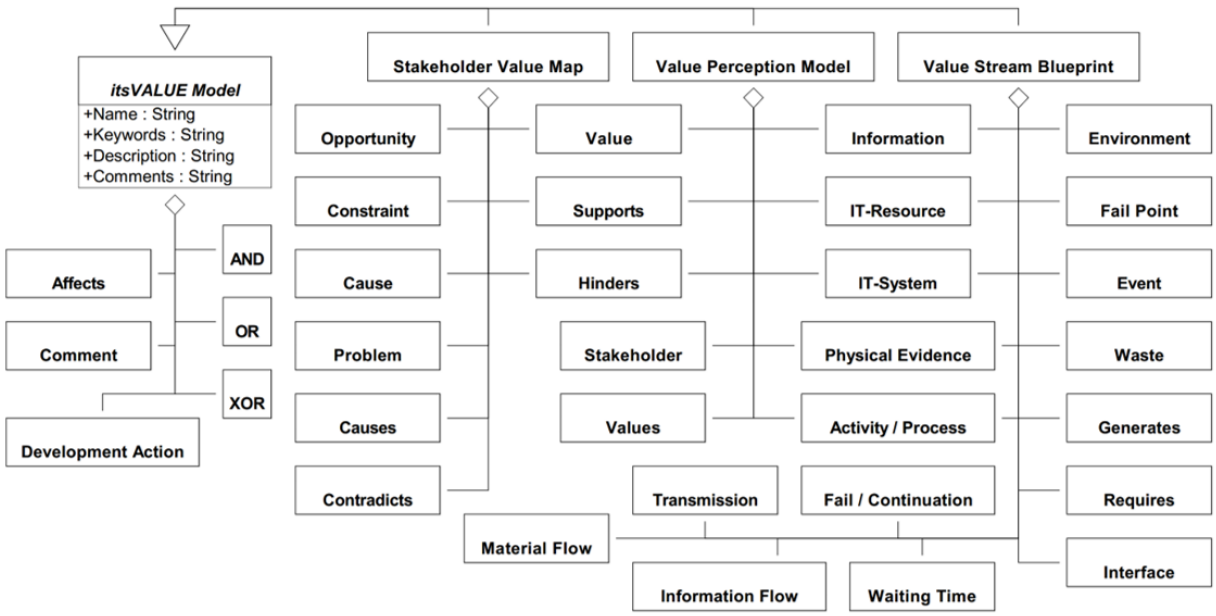


Figure 5.11.: *its*VALUE Meta-model: Model Types

types. The concepts of Development Action, Comment, AND, OR, XOR, and Affects relation are integral to any *its*VALUE model type.

We derived the Comment and Development Action from 4EM. According to Sandkuhl et al. [117], it is beneficial to provide users with the ability to easily add additional information they wish to visualize in any model. The Affects relation is used to connect Development Actions or Comments with any other object type, as we consider the Affects relation to be entirely neutral. Furthermore, we incorporated AND, OR, and XOR from BPMN and 4EM to allow users to define decompositions in any model (e.g., combining multiple relations of the same type into one to reduce the visual complexity of a model).

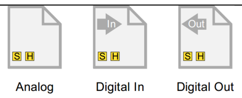
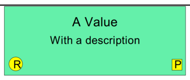
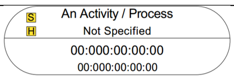
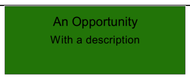
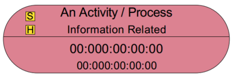
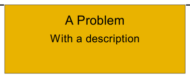
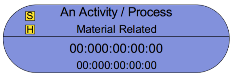
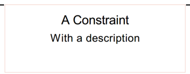
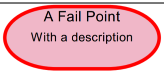
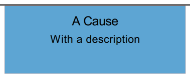
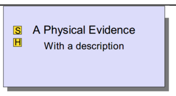
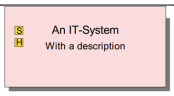
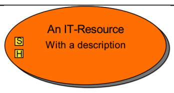
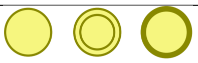
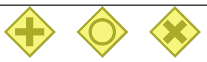
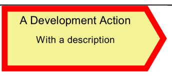
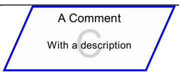
Concept	Visualization	Concept	Visualization
Information		Stakeholder	
Environment		Value	
Activity / Process		Opportunity	
(Information Related)		Problem	
(Material Related)		Constraint	
Fail Point		Cause	
Physical Evidence		IT-System	
Waste		IT-Resource	
Event (Start/Usual/End)		AND/OR/XOR	
Development Action		Comment	

Table 5.1.: Visual Representations of the Object Concept Classes

Concept	Visualization	Concept	Visualization
Fail / Continuation	F/C	Affects	A
Transmission		Generates	G
Interface		Requires	R
Material Flow (Push)		Supports	+
Material Flow (Pull)		Hinders	-
(Product) Information Flow		Contradicts	#
(Process) Information Flow		Causes	!
Waiting Time		Values	

Table 5.2.: Visual Representations of the Relation Concept Classes

5.3.2. The *its*VALUE Visual Notation

For drafting the visual representations of each object concept and relation concept that is part of a model type of *its*VALUE (see Figure 5.11), we adhered closely to the visual representations of 4EM, BPMN, IT S-SB, and VSMN. These notations are familiar in enterprise modeling, supporting the principle of *Cognitive Fit* of the visualizations by Moody [90]. Tables 5.1 and 5.2 provide an overview on all visualizations.

Instances of the concept of Data Information from Figure 5.8 only appear as records within a table, which is a property of every Activity/Process. Any property of a concept can be accessed through a specific view on each instance, known as the *"Notebook"*. For example, the references an instance may have to other instances are provided as a list. Additionally, the S Score and H Score of an *Affecting Object* are presented as floating-point numbers. Furthermore, any property of an instance can be modified within the notebook, allowing the user to adapt the instance freely to their purposes. Figure 5.12 provides an exemplary notebook of an instance belonging to the concept of Activity / Process.

*its*VALUE complies with the *principle of semiotic clarity* [90], as we assigned each semantic construct an individual graphical representation. Furthermore, we adhere to the *principle of perceptual discriminability*, ensuring that every visual representation from Table 5.1 and Table 5.2 is clearly distinguishable by utilizing a wide variety of colors and shapes. This broad range of visual variables also supports the *principle of visual expressiveness*.

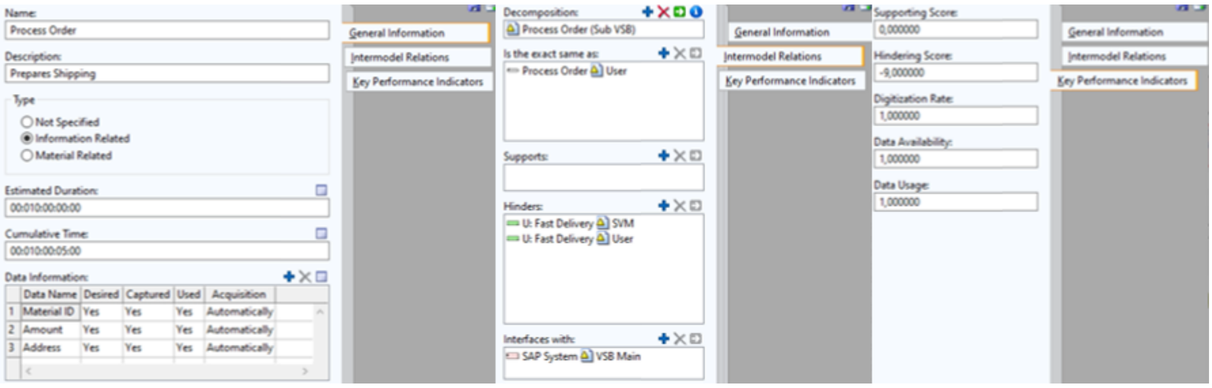


Figure 5.12.: Exemplary notebook of an *its*VALUE object

To follow the *principle of dual coding*, almost every concept includes visual text. Additionally, we added letters to small icons to provide further information for some instances. For example, the name of an instance and additional details like the description or letters such as ”R” for the Requires relation. For SVs, the circle in the lower left corner containing an ”R” indicates its RF, while the square in the lower right containing a ”P” for ”Performance” indicates its CPL by a specific color (red: *Mandatory* or *Poor*; yellow: *Moderate*; green: *High*; blue: *Outstanding*). For *Affecting Objects*, a square containing an ”S” indicates its S Score by color (S Score = 0: yellow; S Score > 0: green). Conversely, a square containing an ”H” indicates its H Score by color (H Score < 0: red; H Score = 0: yellow).

Further, *its*VALUE complies with the *principle of semantic transparency*, as the visual appearances suggest their meaning. For instance, stakeholders are represented by a group of three persons, information by letters, and relations like Supports with symbols indicating their influence (a ”+” indicating a positive influence). Elements inside the VSB can be nested to express a relation, even if not explicitly part of the meta-model.

Inside the VSB, components belonging to a specific environment should be placed inside that environment. Regarding the *principle of cognitive fit*, we designed each model type to work independently without any other linked models. If the audience decides to consider just the VS itself without any further SVs, the VSB still delivers valuable findings regarding its performance in a timely manner or data. Moreover, a VPM could be used independently to understand and define what generally affects a stakeholder’s value perceptions without focusing on a specific VS. The SVM could be used similarly.

The *principle of cognitive integration* is supported by providing the possibility to explicitly define inter-model relations by linking objects across several models. For instance, this enables tracking whether an *Affecting Object* supports or hinders a SV. This can even be displayed in a VSB, as every *Affecting Object* stores this information as a property.

To address the *principle of complexity management*, we adapted the decomposition mechanisms from 4EM for stakeholders and processes in *its*VALUE. To decrease the complexity of a VSB, a process can be decomposed into another VSB containing all subprocesses and components that are part of the decomposed process in the major VSB. The same applies to stakeholders and VPMs, with the option to reference multiple VPMs, as each sub-stakeholder should have its own VPM. However, such a mechanism is not applicable to the SVM. We consider a decomposition of SVs as not beneficial for effectively decreasing a SVM's complexity, as each stakeholder may already have multiple SVs that must be considered. However, since SVs are *Linked Objects*, multiple minor SVMs could be defined, each showing specific relations. To create a global view, all these different instances of the same SVs across all models can be linked.

Lastly, the *principle of graphic economy* remains the biggest challenge for *its*VALUE. This is particularly true for the VSB, which contains the most concepts of all model types. To address this, we omitted some original concepts from VSMN. Specifically, we excluded the buffer and integrated its information into the relations. Additionally, we removed the material and informational areas, only indicating where informational or material-related processes appear, as these processes already differ by their type. Furthermore, we eliminated the icon of the responsible employee from VSMN and all additional icons from IT S-SB to significantly reduce the total number of different objects.

5.4. Modeling and Analyzing with the *its*VALUE Modeler

This section provides an insight into the modeling and analysis of IT Service VSs using the *its*VALUE Modeler (R8). *its*VALUE defines three model types to collect and represent the resulting artifacts of the method components. Subsequently, we introduce each model type in more detail: VPM in Section 5.4.1, SVM in Section 5.4.2, and VSB in Section 5.4.3. The generation of these models is described in the respective method components. For each model type, we explain their construction, intended use, and the derivation of our conclusions from various sources. For this purpose, Table 5.3 provides a brief overview.

	Value Perception Model (VPM)	**Stakeholder Value Map (SVM)**	**Value Stream Blueprint (VSB)**
Purpose	Identify relevant Stakeholders, their values, and value delivery perceptions of the VS Components (Affecting Objects). (R2, R4, R5)	Understand and define the relations between different SVs. (R2)	Define and analyse AS-IS and TO-BE VS. Identification of involved Activity / Processes, Resources, and their relations. Mapping between VS Components (Affecting Objects) and SV. (R3, R4, R6, R7)
Main Concepts	Stakeholder, Value, Affecting Objects (Process, IT System, ...), Values, Affects	Value, Problem, Opportunity, Cause, Supports, Hinders, Contradicts	Activity / Process, Information Flow, Affecting Objects (Process, IT System, ...), Interface, Waste, Requires, Generates, Affects
Method Components	Understand and Define SV	Understand and Define SV	Understanding, defining, creating and improving VSs

Table 5.3.: *its*VALUE Model Types

Finally, we provide an overview of the *its*VALUE ADOxx Modeller with its implemented analysis functionalities in Section 5.4.4.

5.4.1. The Value Perception Model (VPM)

We derived the VPM from the key idea of the DVD method by Souza et al. [124–126]. VPMs provide stakeholder-centric views, with each stakeholder having its own VPM (R2, R4, R5). Figures 5.13, 5.14, and 5.15 present exemplary VPMs of the same fictional example. As shown in Figure 5.11 at the end of Section 5.3.1, a VPM consists of the following concepts and relations: Stakeholder, Value, *Affecting Objects* (Physical Evidence, IT-System, IT-Resource, Information, and Activity/Process), *Decomposition Objects* (AND, OR, and XOR), Development Action, Comment, Values, *Affective Relation* (Supports and Hinders), and Affects.

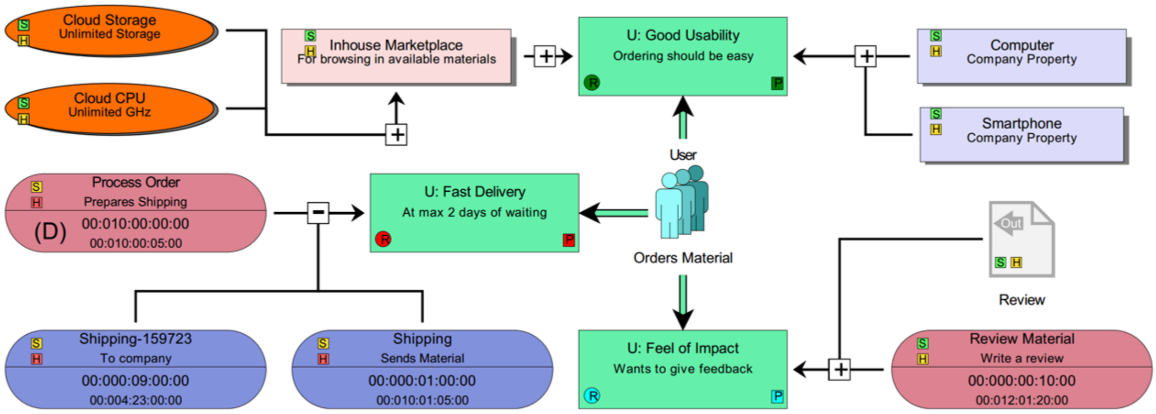


Figure 5.13.: Exemplary VPM of a User

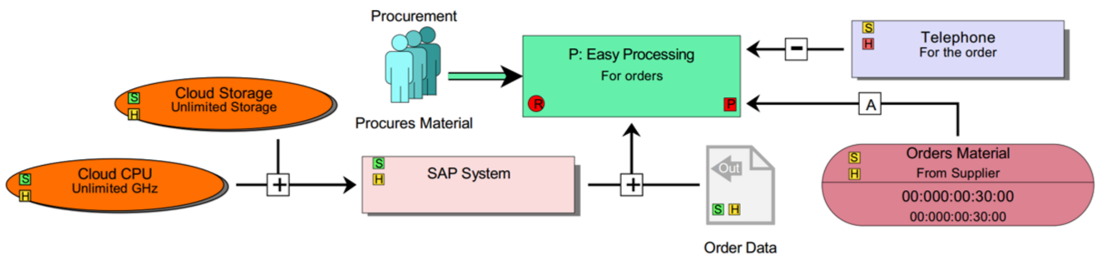


Figure 5.14.: Exemplary VPM of a Procurement Employee

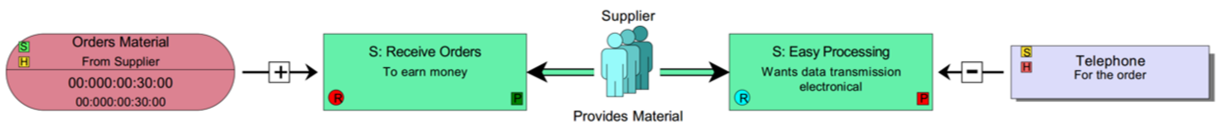


Figure 5.15.: Exemplary VPM of a Supplier

The core of every VPM is its stakeholder, connected to all of its SVs through the Values relation (R2). VS components can be related to SVs as *Affecting Objects* using Supports, Hinders, or general Affects relations (R4). Furthermore, *Affecting Objects* can influence other *Affecting Objects* and thus implicitly, via transitivity, SVs as well (R5). Based on these relations, a stakeholder-specific S Score and H Score can be visualized for each *Affecting Object*, showing how it influences those SVs for that specific stakeholder. For this purpose, their IF, as well as the VW and CPL of the SVs, can be defined. For instance, in Figure 5.15, the process "Orders Material" supports the SV "Receive Orders" belonging to a supplier. As this SV is mandatory to the supplier and performing well, the S Score of the process "Orders Material" is positive. Conversely, the H Score of the Physical Environment "Telephone" is negative. We derived the classifications for the SVs

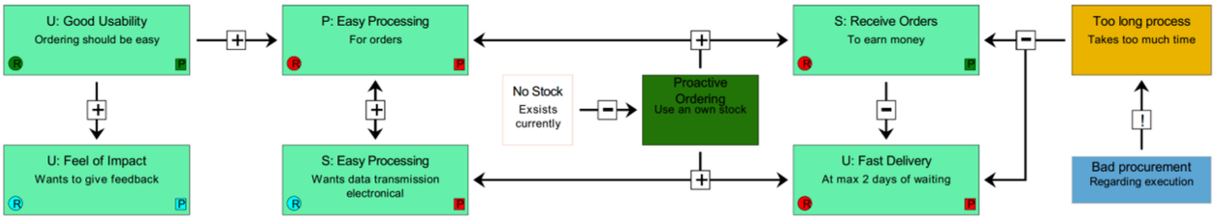


Figure 5.16.: Exemplary SVM for Figure 5.13, 5.14 and 5.15

from the VoPM by von Rosing et al. [143] and the concept of the goal from 4EM by Sandkuhl et al. [117]. The Development Action, Comment, and *Decomposition Objects* are not part of the examples in Figures 5.13, 5.14, and 5.15. To understand their universal application in *its*VALUE, please refer to the VSB in Figure 5.17 in Section 5.4.3.

Lastly, a stakeholder can be decomposed into several sub-stakeholders. For example, the stakeholder "User" could be further divided into specific user groups (e.g., male users, female users, young users, old users, etc.). If decomposed, each of these sub-stakeholders should receive its own VPM.

5.4.2. The Stakeholder Value Map (SVM)

Figure 5.16 provides an exemplary SVM containing all the different SVs from Figures 5.13, 5.14, and 5.15. Thus, it continues the completely fictional example from Section 5.4.1. As shown in Figure 5.11 at the end of Section 5.3.1, a SVM consists of the following object and relation concept classes: Value, Opportunity, Problem, Constraint, Cause, *Decomposition Objects* (AND, OR, and XOR), Development Action, Comment, *Affective Relation* (Supports and Hinders), Contradicts, Causes, and Affects.

he purpose of a SVM is to explicitly define the dependencies between the various value perceptions of all stakeholders involved (R2). Additionally, context information about influences on value delivery can be modeled using Opportunities, Problems, Constraints, and Causes. These concepts are adopted from the Goals Model of 4EM (cf. Sandkuhl et al. [117]). An Opportunity always supports SVs, whereas Problems and Constraints always hinder SV. A Cause always causes something, and only SVs can be contradictory to each other. If a SVM becomes too complex, it can be divided into several parts, with each part focusing on specific clusters of SVs independently from other clusters.

5.4.3. The Value Stream Blueprint (VSB)

We derived the VSB by combining IT S-SB by Bär et al. [120] and VSMN by Heger et al. [52]. Figure 5.17 provides an exemplary VSB, continuing the example from Sections 5.4.1 and 5.4.2. Additionally, Figure 5.18 shows an exemplary decomposition or sub-VSB of the process "Process Order" from the main VSB in Figure 5.17 (visually indicated by a "(D)" inside the process). As shown in Figure 5.11 at the end of Section 5.3.1, a VSB consists of the following concepts and relations: Environment, *Affecting Objects* (Physical Evidence, IT-System, IT-Resource, Information, and Activity/Process), Fail Point, Event, Waste, *Decomposition Objects* (AND, OR, and XOR), Development Action, Comment, *Time-Containing Relation* (Transmission, Waiting Time, Material Flow, and Information Flow), Fail/Continuation, Interface, Requires, Generates, and Affects. Its purpose is define and model VSs (both as-is and to-be), including all components part of it, and displaying waste (R3, R4, R6, R7).

In contrast to the fixed layers of a "traditional" SB, a VSB contains several horizontal lanes of Environments. This provides high flexibility in modeling, as the lanes can be chosen freely (similar to VSMN and in contrast to the very rigid SB). Additionally, flows can easily switch between these environments (like in SB and unlike other approaches such as VSMN). Although environments can be defined freely, we recommend maintaining at

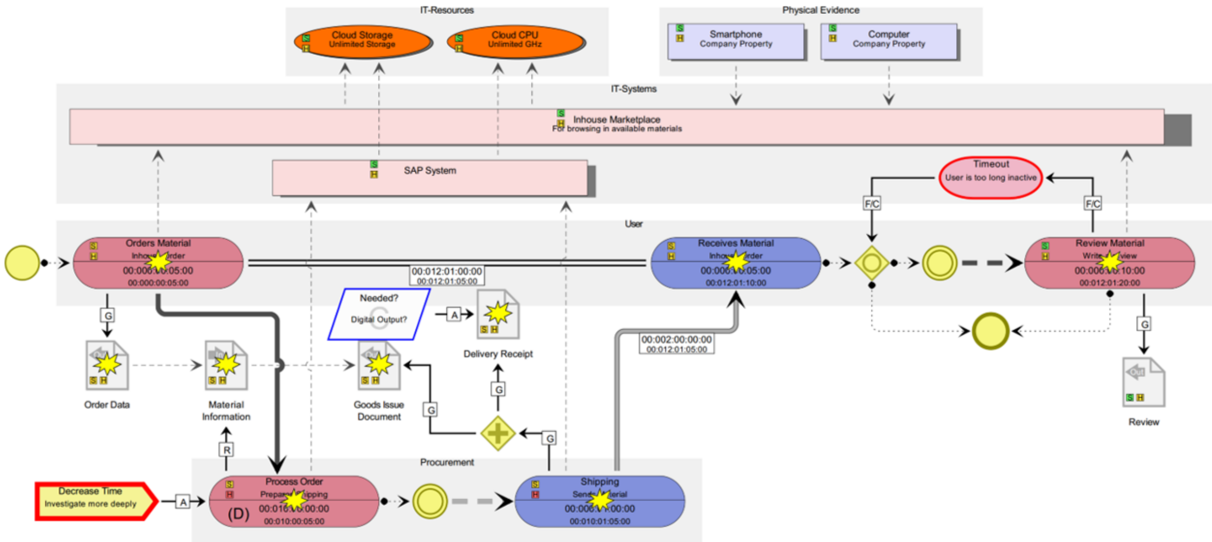


Figure 5.17.: Exemplary VSB for Figure 5.13, 5.14, 5.15 and 5.16

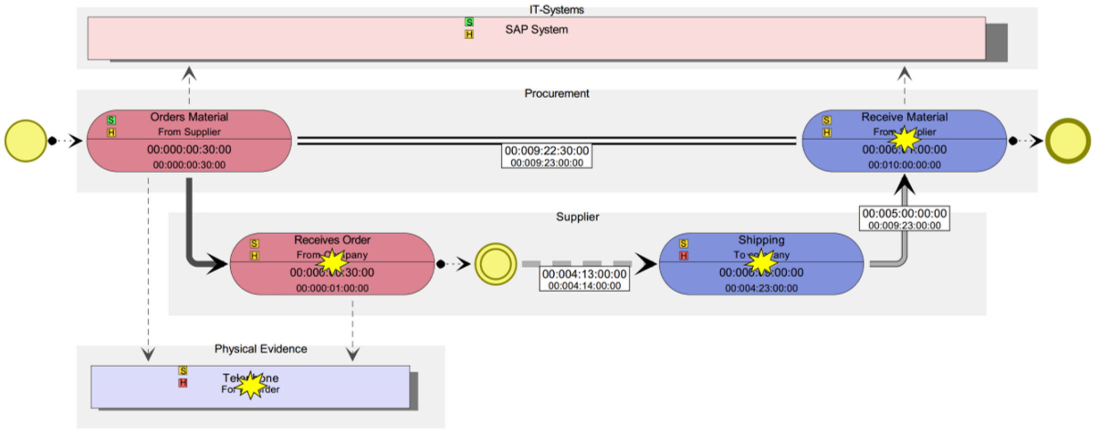


Figure 5.18.: Exemplary sub VSB for a Process of Figure 5.17

least the general order of a "traditional" SB. The higher the environment is positioned in the model, the more visible it is to the customer or user.

To design the flow within the VS, we adopted and amended the concepts of VSMN, extending them with some concepts from the IT S-SB ((R3, R7)). *Time-Containing Relations* include a buffer as "estimated duration" and the cumulative time that has passed in the VS so far. Processes visually provide this timing information, while Events store it. Generally, a VSB always starts with a "Start" Event and ends with an "End" Event. Events must be linked to a Transmission, indicating either the start, end, or switch of flow types within a VS. "Common" Events indicate a switch from a material flow to an information flow or vice versa. An Information Flow can be either a "Product" or "Process" Information Flow, and a Material Flow can be of the type "Push" or "Pull".

Furthermore, *Affecting Objects* can be linked by an Interface relation, indicating that one component uses the other (R6). For a process, this shows which components are used by that particular process. For supporting components, this shows in which processes they are actually used. For Information Flows, an Interface relation can indicate if there is a media breach by specifying the media types of outputs and inputs. Generally, waste can be assigned using the Generates relation, applicable to any *Affecting Object* (R4).

Process data requirements can be specified in the notebook of the process (see Figure 5.12). This allows for the calculation of data processing KPIs. Moreover, a VS of an IT Service should consider Fail Points as suggested in the IT S-SB method by Bär et al. [120]. Typically, they are connected to Processes, *Decomposition Objects*, or Events by the Fail/Continuation relation. Waiting Times can be specified for environments performing multiple Processes, indicating how long it takes to continue the flow. As in the other sub-models, Development Actions or Comments can be defined and connected to any other component by the Affects relation. For complexity management, Processes can be decomposed into a sub-VSB (as Figure 5.18 does for Figure 5.17).

5.4.4. The *its*VALUE ADOxx Modeler

We developed an ADOxx Modeler for *its*VALUE using the meta modeling platform ADOxx, as it includes all the necessary features a meta modeling platform should provide according to Karagiannis et al. [65] (R8). For instance, according to Fill and Karagiannis [39], ADOxx provides a so-called *"meta^2 model"* specifying how to develop further meta models. This includes visual representations and the implementation of scripts (procedures, algorithms, queries, etc.). Kühn [72] describes ADOxx as a "meta modeling-based development and configuration environment to create domain-specific modeling tools". Moreover, it offers high scalability, multi-product availability, web connectivity, adaptability, and extended multi-user support. For more specific information on ADOxx, Kühn [72] and Fill and Karagiannis [39] provide a detailed introduction to ADOxx as a meta modeling platform and its functionalities.

In this section, we introduce the procedures and algorithms we developed for *its*VALUE, following the meta^2 model of ADOxx for the creation of models, concepts, and their visual representations. All additional scripts for a modeling method must be specified in the attribute called "External Coupling". In this attribute, different events can trigger commands or procedures. Such triggerable events can include the change of an attribute value of an instance, the creation of a relation, or the general start of the application itself. In the latter event, we defined all our custom procedures, which are also called during other events. Next, Section 5.4.4.1 provides an overview of all scripts and procedures we defined to achieve a highly dynamic modeling environment. Then, we introduce in section 5.4.4.2 all further procedures callable by the user when working on a VSB.

5.4.4.1. Dynamic Modeling Environment

To enable a highly dynamic modeling environment across several different models and model types, we assigned any *Linked Object* the property *"Is the exact same as"* (see Figure 5.8). Using this property, different instances of the same object can be linked. Once one link is established, all further links implicitly given by that new link (transitivity) are created automatically. When instances are linked or ”entangled” with each other, any change to one of those entangled instances will be automatically applied to all of its clones. This ensures the user having multiple instances of the same element across several methods updated at any time (R4, R5, R8). If an instance already part of such a network is copied, its new pasted clone is also automatically integrated into its network, and all clones will be updated accordingly. This network of instances of the same object can be created by using the notebook of just one of the clones. To achieve complete consistency, the initial clone (i.e., the one the user uses its notebook) overrides all other clones with its own information. Thus, the user should not add a blank clone to such a network using the notebook of that blank clone, as all previous information will be lost. Instead, the user should only apply this via an already linked, and thus, synchronized clone.

However, if the changed attribute is a record table like the Data Information for Processes (see Figures 5.8 and 5.12), the event ”SetAttributeValue” is not triggered. Thus, only for record tables, a special custom background procedure is also called during the event ”AfterEditAttributeValue”, which is triggered in such a case instead. Consequently, any entries of a record table will be synchronized throughout the entire network of an object. Conversely, the attribute for the position of the object inside a model will never be synchronized in such a network, as this would drastically decrease any model’s comprehensibility. Moreover, the attribute *”Is the exact same as”* will not be identically overwritten either, as this would cause any clone to reference itself in addition to the other clones. Further, the S Score and H Score of *Affecting Objects* will never be overwritten inside such a network. Thus, they will remain specified for each model. Consequently, the S Score and H Score will be specifically calculated for entire VSBs or single stakeholders. This enables checking whether the S Score or H Score of an *Affecting Object* is positive, negative, or equal to 0 for different stakeholders and in total when considering all stakeholders at once. Additionally, our code ensures that the network of an object remains entirely consistent when deleting one of its instances. Before that instance is deleted, its incoming references by its clones are automatically removed.

Furthermore, we added some more tools and scripts to support the dynamic environment by being triggered automatically. For instance, if a *Typable Object* or *Typable Relation* (see Figures 5.8 and 5.9) is created, the user is immediately asked to decide which type of that object is desired instead of requiring the user to manually change it afterward and using a default value. Further, we made each *Affecting Object* track and store its

Interface relations. For example, this provides an overview for an IT-System on where (i.e., by which Processes) or by which components it is actually used. Moreover, if a Contradictory relation is created between one object and another, it is automatically created from the other to the original as well, as Contradictory cannot be a single-directed relation. However, we could not implement that a decomposed process automatically receives all data information from its sub-processes.

5.4.4.2. Value Stream Blueprint (VSB) Analysis Functionality

VSB analysis functionalities can be triggered manually through the upper menu bar of the *its*VALUE Modeler (R4, R8). All of them can be applied to either an object, a group of selected objects, or the entire model:

1. The "Cumulative Time Calculator" calculates and stores the cumulative time for *Time-Storing Objects* in a VSB. For Waiting Times, it further calculates their estimated duration. Waiting Times are generally considered as waste.

2. The "Receive Value Information" detects and stores all direct and implicit affections a component has to a SV. Moreover, it calculates and stores both the S Score and H Score of *Affecting Objects*. Therefore, these components are considered for any VPM they are part of. All SVs that are supported or hindered are listed with references inside each *Affecting Object*. This allows the accumulation of positive (S Score) and negative (H Score) value perceptions for VS components.

3. The "Data Information Calculator" calculates and stores the DR, DA, and DU KPI for each Activity/Process.

4. The "Waste Detector" detects and places visual Waste indicators for each object of a VSB. It can detect "bad" KPIs, indicating further potential for the improvement of data processing or value creation, and media breaches in Information Flows. DR, DA, and DU not equal to 1, S Score equal to 0, and H Score less than 0 are considered as "bad" KPIs.

Based on the analysis results, potential improvement spots can be identified in the VS. The *its*VALUE Modeler allows further investigation of these spots with regard to the type of waste and possible side effects of changes. For example, if a VS component is subject to change, the mapping to the SVMs identifies all involved stakeholders and their perceptions of the component. Positive and negative perceptions can be negotiated between stakeholders.component. Positive and negative perceptions can be negotiated between stakeholders.

5.5. Discussion of the Initial Development

In this Chapter, we have introduced the results of our first development iteration on *its*VALUE. We derived them primarily from our findings in Chapter 4. For the method, we broadly adapted the VSM 4.0 approach. Consequently, *its*VALUE starts each iteration by understanding and defining what each relevant stakeholder values (see Section 5.2.1). However, according to Minoja [87], not all stakeholder demands can be satisfied immediately in a tailored way. Minoja [87] concludes that stakeholder commitment is crucial for sustainable stakeholder management. The strategy and commitment of decision-makers drive this performance regarding stakeholder engagement. Moreover, Minoja [87] emphasizes ethical commitment, as common ethics or beliefs increase reciprocal commitment. Minoja [87] recommends ranking stakeholder demands by answering three questions for each demand: *"Whether?" (yes or no)*, *"When?" (soon or long-term)*, and *"How?" (customized or standardized)*. These answers assist in understanding and defining stakeholder demands as well as in defining development actions. Additionally, Minoja [87] advises managing stakeholders dynamically to adapt to new possibilities or handle potential problems in advance. Perrini et al. [102] underline the importance of monitoring the sustainability of relationships with stakeholders for successful management. Both quantitative (e.g., DR, DA, or DU) and qualitative measures (e.g., S Score or H Score), as well as economic-monetary aspects (e.g., time consumption), should be considered. Perrini et al. [102] recommend developing additional measures specific to the domain (e.g., measuring workplace satisfaction for employees). Such indicators could be specified for each relevant stakeholder to assign a reasonable CPL for its SVs. *its*VALUE addresses these requirements by providing techniques and considering activities dealing with these issues.

However, the results of our first development iteration on *its*VALUE must be investigated to validate whether they satisfy the method hypothesis. For this purpose, Moody [89] categorized different aspects of a method that can be evaluated. Firstly, the *actual efficacy* or performance (i.e., the actual efficiency and effectiveness). Secondly, the *perceived efficacy* or perception (i.e., the perceived ease of use and usefulness). Lastly, the adoption in practice, divided into the intention to use and actual usage. For *its*VALUE, only the perceived efficacy and intention to use seem reasonably checkable at this early stage, as actual factors are currently not. We do not have access to data reasonably comparable to *its*VALUE, making it difficult to evaluate whether *its*VALUE performs well. Further, we cannot evaluate the actual usage of *its*VALUE, as it has not been implemented yet. In addition to Moody's categorization of what can be evaluated regarding a method, Venable et al. [140, 141] introduce Framework for Evaluation in Design Science Research (FEDS), a framework for designing the evaluation of an *artifact* (i.e., the result of a creation process). For *its*VALUE, we created three artifacts: the method, the notation, and the ADOxx Modeler. For each evaluation of an artifact, Venable et al. [140, 141] advise defining contextual factors of goals, conditions, and constraints (e.g., the type and level of desired rigor, the type of artifact, etc.). Moreover, Venable et al. [140, 141] provide different views on achieving the purpose of the evaluation: Firstly, the evaluation of an instantiation to establish utility and efficacy. Secondly, the evaluation of formalized utility knowledge. Thirdly, the evaluation in comparison to similar methods. Fourthly, the evaluation regarding side effects or undesirable consequences of use. Lastly, the formative evaluation to identify weaknesses for something still in development. Our prototype is an instance of the *its*VALUE method and notation. Thus, evaluating *its*VALUE through this prototype seems the most reasonable approach. However, considering side effects or undesirable consequences of using our prototype is also important, as the prototype has not yet received a first evaluation. Further, Venable et al. [140, 141] distinguish between different strategies to evaluate artifacts: *ex ante* (before the artifact construction) versus *ex post* evaluation (after the artifact construction) and *naturalistic* (e.g., field setting) versus *artificial* evaluation (e.g., laboratory setting). As we have already created all artifacts, only the ex post setting is applicable to us. Further, the naturalistic setting seems more reasonable than the artificial approach, as *its*VALUE is intended to support actual practitioners in real scenarios. For this combination, Venable et al. [140, 141] recommend performing a case study for the evaluation. Moreover, guided interviews carried out afterward can assist in assessing the desired information regarding the perceived efficacy and intention to use in the sense of Moody [90]. With such guided interviews, further questions regarding the quality of the *its*VALUE notation (to detect if it meets the guiding principles by Moody [90], as we assume in Section 5.3.2) or the ADOxx Modeler itself (especially to detect whether the intention of use differs for the method itself and our ADOxx Modeler in particular) can be asked.

5.5.1. Limitations of the Initial Development

This first version of *its*VALUE introduces new techniques such as the calculation of the VW of a SV or the S Score and H Score of an *Affecting Object* within a VS. These calculations need to be evaluated for their reasonableness and usefulness. At present, algorithm 1 only sums up intermediate results and does not indicate whether higher numbers are better than lower ones. Its only reasonable statements are that a positive S Score indicates that at least one SV is supported, and a negative H Score indicates that at least one SV is hindered. Conversely, if the S Score or H Score is equal to 0, no value is supported or hindered. However, the higher a S Score or H Score is, the more the calculated VW is supported or hindered. But, algorithm 1 does not provide any average values for supporting or hindering SVs. Thus, the S Score and H Score are not well-suited for direct comparisons. They are not scalable either, as a VS with more detailed information and defined SVs likely contains higher values for S Score and H Score than a smaller VS.

Additionally, *its*VALUE does not allow setting different values for the RF and CPL of different instances of the same SV. Therefore, a specific declaration for different stakeholders of the same SV is not possible. Users must assign each SV to exactly one stakeholder. Moreover, stakeholders cannot receive a RF like their SVs do, making it impossible to explicitly define which stakeholder is more important. Consequently, deciding which SV is more important to the service provider must be manually discussed, as the RF of a SV only indicates its importance to the particular stakeholder.

Furthermore, our ADOxx Modeler does not support the automatic handling of data information for a decomposed process and its sub-VSB. As a result, the user must manually track all data information from the sub-VSB and add it to the major decomposed process in the main VSB. Optimizing such a sub-VSB is possible but might distract from and hinder the optimization of the main VSB, which is the essential objective of *its*VALUE.

5.5.2. Summary and Conclusion

We have developed a completely new approach to model, analyze, and improve the creation of SV in the field of IT services: *its*VALUE. In combination with the Modeler, it supports comprehensive modeling and analysis of IT Service-related VSs. By considering ITIL 4 concepts, it has the potential to help practitioners adopt that standard. Unlike any existing approach we found in Chapter 4, this first version of *its*VALUE explicitly considers the creation of value for any relevant stakeholder by directly taking their value perceptions into account. Additionally, *its*VALUE addresses the detection and prevention of waste within a VS. To this end, *its*VALUE provides guidance to help practitioners define development actions that maximize flow, minimize waiting times, and overall achieve a better-performing VS.

Generally, *its*VALUE consists of multiple iterations, each comprising either two or three phases. If a new service needs to be designed, *its*VALUE supports drafting an entirely new VS before proceeding with iterations to check, analyze, and discuss the first draft. *its*VALUE also allows for the analysis of existing VSs. Development actions can be defined, and a future state can be aimed at by applying the previously defined development actions.

In addition to the method itself, we developed a specific notation for *its*VALUE, derived from several existing notations that may be familiar to practitioners or scientists. The method and notation consist of three different model types in total. Two of them (VPM and VSB) are entirely new, as we derived and combined them from the scopes and key ideas of several existing approaches. The notation of *its*VALUE is specifically designed to suit the activities of the method (e.g., by providing visualizations of waste, media breaks, interfaces between processes and IT systems, etc.).

Additionally, we developed an ADOxx Modeler, an instance of *its*VALUE that can be used to evaluate *its*VALUE. We implemented several procedures to assist users of our prototype in modeling and analyzing their cases. Notably, we achieved a highly dynamic environment where different instances of the same object can be linked and automatically updated across multiple models. Making the Modeler freely available at OMiLAB ensures access for and involvement of potential users.

An important next step will be the evaluation and improvement of complexity handling in a more complex scenario compared to the fictional case in this section, which serves only as a proof-of-concept.

6. A Case Study on the Initial Version

As concluded in Section 5.5, that first version of *its*VALUE should be evaluated regarding its perceived efficacy and intention to use, as suggested by Moody [89]. Venable et al. [140, 141] recommend performing a case study, as *its*VALUE consists of three already created artifacts whose evaluation seems most reasonable in a real-world scenario. Furthermore, Baxter et al. [15] state that a case study can be performed when the behavior of the participants cannot be influenced or when the contextual conditions are not clearly distinguishable from the phenomenon. Since the real end users of *its*VALUE should not be influenced when applying *its*VALUE to their own cases, this is another reason to perform a case study.

According to Gerring [45], a case study is an intensive study of a single unit aimed at generalization across a larger set of similar units. For *its*VALUE, this means aiming for initial findings that indicate whether *its*VALUE meets its method hypothesis, complies with the guiding principles by Moody [90], and provides a good ADOxx modeler. However, since there has not been any evaluation yet, the outcome remains highly unpredictable. For such scenarios, Baxter et al. [15] advise designing the case study to be exploratory.

For exploratory research, Döring and Bortz [30] state that the objective should be to detect findings in order to develop hypotheses using open RQs. For *its*VALUE, this implies that we first understand its method hypothesis as open RQs that should assist in transforming them into a real hypothesis that can be checked across several domains. Moreover, Baxter et al. [15] recommend deciding whether a single or multiple case study should be conducted. According to them, single cases are only reasonable for highly similar situations, which is not the case for the intended application of *its*VALUE in many different real-world scenarios. However, due to limited resources, we are forced to investigate a single case. This underlines the importance of defining open RQs for this case study instead of a hypothesis, as Gerring [45] states that proving a hypothesis based on just a single unit (out of many possible) is not feasible. Thus, he concludes that an exploratory approach should be followed.

For scenarios with just a single case investigated (or a very small n of participants), Gerring [45] further recommends a qualitative approach for evaluation. However, he also states that a qualitative analysis is much harder to handle objectively than a quantitative one. This argues for designing the case study to be exploratory, as the analysis of a single case should be designed qualitatively.

6.1. The Case Study Design

According to Döring and Bortz [30], GIs (Guided Interviews) are a qualitative approach capable of providing promising information, especially for unexplored and unpredictable outcomes. For this reason, we primarily focused on assessing information from conducting such GIs. We followed the steps for executing GIs as outlined by Döring and Bortz [30]:

1. Contextual Preparation:
   - Determine the topic.
   - Define the Research Questions (RQs).
   - Identify the target group (i.e., the participants and the interviewers).
   - Choose the interview technique (structured, unstructured, group, single, etc.).
2. Defining the GI questions.
3. Practicing the GIs in advance.

To provide the participants with the knowledge to answer the questions of the GI properly, we conducted a participatory modeling session with the participants, roughly following the *its*VALUE framework (see Figure 5.1) and using the ADOxx modeler. The participants' perceptions during that modeling session were the topic investigated in the subsequent GIs. We divided the interviews into four distinct parts to differentiate between our method artifacts and how they were perceived. We investigated the *its*VALUE method, notation, and ADOxx modeler. Additionally, we evaluated the execution of our modeling session, as this setting may have affected the participants' perceptions of our artifacts.

In the following subsections, we describe our case study setting, relevant related work, and how we derived both our RQs and GI questions.

6.1.1. The Case Study Setting and Modeling Session Execution

This section specifies and delimits the case investigated in our case study, as recommended by Baxter et al. [15] and Zucker [155]. We investigated the VS for ordering a notebook for employees at the company Drägerwerk AG & Co. KGaA, an enterprise located in Lübeck (Schleswig-Holstein, Germany) whose core business model is the development and maintenance of technical, medical, and safety equipment worldwide. This VS was already modeled at Dräger in a spreadsheet called "Makigami Diagram", depicting the main steps, stakeholders, IT components, and known issues. This document helped create a first draft of a VSB before executing the participatory modeling session. We did this prior to accelerate the collection of all steps required for the VS due to limited resources (which we will later address in Section 6.3.1). However, we did not investigate the actual procurement of such notebooks for work performed by the relevant division due to limited resources. In this case study, we only investigated the VS from a Dräger employee initially ordering a new notebook for work to its final delivery, marking the VS's particular end.

6.1.1.1. The Participants of the Case Study

The investigated VS involves six groups of stakeholders: the user (the employees requiring a new notebook for work), the global service desk (assisting the user with purchasing and answering questions), the team leader (approving any orders from their employees), the client service team (responsible for the procurement and delivery of notebooks), and the external field service (executing the delivery of the ordered notebook). Further, we considered the stakeholder group of the service managers responsible for this VS.

However, we could not cover all six groups of stakeholders with the participants we had. For this case study, we encouraged four employees to participate. Three participants had prior modeling experience. None of them had any relationship to the author. To comply with local data privacy laws and company restrictions, we did not track any personal information from the participants. Additionally, since all participants and the author of this work (who hosted both the modeling session and the GIs) are native German speakers, the entire case study was conducted in German.

As all participants were Dräger employees, they could embody the stakeholder group of the user, but the external field service group was not represented. No participant worked at the global service desk, so this group was also not covered. One participant was a team leader, allowing them to embody that stakeholder group. Another participant was part of the client service team, and two participants were service managers. Table 6.1 provides an overview of which participants (A, B, C, and D) embodied which particular group of stakeholders.

Group of Stakeholders	**P A**	**P B**	**P C**	**P D**	$\sum$
User (Employee)	*Yes*	*Yes*	*Yes*	*Yes*	4
Global Service Desk	*No*	*No*	*No*	*No*	0
Team Leader	*Yes*	*No*	*No*	*No*	1
Client Service Team	*No*	*No*	*Yes*	*No*	1
Field Service (external)	*No*	*No*	*No*	*No*	0
Service Manager	*No*	*Yes*	*No*	*Yes*	2

Table 6.1.: Mapping the participants (P) to the groups of stakeholders involved

6.1.1.2. The Modeling Session

To provide the participants with a proper understanding of what *its*VALUE is and how it should work, we conducted a participatory modeling session lasting 2:30 hours. We roughly followed the first framework of *its*VALUE (see Figure 5.1). However, due to the COVID-19 pandemic, we had to conduct the session remotely via Microsoft Teams. Additionally, ADOxx does not support multiple users in parallel, so we had to split the tasks. While the participants discussed and shared their input, a host guided the discussion and progress of the modeling session. The host also modeled the participants' input in real time, sharing their screen for the entire duration of the session.

We derived this approach from Sandkuhl et al. [117]'s sections 5.1.2 (using a video projector, a guiding host, and a modeling tool operator to assist the participants) and 5.2 (using IT-based tools to support a modeling session). Zucker [155] also recommends using further technical tools to carry out and analyze a case study. Although we did not directly analyze the modeling session itself, we recorded it via Microsoft Teams to review our perceptions and provide an evaluation for possible future work.

Due to limited resources and the availability of the participants, we had to set the duration for the modeling session at 2:30 hours. Consequently, we were only able to perform a single iteration of *its*VALUE on an already existing and relatively small VS. We requested the participants to provide some preparations in advance of the modeling session (e.g., what they value, what they do not, etc.). Based on their input, we prepared first drafts of all relevant VPMs and a corresponding SVM. We also prepared a first draft of a VSB derived from an existing model for the VS. Additionally, we provided all participants with a short introduction (two pages) to our topic in advance of the modeling session, allowing them to gain a general understanding of *its*VALUE. This approach was intended to accelerate the first phases of *its*VALUE and shift the focus primarily to the detection of waste and the definition of development actions. We started discussing and re-adjusting each prepared VPMs and the SVM followed by the VSB. Afterwards, we focused on collaboratively developing a first draft on how an enhanced (just considering the SVs by the participants) VS for ordering a new notebook could look like. This participatory modeling session took place on Thursday, April 8, 2021, from 09:00 to 11:30 am.

6.1.2. The Research Questions (RQs)

We explored and addressed the participants' perceptions and experiences during and after the participatory modeling session conducted in advance as part of our GIs. Based on the participants' impressions, we investigated the following aspects: 1) If the method fulfills its purpose, 2) the quality of the notation, 3) the effectiveness of the ADOxx modeler as an instance, and 4) the proper execution of the modeling session.

6.1.2.1. RQs regarding the *its*VALUE Method

As previously mentioned, we understand the *its*VALUE method hypothesis for the case study as RQs we want to investigate. Therefore, we paraphrased each statement of the original method hypothesis (see at the beginning of Section 5.2) into actual questions. These resulting questions form our first RQs for this case study. Further, we explicitly questioned the influence each model type (VPM, SVM, and VSB) might have on each statement it was intended to support. Moreover, these first RQs should assist us in determining whether *its*VALUE meets the requirements of ITIL 4, as the method hypothesis was defined accordingly. However, the last RQ cannot be evaluated as precisely as the others, as it focuses on the suitability of *its*VALUE for modeling an entirely new service, whereas the case study focused on an already existing one. All RQs regarding the *its*VALUE method hypothesis are listed below:

- RQ 1: Does the method meet its purpose and comply with ITIL 4?
  - RQ 1.1: Does it support understanding and explicitly defining SVs?
    - RQ 1.1.1: How is the VPM perceived in this regard?
    - RQ 1.1.2: How is the SVM perceived in this regard?
  - RQ 1.2: Does it support understanding and explicitly defining a CVS?
    - RQ 1.2.1: How is the VSB perceived in this regard?

RQ 1.3: Does it support understanding how SVs are affected by various components of a VS?

RQ 1.3.1: How is the VPM perceived in this regard?

RQ 1.3.2: How is the VSB perceived in this regard?

RQ 1.4: Does it support understanding what actually generates waste?

RQ 1.4.1: How is the VSB perceived in this regard?

RQ 1.5: Does it support detecting where components (e.g., IT systems) are used and where information is required or generated?

RQ 1.5.1: How is the VSB perceived in this regard?

RQ 1.6: Does it support explicitly defining development actions to create an enhanced FVS from an existing CVS?

RQ 1.6.1: How is the VPM perceived in this regard?

RQ 1.6.2: How is the SVM perceived in this regard?

RQ 1.6.3: How is the VSB perceived in this regard?

RQ 1.7: Does it support explicitly defining a VS for an entirely new service that immediately supports SV as best as possible?

RQ 1.7.1: How is the VPM perceived in this regard?

RQ 1.7.2: How is the SVM perceived in this regard?

RQ 1.7.3: How is the VSB perceived in this regard?

6.1.2.2. RQs regarding the *its*VALUE Notation

To evaluate our *its*VALUE notation, we derived our RQs from the nine design principles for good notations by Moody [90]. Similar to our approach for the *its*VALUE method hypothesis, we paraphrased these principles into specific questions. However, semiotic clarity and cognitive fit are not reasonably evaluable within our case study, as we investigated only a single case rather than multiple ones. A single target group cannot provide evidence regarding the suitability of the notation for various target groups.

Furthermore, we cannot reasonably estimate whether some concepts are unnecessary or missing, as different scenarios might require different concepts. Additionally, complexity management and cognitive integration cannot be reasonably evaluated either, as the participants did not model independently. They provided input and engaged in discussions while a host modeled in parallel. Since the participants did not model independently, they likely could not offer valuable insights on whether the techniques for managing complexity within and across models are well designed. Consequently, we did not consider these four design principles by Moody [90]. All RQs related to these principles are listed below:

RQ 2: Does the notation comply with the principles of Moody [90]?

- RQ 2.1: Does it provide a good perceptual discriminability?
- RQ 2.2: Does it provide a good visual expressiveness?
- RQ 2.3: Does it provide a good semantic transparency?
- RQ 2.4: Does it provide a good dual coding?
- RQ 2.5: Does it provide a good graphic economy?

6.1.2.3. RQs regarding the *its*VALUE ADOxx Modeler

Since our modeler relies on ADOxx as a fundamental platform, we inquired whether ADOxx is perceived as an appealing platform for modeling VSs and SV using *its*VALUE. Additionally, we asked if our procedures are seen as valuable contributions to the modeling process. Generally, the perceived ease of use cannot be evaluated, as the participants did not directly interact with *its*VALUE or the ADOxx modeler. However, we aimed to assess the perceived usefulness and intention to use the platform among the participants. All RQs regarding the ADOxx tool prototype are listed below:

RQ 3: Is the ADOxx modeller a good instance of *its*VALUE?

- RQ 3.1: Does ADOxx generally appeal as a fundamental platform?
- RQ 3.2: Are our own procedures supportive and desired?
  - RQ 3.2.1: Calculating the cumulative times in a VSB?
  - RQ 3.2.2: Receiving the additional SV information for a VSB?
  - RQ 3.2.3: Calculating the DR, DA and DU for a process?
  - RQ 3.2.4: Detecting waste in a VSB following some patterns?
- RQ 3.3: Is there an intention to use *its*VALUE?

RQ 3.3.1: Are the participants confident of using it on their own?

RQ 3.3.2: Can they imagine working with it in the future?

RQ 3.3.3: Would they use it independently from ADOxx?

6.1.2.4. RQs regarding the Participatory Modeling Session

Lastly, all RQs are limited to the perceived efficacy and intention to use by the participants. Furthermore, the participants' responses are highly specific to the participatory modeling session we conducted. Therefore, we also questioned our approach with the following RQs. Any RQ is listed below:

RQ 4: Was the modeling session generally executed well?

RQ 4.1: Was following an entire iteration in a single session appropriate?

RQ 4.2: Was the separation of work appropriate?

RQ 4.3: Was the remote execution appropriately performed?

RQ 4.4: Was the preparation for the modeling session appropriate?

6.1.3. The Guided Interviews (GIs)

As previously mentioned, the GIs we conducted with the participants after the modeling session are our source for answering the RQs defined in section 6.1.2. We have attached all GIs questions to this work in appendix A.1. Following Zucker's [155] recommendation to design GI questions based on the previously defined RQs, we structured our GI questions accordingly. However, we altered the order of the GI questions compared to the corresponding RQs. Table 6.2 provides an overview of the order of the GI questions and shows how it is mapped to the corresponding RQs. This approach aimed to achieve a smoother introduction and conclusion for the GIs by placing more suitable questions in those spots, as recommended by Döring and Bortz [30].

Consequently, we began all GIs by asking how the participants generally perceived the execution of the modeling session. We then delved into *its*VALUE by asking about their general perception of the notation, followed by questions on the *its*VALUE method. Finally, we concluded the GIs by inquiring about their perception of the ADOxx modeler and their intention to use it. In defining the GI questions, we adhered to the guidance of Döring and Bortz [30]. For instance, we avoided expert vocabulary as much as possible when rephrasing our RQs into GI questions to enhance participants' understanding of the concepts we were investigating. Further, we used open questions to avoid any framing.

For the procedural execution of the GIs, we followed the guidance of Döring et al. [30]. This overall Section 6.1 provides all the information we considered to achieve good contextual preparation. To ensure good organizational preparation, we scheduled appointments for the GIs with each participant individually, within four days after the modeling session. Further, we designed these GIs to last no more than 30 minutes due to limited resources. Initially, the GIs were conducted in German and later translated into English (see appendix A.1), as all participants were native German speakers. Additionally, we conducted and recorded all GIs using Microsoft Teams.

To extract information from the GIs, we carefully re-listened to all recordings and created memory logs according to our RQs. We started each appointment by welcoming the participants and outlining the conditions of the GI, directly requesting permission to record. We also summarized the modeling session to provide a smooth transition into the GI. After conducting the GIs, we allowed time for informal discussions or questions from the participants, followed by an appreciative farewell and note of thanks. Lastly, we created a brief postscript for each GI, noting our impressions of the participants' condition and the discussion atmosphere (including any interruptions). To enhance the quality of the participants' answers, we showed them their created models in the ADOxx modeler during the GIs.

For the evaluation, we conducted a deductively structured analysis following Mayring et al. [83], using memory logs (including direct quotes) created after re-watching the recordings of the GIs. As we developed the GI questions based on their corresponding RQs, we defined our coding guide in the broader sense of Mayring et al. [83] as follows: Sentences are the smallest units of coding (the smallest amount of text to be analyzed), complete answers to a previously asked GI question are the contextual units (the largest amount of text to be evaluated), and the GI questions (and their corresponding RQs) are the analysis units (the texts set to be evaluated separately). As our RQs were designed to be answered with *Agreement* or *Disagreement*, we defined those as categories, as well as

GI Question	1	2	3	4
Research Question (RQ)	4	2	1	3

Table 6.2.: Mapping the RQs and GI questions

Neutral. For the RQs regarding participants' perceptions of the different model types of *its*VALUE, we defined the categories: *Positive*, *Negative*, and *Neutral*. For instance, if a participant's response was positive regarding an aspect covered by our RQs, we assigned a "+" to the relevant spot (see table 6.3, 6.4, 6.5, and 6.6 in section 6.2). Conversely, we assigned "−" for negative and "n" for neutral responses. We used this limited range of grading to minimize bias. For these analyses, we considered the memory logs of the GIs attached to appendix A.2, A.3, A.4, and A.5. Each individually conducted GI lasted 20 to 30 minutes.

6.1.4. The Pre-Test

In advance of the modeling session, we conducted a pre-test followed by a GI. We used the exact same environment as in the actual case study. Since everything performed well during this pre-test, we adhered to our plan for the real case study. Additionally, we tested the GIs with one of the participants from the modeling session pre-test. Based on the feedback, we excluded questions on semiotic clarity, complexity management, cognitive integration, and fit as defined by Moody [90], since the participant felt unable to provide valuable information on these topics by merely observing and not actively modeling.

We also encountered difficulties with the interviewer using expert vocabulary related to *its*VALUE when asking the GI questions. We concluded that paraphrasing such terms would enhance the comprehensibility of the GIs. Consequently, we slightly adapted our GIs and conducted a second pre-test with a person completely unrelated to any technical topics to check the comprehensibility of our GIs. To enable this new participant to answer the GI questions properly, we provided a 30-minute introductory presentation on *its*VALUE, explicitly demonstrating our ADOxx Modeler. This new participant felt comfortable answering any GI question and did not struggle with the vocabulary.

6.2. Evaluation Results

In the following subsections, we present the results derived from our GIs as described in Section 6.1.3. Overall, we found the execution of the modeling session to be successful, as we achieved all our objectives. Although we spent more time explaining the models and preparations (based on the participants' previous input) than initially intended, we still managed to investigate several examples for each step of one iteration of the *its*VALUE framework, following the path for an existing VS.

Additionally, we observed that the proportion of speaking time shifted from the participants to the host as the session progressed. This shift may have been due to our intention to demonstrate all aspects of *its*VALUE. However, nothing was modeled without the explicit agreement of all participants.

The following results are based on our memory logs for each GI (see Appendix A.2, A.3, A.4, and A.5). We evaluated the major RQs based on their corresponding sub-RQs. We begin with the results for the *its*VALUE method, followed by its notation, the ADOxx Modeler, and conclude with the execution of our modeling session. We attached every *its*VALUE model resulted during this case study to Appendix B.

6.2.1. Results on the *its*VALUE Method

Table 6.3 provides an overview of how the participants' answers from the GIs correspond to the RQs from Section 6.1.2.1. It reveals a slight difference in the perceptions of participants already familiar with modeling (A, B, and D) compared to the one who is not (C). While A, B, and D perceive the VSB as supportive to the method, C seems uncomfortable with it. However, all participants found the order of the *its*VALUE phases to be very good and reasonable.

Moreover, all participants felt that considering all SVs worked very well, setting *its*VALUE apart from other approaches known to them. Additionally, B stated that setting the RF and CPL increased their feeling of being considered and represented. Therefore, all participants perceived the VPM and SVM as excellent and unique. However, A and D questioned whether the SVM might be too "fuzzy" or academic from a practitioner's point of view. A, B, and D found that understanding and defining a CVS worked very well, whereas C found it too complex due to the VSB, which they perceived as incomprehensible and unstructured. Conversely, A, B, and D found the VSB to be very good due to its good structure and comprehensive content required for modeling a VS.

Furthermore, all participants perceived that understanding and connecting the SVs worked very well and was crucially important. All participants agreed that the VPM was very supportive and optimal. However, only A, B, and D agreed that the VSB was also optimal and very good, as it displayed those connections almost immediately. Conversely, C found it not comprehensible.

All participants perceived that understanding and detecting what creates waste worked very well and was even "sensational". Therefore, A and B found the VSB acceptable, although initially overwhelming. A desired an external report on the waste instead of it being shown in the VSB. Conversely, C and D believed that the VSB suited the detection of waste very well.

Moreover, all participants perceived that understanding the connections between processes and other objects was supported very well (except C, who considered it important). B emphasized that any *Affecting Object* recording its interface relations was very good. Although C found the VSB too complexly structured, A, B, and D found it very suitable, as the VSB easily showed all connections between processes and other objects.

RQ	**P A**	**P B**	**P C**	**P D**	$\sum +$	$\sum n$	$\sum -$
1.1	+	+	+	+	4	0	0
1.1.1	+	+	+	+	4	0	0
1.1.2	+	+	+	+	4	0	0
1.2	+	+	−	+	3	0	1
1.2.1	+	+	−	+	3	0	1
1.3	+	+	+	+	4	0	0
1.3.1	+	+	+	+	4	0	0
1.3.2	+	+	−	+	3	0	1
1.4	+	+	+	+	4	0	0
1.4.1	n	+	+	+	3	1	0
1.5	+	+	n	+	3	1	0
1.5.1	+	+	−	+	3	0	1
1.6	+	+	+	+	4	0	0
1.6.1	+	n	+	+	3	1	0
1.6.2	+	n	+	n	2	2	0
1.6.3	+	+	−	+	3	0	1
1.7	+	+	n	+	3	1	0
1.7.1	+	+	n	+	3	1	0
1.7.2	+	+	n	n	2	2	0
1.7.3	+	+	n	+	3	1	0

Key: *"P" = Participant; "+" = Agreement $\vee$ Positively; "n" = Neutral; "−" = Disagreement $\vee$ Negatively*

Table 6.3.: Results by the GIs on the method of *its*VALUE

All participants agreed that identifying needs for change and defining development actions was very well supported and easy (even for uninvolved people). Moreover, A, C, and D found the VPM very suitable, whereas B found it supportive for understanding but not explicitly for placing development actions. Similarly, B found the SVM difficult to evaluate properly, while A and C liked it. A, B, and D found the VSB good, although A slightly questioned its readability when defining multiple development actions. B and D found the VSB perfect, as it could even be used to transform into a user story for developers. Conversely, C found the VSB too complex and incomprehensible.

According to A, B, and D, *its*VALUE seems suitable for designing new services, whereas C did not have an opinion on this. However, A stated that not every process might be displayable, as it would be too extensive using *its*VALUE. B believed that a second modeling session analyzing the first draft might be reasonable. A, B, and D found the VPM very supportive to start with and to cover all stakeholders. A and B found the SVM especially supportive, as it provided a new possibility to design a service primarily with the value perspective. Conversely, D did not feel capable of giving a proper opinion on that. Lastly, A, B, and D found the VSB very suitable for the VS draft. However, B considered the times inside the VSB problematic, as they must be estimated based on similar experiences.

To conclude, *its*VALUE seems to meet its method hypothesis according to the answers and impressions of all four participants (even C, who mainly struggled with the VSB as a model and not the method or its mechanics itself).

6.2.2. Results on the *its*VALUE Notation

Table 6.4 shows how the participants' answers from the GIs correspond to the RQs from Section 6.1.2.2. These results reveal a significant difference between the perceptions of participants already familiar with modeling (A, B, and D) and the one who is not (C). A, B, and D perceived the notation as generally good, with visual differences easy to perceive, and they appreciated the wide range of different visualizations. However, B and C noted that the colors of some objects might look too similar (e.g., information-related processes and IT systems). Further, A found relations harder to differentiate than objects.

Moreover, A, B, and D found the notation across all models intuitive. They particularly liked the colors for the RF, CPL, S Score, and H Score, as they resemble traffic lights, which helps in understanding the meaning those KPIs embody. Although A stated that

RQ	P A	P B	P C	P D	$\sum +$	$\sum n$	$\sum -$
2.1	+	+	n	+	3	1	0
2.2	+	+	−	+	3	0	1
2.3	+	+	−	+	3	0	1
2.4	+	+	+	+	4	0	0
2.5	+	+	−	+	3	0	1

Key: *"P" = Participant; "+" = Agreement ∨ Positively; "n" = Neutral; "−" = Disagreement ∨ Negatively*

Table 6.4.: Results derived from the GIs on the notation of *its*VALUE

the VSB is very well structured, C found it and the SVM hard to understand. Generally, C also perceived the range of different visualizations as too complex. However, C enjoyed the VPM (especially its graphic economy) and agreed with all other participants that the amount of text is well balanced across all models.

Further, all participants found the VSB overwhelming, at least initially. However, A, B, and D found it manageable and even necessary, whereas C disagreed. Moreover, C disliked the number of objects inside the SVM. To conclude, there are differences in the perception of the notation for the different model types, although we designed it combined. Thus, we considered the overall participants' perception for Table 6.4. For three participants, the *its*VALUE notation seems to comply with five principles by Moody [90].

6.2.3. Results on the *its*VALUE ADOxx Modeler

Table 6.5 shows how the participants' answers from the GIs correspond to the RQs from Section 6.1.2.3. It reveals that all participants perceive the ADOxx modeler as supportive and see high potential for its use. However, A questioned its mechanics for designing a new VS (e.g., missing recommendation functionalities) and disliked ADOxx as a fundamental platform, questioning its potential integration with already common systems. Conversely, B, C, and D found ADOxx well-suited and useful, although B limited their impressions due to a lack of personal experience with it.

All participants found all procedures useful and supportive. They underlined the importance and usefulness of the *Cumulative Time Calculator* for decreasing time consumption in a VS on the fly. They stated that the *Receive Value Information* feature enriches the VS with very supportive and useful information. Additionally, they found the *Data Information Calculator* good and useful, although A desired an extended calculation for the

RQ	P A	P B	P C	P D	$\sum +$	$\sum n$	$\sum -$
3.1	$-$	n	$+$	$+$	2	1	1
3.2	$+$	$+$	$+$	$+$	4	0	0
3.2.1	$+$	$+$	$+$	$+$	4	0	0
3.2.2	$+$	$+$	$+$	$+$	4	0	0
3.2.3	$+$	n	$+$	$+$	3	1	0
3.2.4	$+$	$+$	$+$	$+$	4	0	0
3.3	$+$	$+$	$+$	$+$	4	0	0
3.3.1	$-$	$-$	$-$	$-$	0	0	4
3.3.2	$+$	$+$	$+$	$+$	4	0	0
3.3.3	$+$	$+$	$+$	$+$	4	0	0

Key: *"P" = Participant; "+" = Agreement ∨ Positively; "n" = Neutral; "−" = Disagreement ∨ Negatively*

Table 6.5.: Results derived from the GIs on the ADOxx modeler

entire VS instead of just single processes, and B felt unable to properly evaluate it. Lastly, all participants perceived the *Waste Detector* as outstandingly supportive. C desired an additional *Cost Calculator* to visualize cost savings from dealing with waste.

Overall, all participants found *its*VALUE very suitable for future applications, both for designing new and improving existing VSs. While D could imagine introducing and using it immediately in their company, A's willingness depended on the future maintenance of *its*VALUE. Although no participant felt capable of using *its*VALUE independently, they all could imagine and even desired a workshop to achieve that capability. They all expressed a desire to work with *its*VALUE again, with B even imagining becoming a modeling host for similar sessions.

Lastly, all participants would use *its*VALUE independently from ADOxx if there were an alternative. Without software (e.g., using a plastic wall and colored pieces of paper), B found only the VPM and SVM applicable, noting that the VSB requires a software tool, especially for calculated times. To conclude, all four participants seem to perceive the ADOxx modeler as a good instance of *its*VALUE.

6.2.4. Results on our Modeling Session Execution

Table 6.6 shows how the participants' answers from the GIs correspond to the RQs from Section 6.1.2.4. It indicates that participants were satisfied with the execution and guid-

RQ	**P A**	**P B**	**P C**	**P D**	$\sum +$	$\sum n$	$\sum -$
4.1	+	n	+	n	2	2	0
4.2	+	+	+	+	4	0	0
4.3	+	+	+	+	4	0	0
4.4	n	+	n	+	2	2	0

Key: *"P" = Participant; "+" = Agreement ∨ Positively; "n" = Neutral; "−" = Disagreement ∨ Negatively*

Table 6.6.: Results derived from the GIs on the execution of the modelling session

ance throughout the modeling session. Although A demanded a stricter execution of the procedure without jumping between different types of tasks, B stated that this was not a problem due to the good guidance. Additionally, A mentioned that the moderation sometimes delved too deeply into the mechanics of the ADOxx modeler.

A and C perceived the duration of 2:30 hours for the session and an entire iteration as perfect, whereas B and D considered it too short but still acceptable due to the good preparations in advance. Generally, D found the objective "tangible." Moreover, the separation of tasks and remote execution via Microsoft Teams was positively perceived by all participants. Since they all knew each other beforehand, they found their collaboration to be good and productive. B even considers a similar approach reasonable for potential future applications.

Furthermore, all participants can imagine that a similar procedure could also (or even better) work in person. B and D perceived the preparations for the modeling session, including the introduction to the topic and the prepared models, as well done or even "impressive", facilitating a smoother start. To conclude, all participants perceived the execution of the modeling session as good.

6.3. Discussion of the Case Study

We wanted to check if the participants (dis-)liked something because of a) how it actually is or b) just the way we designed the modeling session (i.e., the contextual condition). As they often mentioned that something was still good due to the detailed guidance and explanations, we believe that the modeling session was well executed. Moreover, the modeling session seems to have not suffered from being completely executed remotely via Microsoft Teams. With the exception of disturbing notifications the participants had not turned off during the meeting, everything worked surprisingly well (including the shared screen). Considering all those aspects, the expressiveness of the answers given by the participants may have a good quality.

However, the participants' perceptions are limited as none of them had used or even known about ADOxx before. Thus, they cannot provide expressive input on whether ADOxx is an appealing fundamental platform. Still, they all encountered the ADOxx software and our modeler extensively from an observational point of view. Thus, their perceptions may still be valuable. Overall, their general perception of ADOxx (with the exception of participant A) and especially our tool prototype is very positive. Hence, we believe that the ADOxx modeler (as an instance of *its*VALUE) had an impact on how the participants perceived the method and notation, as it directly implements what *its*VALUE is all about. For instance, they were impressed by the possibilities ADOxx offers through our procedures and dynamic scripts we implemented to support the users. Consequently, the ADOxx modeler may have increased their satisfaction with *its*VALUE generally. Conversely, the answers given by participant A reveal that his negative impressions and opinion on ADOxx did not reflect on the perceptions he gave regarding the method, notation, or even the tool prototype itself (i.e., A was able to clearly state that he just dislikes ADOxx and not anything else). Consequently, we believe that our GIs served well to achieve clear results for each RQ distinctively. Lastly, all participants seemed to have an intention to use *its*VALUE and especially the ADOxx modeler. Thus, we believe it is a good instance for evaluating *its*VALUE as a method and notation.

With regard to the answers given by participant C, we believe that the *its*VALUE notation (especially for the VSB) had a negative influence on how C perceived the method of *its*VALUE for understanding and defining VSs. As C perceived the notation for the VSB as too complex and incomprehensible, C concluded that understanding and defining a CVS is hard to achieve using *its*VALUE overall. Although A, B, and D also stated that the VSB might tend to become too complex or overwhelming, they did not perceive those issues as problematic. However, in contrast to C, they all claim to be familiar with modeling. Thus, the *its*VALUE notation (especially for the VSB) may only suit those already familiar with similar modeling techniques (e.g., BPMN, 4EM, etc.). This assumption is underscored by C additionally stating that they do not feel comfortable with modeling or even notations in general.

Further, the quality of the *its*VALUE notation seems to differ for its different model types. As the VSB contains many more different concepts than the VPM or SVM, especially its complexity management and cognitive fit are probably harder to handle and accomplish. Explicitly considering the resulted VSB out of this case study (cf. Figure B.6), we believe that the notation for the VSB even underperforms compared to both the VPM and SVM. For instance, participant C stated that he perceives the VPM as perfectly comprehensible. Although participants B and D have not felt that comfortable with the SVM due to believing that they have not fully understood its capabilities yet, no participant assigned similar issues to the SVM as they did for the VSB. Unfortunately, we have not explicitly asked for the perceived differences of the notations for all three model types due to time limitations.

As even C stated that the mechanics of the method are easy to understand, we conclude that the results regarding the method of *its*VALUE have a satisfying quality and promise valuable first indications. Overall, all participants liked the order of the method framework and felt supported by it in understanding and defining what a VS is all about. Additionally, they felt supported in understanding and defining how SVs are affected by several components of the VS. Moreover, they felt supported in understanding what actually generates waste inside a VS and what kinds of different types of waste exist. Furthermore, they also felt supported in detecting and understanding where further components of a VS (e.g., IT systems or information) interface (i.e., are used, required, generated, etc.) with other components or processes that are part of the VS. In addition, they also felt supported in identifying and explicitly defining needs for change and development actions to achieve a draft for a potentially improved future version of the VS investigated. Although we did not cover the case for using *its*VALUE for designing an entirely new service and thus VS from scratch, all participants believe that *its*VALUE is probably well suited correspondingly. To sum up, these results indicate that the *its*VALUE method meets its hypothesis and, in turn, complies with the requirements of ITIL 4.

6.3.1. Limitations of the Case Study

Our case study and, in turn, evaluation of *its*VALUE are limited in several aspects. Firstly, we have investigated only a single case. Consequently, generalizing from this particular case to several other different ones is not reasonably possible, as noted by Zucker [155] and Gerring [45]. To reasonably draw generalizations, many additional case studies must be performed in various scenarios with much more participants or even other evaluation techniques (e.g., questionnaires). Further, we have gathered findings for *its*VALUE on the perceived efficacy and intention to use, whereas information on the actual efficacy and usage remains unknown. This must also be investigated in future work.

Moreover, we have explored only one of the two possible paths of the *its*VALUE method and performed just a single iteration that did not cover all stakeholders and aspects of the investigated VS. Consequently, our findings provide only initial implications and do not offer reasonable evidence, especially regarding the suitability of *its*VALUE for designing an entirely new service and VS. Additionally, the notation was not explicitly investigated for each model type of *its*VALUE separately. However, their quality seems to differ according to the participants' answers. Thus, their statements regarding the notations for each model type are mainly limited to their general overall perception. In future work, each model type should be investigated separately regarding its notation quality.

Furthermore, as the participants did not actually use the ADOxx modeler themselves, their perceptions and thus our results on it are also limited. The available time for both the modeling session and the GIs was limited and, in turn, short. As some participants suggested that more time would be required to cover all stakeholders and aspects of a VS (which we did not achieve), this should be carefully considered in future work, especially when performing several iterations of *its*VALUE. Additionally, we did not consider the desirability bias during the GIs, where participants may have intended not to insult the interviewer, especially in face-to-face communication. However, since we conducted everything via Microsoft Teams, this may have mitigated the influence of the desirability bias.

Lastly, we want to mention that we could only encourage four people to participate and provide input. This limits the expressiveness of our results. To conclude, we understand our findings as an initial direction that seems promising to follow.

6.3.2. Summary and Conclusion

Our first version of *its*VALUE, in combination with the first version of our ADOxx modeler, supports comprehensive modeling and analysis of IT-Service related VSs. Based on its consideration of ITIL 4 concepts, it may support practitioners in adopting that standard. Our case study revealed the great relevance of the *its*VALUE models and analysis results for value-oriented IT-Service modeling according to the participants involved. Furthermore, they showed interest in future use of the *its*VALUE method and ADOxx modeler. Moreover, they perceived all three *its*VALUE model types as good and supportive (with the exception of one participant perceiving the VSB as too complex and incomprehensible). Considering the answers of all participants, this may reveal that the *its*VALUE notation suits experienced modelers better than inexperienced ones. Additionally, they perceived the ADOxx modeler as powerful and beneficial. Lastly, all participants were satisfied with the way we executed the participatory modeling session.

Considering the limitations of the discussed case study, further evaluations and iterations of method engineering are required, as suggested by Buchmann and Karagiannis [22, 62–64]. Following the AMME methodology by Buchmann and Karagiannis [22, 62–64] (an iterative process for method engineering), we defined new modeling requirements specifically aimed at enhancing the VSB. Our results revealed that the VSB easily tends to become too "full" (i.e., it may contain too many different objects). This may reduce the clarity of the actual flow of a VS. In turn, enhancing and especially understanding VSs may suffer.

To address this issue, some kind of Process Specification Model (PSM) could be introduced to source out many objects. Following this idea, any process part of a VS would receive its own PSM. Similarly to the VPM, the process itself would embody the core of that model. Any other object the process interacts or interfaces with would be placed around that process and linked to it. Such information visually stored inside the PSMs could be transferred to the VSB (like the VPMs). There, it would be stored inside internal annotation tables of the processes (accessible via double-click in ADOxx). This would make the VSB leaner, as it would just present the actual flow between all processes, and no information would be lost due to our dynamic script.

To conclude, our first artifacts whose development was introduced in Chapter 5 already enable applicants to explicitly consider SV when designing or improving VSs from a more generic point of view.

7. Developing the Updated Version

Our case study from Chapter 6 showed that the first version of *its*VALUE already serves its purpose well. However, it also revealed that its notation suffers a crucial weakness regarding a specific model type, the Value Stream Blueprint (VSB). Thus, refinements and re-engineering of *its*VALUE were necessary to address this and other minor issues. This Chapter introduces the current state of *its*VALUE, including all of these changes. First, Section 7.1 describes our methodological approach and the requirements we derived for refinement. This section details the steps taken to identify and prioritize the necessary improvements, ensuring that the refinements are aligned with the overall goals of *its*VALUE.

Following this, Section 7.2 presents the updated *its*VALUE method framework. This section outlines the revised steps and processes that constitute the *its*VALUE method, highlighting the improvements made to streamline the modeling process and enhance clarity. The updates aim to make the method more intuitive and user-friendly. Section 7.3 then details the updated conceptualization and notation, mainly focusing on the modifications made to the VSB to reduce complexity and improve cognitive fit. These changes are intended to facilitate a better understanding of the VSs and their components, making the notation more intuitive and easier to use. The refinements in notation are crucial for ensuring that the *its*VALUE method can be effectively applied by both novice and experienced modelers. Section 7.4 introduces the updated ADOxx modeler. This section covers the enhancements made to the tool to support the refined *its*VALUE method and notation. The updates include new features and functionalities designed to assist users in creating and analyzing VSs more efficiently. These improvements are based on the feedback from our initial case study and aim to provide a more robust and user-friendly modeling environment.

Then, Section 7.5 discusses the results of these updates, providing an in-depth analysis of their impact on the modeling process. This discussion includes a comparison of the initial and updated versions of *its*VALUE, highlighting the benefits and any remaining challenges. By examining the outcomes of the refinements, we can assess the effectiveness of the changes and identify areas for further improvement. Section 7.5.1 outlines our limitations, acknowledging the constraints of our study and the areas that require further research. Recognizing these limitations helps to frame the results within the appropriate context and guides the direction of subsequent research efforts. Lastly, Section 7.5.2 draws a conclusion and summary of our results from this Chapter. This section summarizes the key improvements made to *its*VALUE and their implications for IT-Service modeling.

7.1. Towards the Refinement of *its*VALUE

In the Design Science Research (DSR) process by Peffers et al. [99, 100], we are currently at iterating back after the first evaluation of our proposed artifacts from Chapter 5. Based on these evaluations from Chapter 6, we derived new requirements for changing and enhancing *its*VALUE. Therefore, we followed the AMME methodology by Buchmann and Karagiannis [22, 62–64], an iterative process for method engineering.

Although we initially focused on the findings from the case study from Chapter 6, we also performed a complete iteration of its method framework on a completely fictional case to derive further requirements for improvements after applying those initial requirements to *its*VALUE. This approach allowed us to test the robustness and flexibility of the *its*VALUE method in different contexts and scenarios. By simulating various conditions, we aimed to uncover additional areas for enhancement that might not have been evident in the initial case study.

In doing so, we conducted both an ex post evaluation under artificial and naturalistic conditions in the sense of Venable et al. [140, 141]. This combined approach ensured that our findings were comprehensive and applicable to real-world situations. The artificial conditions allowed us to control variables and isolate specific factors, while the naturalistic conditions provided insights into how *its*VALUE performs in more realistic and uncontrolled environments. These evaluations are crucial for refining the method and ensuring its practical applicability and effectiveness.

7.1.1. Derived Requirements (Rs) from a Case Study (Naturalistic)

All of the following requirements were derived from the findings of a case study described in Chapter 6. It indicated that the Value Stream Blueprint (VSB) model type was the main disadvantage of *its*VALUE. The VSB became too incomprehensible to all participants, as it was overloaded with different concepts and relations. Consequently, the participants perceived that the overall method could also be improved in terms of supporting the understanding of VSs, as it is highly dependent on the conceptual design of the VSB. To tackle this issue, we introduced another model type called the Process Specification Model (PSM). Its objective is to source out further important information from the VSB. The VSB should still consist of any component that is part of a VS, but it should only display the relations showing the flow to really focus on that flow. However, this information should not be lost from the VSB. Thus, the relations and dependencies outsourced to the PSM must be stored inside the objects that are part of those relations. For the ADOxx modeler, several issues were discovered during the case study, including a variety of bugs and minor enhancement potentials. To sum up, we list all proposed requirements:

R1: Implement a Process Specification Model (PSM) and ensure storing all its displayed relations inside the objects being part of those.

R2: Implement a functionality allowing stakeholder-specific views on the value creation inside a VS, not just the global one (as desired by participants).

R3: Values should be assigned to their corresponding stakeholder for better distinguishing them inside a Stakeholder Value Map (SVM).

R4: The participants demanded assistance regarding placing allowed relations.

R5: Fix several bugs to maintain consistency across all models (especially when removing relations or instances) more reliably.

R6: Create an application manual for the ADOxx modeler explaining all different aspects of *its*VALUE and how to use the modeler accordingly.

7.1.2. Derived Requirements (Rs) from a Fictional Case (Artificial)

When performing this further iteration after having implemented the previously listed requirements, we still encountered additional areas for improvement. Once we identified these areas, we immediately implemented the necessary changes before continuing. The resulting models of this fictional iteration are shown later in Section 7.3.3. While we could only follow the method framework roughly during the case study, we adhered to it strictly this time. During this process, we noticed that some parts of the framework were not as precisely described as originally intended. Consequently, these parts had to be re-arranged and paraphrased for clarity. Moreover, upon re-investigating the different model types, we realized that the concept classes AND, OR, and XOR (previously part of all model types) could cause consistency errors within a VPM. Therefore, they needed to be removed from this model type. Additionally, we observed that the data information for a process could be simplified and its related KPIs could be automatically calculated instead of being manually called. We also identified a previously unconsidered type of waste for analog information, which should be added, and detected further minor bugs and improvement potentials for the ADOxx modeler. Furthermore, the "Interface" relation class needed to become bidirectional. To sum up, we list all further derived requirements:

R7: Re-arrange and paraphrase Phase 3 (see Section 7.2.3) and Phase 4 (see Section 7.2.4), and adapt the overall method framework (see Section 7.2) accordingly.

R8: Remove the connector concept classes AND, OR, and XOR from the Value Perception Model (VPM) and automatically check the correct number of stakeholders.

R9: Simplify the data information inside a process and automate the calculation of its related KPIs (DA, DU, and DR).

R10: Implement automatic recognition of waste for analog information.

R11: Extend the Development Action concept class so that multiple instances can exist across several models and stay updated.

R12: Simplify the use of callable procedures.

R13: Improve the "Interface" relation class' visualization to show its bidirectional nature.

7.2. The Updated *its*VALUE Method Framework

Figure 7.1 shows the *its*VALUE method framework. It consists of four different phases. The process begins with understanding and defining SV to initially focus on what must be accomplished and considered. This foundational phase ensures that all relevant value aspects are identified and understood before proceeding.

Next, the proposed path splits into two different directions: either design an entirely new VS from scratch or focus on an already existing VS. This bifurcation allows for flexibility depending on the specific needs and context of the project. For new VSs, the

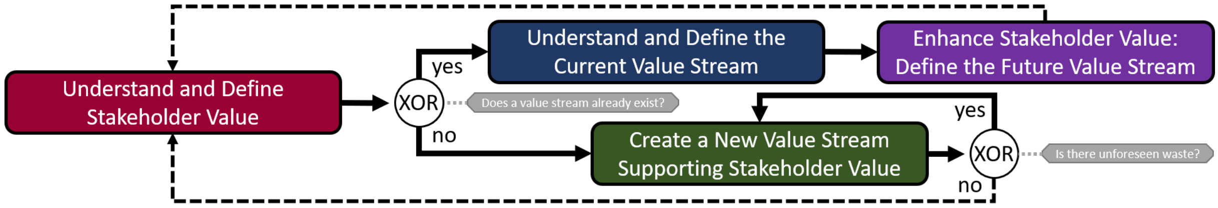


Figure 7.1.: The Updated *its*VALUE Method Framework

method provides a structured approach to create a comprehensive VS from the ground up. For existing VSs, the focus shifts to analyzing and enhancing the Current Value Stream (CVS).

Once a Current Value Stream (CVS) is determined and analyzed, it should be enhanced by drafting a proposed Future Value Stream (FVS). This phase involves identifying areas for improvement and developing strategies to optimize the VS. The method supports an iterative approach to develop the required insight into the proposed VS. In such a modeling context, Geist [44] suggests performing four iterations to ensure thorough analysis and refinement.

This updated method framework differs from its predecessor by introducing a splitting path after creating an entirely new VS. This change results from the modifications discussed in Section 7.2.4. If any unforeseen waste is detected during this phase, instead of continuing with another iteration of the entire method framework, this phase is repeated to address the issues (R7). This iterative refinement ensures that the VS is continuously optimized and aligned with the project's goals.

Overall, the updated *its*VALUE method framework provides a comprehensive and flexible approach to IT-Service modeling, accommodating both new and existing VSs. By incorporating iterative refinement and addressing specific weaknesses identified in previous evaluations, the framework aims to enhance the effectiveness and usability of the *its*VALUE method.

7.2.1. Understand and Define Stakeholder Value (SV)

Compared to its predecessor, this phase remained exactly the same. Initially, all different value perceptions by all stakeholders involved must be assessed, understood, and explicitly defined. Figure 7.2 illustrates the three steps that must be conducted.

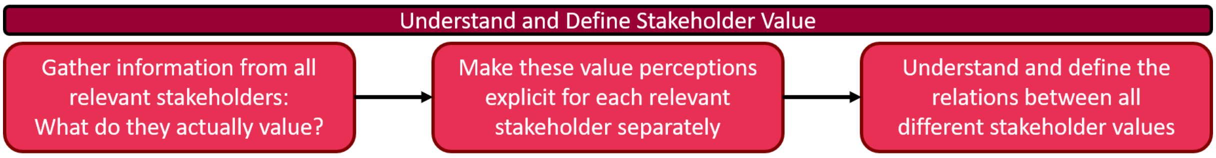


Figure 7.2.: Understand and Define Stakeholder Value (SV)

First, information must be gathered from every relevant stakeholder regarding what they actually value. This step is crucial for ensuring that all perspectives are considered and that the VS reflects the needs and priorities of all stakeholders. Effective communication and thorough data collection methods are essential at this stage to capture accurate and comprehensive value perceptions.

Next, these SV perceptions must be made explicit. This involves clearly defining and documenting each stakeholder's value perceptions to ensure they are well understood and can be effectively incorporated into the VS. For each of these perceptions, one should determine a Relevance Factor (RF), inspired by hygiene and success factors according to Nerdinger [93], and a Current Performance Level (CPL). These factors help in categorizing and prioritizing the value perceptions, providing a structured approach to understanding stakeholder needs.

Lastly, the relations and dependencies among all SVs perceptions must be investigated. This step involves analyzing how different value perceptions interact and influence each other. Understanding these relationships is vital for identifying potential conflicts or synergies between SVs. It also helps in designing a VS that optimally balances and integrates these diverse perceptions.

By following these steps, the phase ensures a comprehensive understanding of SVs, which is foundational for the subsequent phases of the *its*VALUE method. This thorough assessment and explicit definition of value perceptions enable the creation of a VS that is aligned with stakeholder needs and priorities, ultimately enhancing the effectiveness and relevance of the *its*VALUE method.

7.2.2. Understand and Define the Current Value Stream (CVS)

Like the previous phase, this one also remained the same compared to its predecessor. However, there is a slight difference that will be described later. Following the path for a CVS, it must be investigated by first modeling and then analyzing it. Therefore,

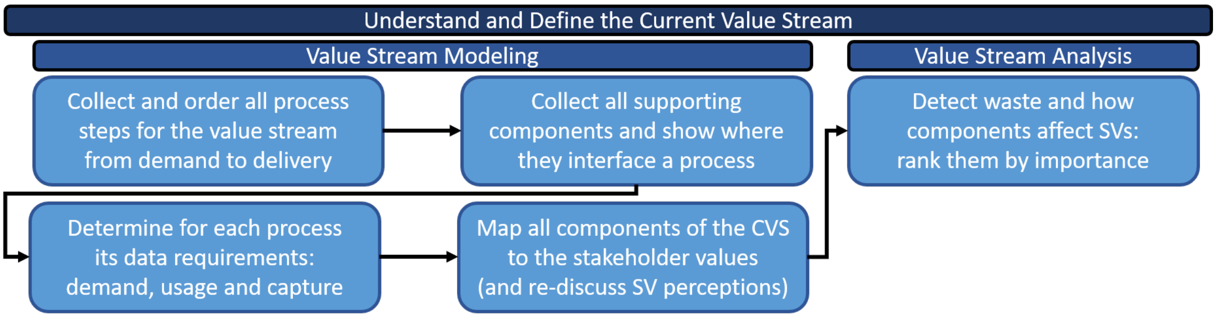


Figure 7.3.: Understand and Define the Current Value Stream (CVS)

this phase is divided into two main clusters: VS modeling and VS analysis. Figure 7.3 illustrates all the steps that must be carried out.

In the VS modeling cluster, the CVS is meticulously mapped out. This involves identifying all relevant processes, resources, and interactions that constitute the CVS. The goal is to create a comprehensive model that accurately represents the existing VS, capturing all essential elements and their relationships. This model serves as the foundation for subsequent analysis and improvement efforts.

Once the VS modeling is complete, the focus shifts to the VS analysis cluster. In this cluster, the modeled CVS is thoroughly examined to identify inefficiencies, bottlenecks, and areas for improvement. Various analytical techniques and tools are employed to assess the performance of the VS, evaluate its effectiveness, and uncover opportunities for optimization. This analysis is crucial for understanding the current state of the VS and forming the basis for developing a more efficient and effective FVS.

By dividing this phase into VS modeling and VS analysis clusters, the *its*VALUE method provides a structured and systematic approach to understanding and improving the CVS. This comprehensive investigation lays the groundwork for developing a more optimized and value-driven FVS, ultimately enhancing the overall effectiveness of the *its*VALUE method.

7.2.2.1. Value Stream Modeling

Firstly, any process or activity that is part of the value creation must be collected and ordered from the initial demand to the final delivery. This step ensures that the entire VS is mapped out in a logical sequence, providing a clear overview of how value is created and delivered.

Next, all additional components (IT systems, IT resources, physical evidences, and information) must be collected and connected to those processes wherever they interface, require, or generate each other. This step is crucial for understanding the interactions and dependencies between different components of the VS. By mapping these connections, we can identify potential bottlenecks, inefficiencies, and improvement areas.

Afterwards, for each process, its data requirements should be defined. This includes specifying whether the data is desired (*Desired: Yes/No*), whether it is used (*Used: Yes/No*), and how it is acquired (*Acquisition: None/Automatically/Manually*). Defining these data requirements helps in understanding the data flow within the VS and identifying any gaps or redundancies.

From these data requirements, important KPIs can be calculated (see Figure 7.4): the Data Availability (DA), Data Usage (DU), and Digitization Rate (DR). These KPIs provide valuable insights into the efficiency and effectiveness of the data management processes within the VS. For instance, the Data Availability (DA) measures the accuracy of data acquisition, the Data Usage (DU) assesses the utilization of data, and the Digitization Rate (DR) evaluates the digitization of the data.

To simplify the process, we left out counting captured data and instead added "None" to the "Acquisition" category. This adjustment implicitly covers whether data is captured while reducing the input effort required from the user (R9). This simplification makes the

$$DR = \frac{\sum \textit{automatically acquired data}}{\sum \textit{acquired data}} \qquad DA = \frac{\sum \textit{acquired data}}{\sum \textit{desired data}}$$

$$DU = \frac{\sum \textit{used data}}{\sum \textit{acquired data}}$$

Figure 7.4.: Calculating the DR, DA & DU, based on Hartmann and Meudt et al. [51,85]

$$RF: \begin{cases} 3 \ \textbf{if} \ \textit{Mandatory} \\ 1 \ \textbf{if} \ \textit{Moderate} \\ 2 \ \textbf{if} \ \textit{High} \\ 3 \ \textbf{if} \ \textit{Outstanding} \end{cases} \qquad CPL: \begin{cases} -3 \ \textbf{if} \ \textit{Poor} \\ \ \ 1 \ \textbf{if} \ \textit{Moderate} \\ \ \ 2 \ \textbf{if} \ \textit{High} \\ \ \ 3 \ \textbf{if} \ \textit{Outstanding} \end{cases} \qquad IF: \begin{cases} \frac{1}{2} \ \textbf{if} \ \textit{Low} \\ 1 \ \textbf{if} \ \textit{Moderate} \\ \frac{3}{2} \ \textbf{if} \ \textit{High} \end{cases}$$

$$VW = RF \times CPL$$

Figure 7.5.: Variable Assignments & Calculating the Value Weight (VW) of a SV

process more user-friendly and efficient, ensuring that users can easily define and manage data requirements.

Next, all components should be mapped to the SV perceptions with regard to their Impact Factor (IF) on them. This mapping helps in understanding how each component influences the value perceptions of stakeholders. By analyzing these influences, we can identify key drivers of value and areas where improvements can have the most significant impact. This step is essential for aligning the VS with stakeholder needs and ensuring that the value creation process is optimized for maximum effectiveness.

7.2.2.2. Value Stream Analysis

During the analysis, waste within the CVS and potential improvement spots should be detected. Waste can be identified through the DA, DU, and DR metrics, particularly if their values are lower or higher than 1 (indicating poor use, bad availability, or digitization potential). The closer these KPIs are to 1, the better optimized the process is. These metrics can also indicate potential media breaks, while waiting times and bottlenecks can also signal waste.

Algorithm 2: Calculating the S Score & H Score of a VS component

set $S,\ H : 0$
foreach *affectedObject* **do**
    if $(affectedObject \in Value)$ **then**
        set $eachResult : VW_{affectedObject}$
    if $(relationType \in Supports)$ **then**
        if $(affectedObject \notin Value)$ **then**
            set $eachResult : S_{affectedObject} \times \frac{1}{2}$
        if $(eachResult < 0)$ **then**
            set $eachResult : eachResult \times -\frac{1}{3}$
        set $S : S + (eachResult \times IF_{relationType})$
    else if $(relationType \in Hinders)$ **then**
        if $(affectedObject \notin Value)$ **then**
            set $eachResult : H_{affectedObject} \times \frac{1}{2}$
        if $(eachResult > 0)$ **then**
            set $eachResult : eachResult \times -\frac{2}{3}$
        set $H : H + (eachResult \times IF_{relationType})$
end
return S, H

A unique feature of *its*VALUE is the consideration of the stakeholder perspective in identifying waste. In this context, consumed value refers to costs that can be calculated for value delivery activities, represented by the Hindering Score (H Score). Conversely, added value can be determined by the Supporting Score (S Score). Both are calculated based on the influence (supporting or hindering) that a VS component has on SV perceptions. While Algorithm 2 explains this calculation, Figure 7.5 shows how important variables are assigned.

However, since we are not dealing with a metric scale in this regard, directly weighting the created value against the detected waste is problematic. Therefore, the interpretation of both is left to human analysis. Moreover, there is no empirically validated calculation for this yet. Thus, we aimed to keep it as simple and intuitive as possible by defining and primarily using a Value Weight (VW), based on implications by Nerdinger [93] through the RF. Additionally, we ensured that a supporting impact (both direct and indirect / transitive) never generates a negative S Score, and vice versa, a hindering impact never generates a positive H Score.

Lastly, all identified waste should be ranked (e.g., via the KPIs) to determine the most urgent issues to be addressed, especially when there are not enough resources to tackle all problems simultaneously. This prioritization helps in focusing efforts on the most critical areas, ensuring that the most significant improvements are made first.

7.2.3. Enhance SV: Define the Future Value Stream (FVS)

This phase has been re-arranged and paraphrased compared to its predecessor (R7). Figure 7.6 outlines all the steps that should be undertaken. First, based on the identified and ranked waste, value opportunities should be defined alongside any related problems, causes, and constraints. This initial step is crucial for setting the stage for targeted improvements and ensuring that all relevant factors are considered.

Next, the path splits into three possible directions with an inclusive "OR" instead of following a continuous path. We switched to this arrangement because, during the artificial evaluation, we found that not all of these steps are always necessary. This flexible approach allows for a more efficient process, as it ensures that if only one step is completed, the final step is still reached. This adaptability is essential for accommodating different project needs and contexts. Those three middle steps all focus on defining development actions for different aspects: value opportunities, media breaks, and the flow. Each of

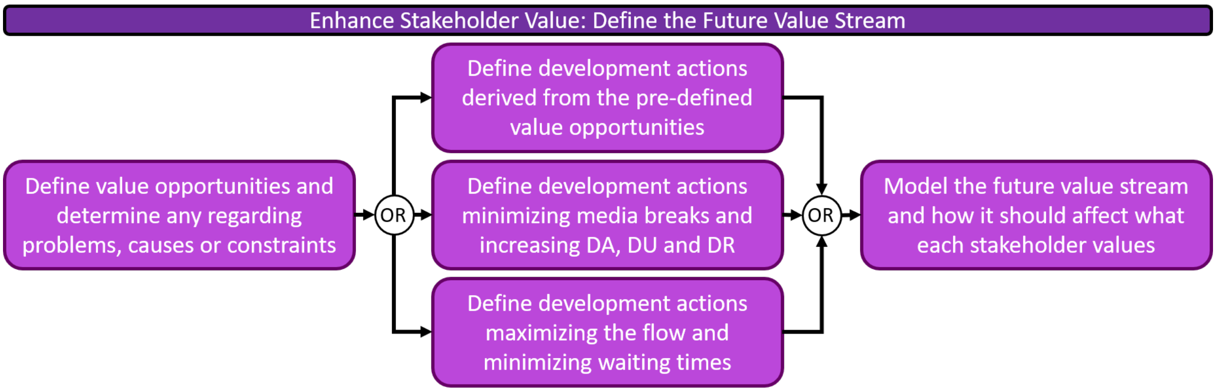


Figure 7.6.: Enhance Stakeholder Value: Define the Future Value Stream (FVS)

these steps addresses a specific area of improvement, ensuring a comprehensive approach to enhancing the VS. By targeting these key areas, the method aims to optimize the overall performance and effectiveness of the VS.

Lastly, the FVS should be modeled according to and in compliance with the previously defined development actions. This step involves creating a detailed model of the FVS that incorporates all the planned improvements. Additionally, the new desired impacts on the SV perceptions should be modeled as well. This ensures that the VS not only addresses the identified issues but also aligns with the stakeholders' value perceptions, ultimately enhancing the overall value creation process.

By re-arranging and paraphrasing this phase, we have made it more flexible and adaptable to different scenarios. This updated approach allows for a more efficient and targeted improvement process, ensuring that the *its*VALUE method remains effective and relevant in various contexts.

7.2.4. Create a new VS Supporting Stakeholder Value (SV)

Like the previous phase, this one has been re-arranged, paraphrased, and even extended compared to its predecessor (R7). Figure 7.7 shows all the steps that must be conducted. During the artificial evaluation, we noticed that instead of just modeling, an additional analysis phase may be crucial for a new VS. Hence, we arranged all steps similarly to those in Section 7.2.2. However, it starts like in Section 7.2.3 with defining value opportunities alongside any related problems, causes, and constraints.

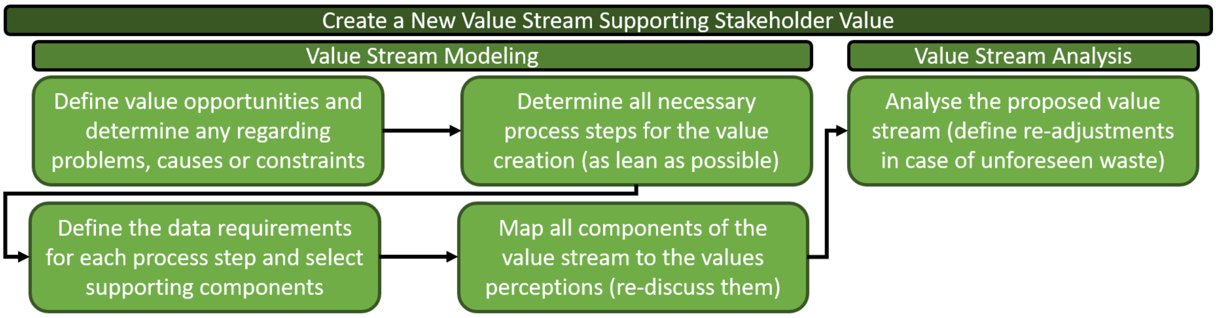


Figure 7.7.: Create a New Value Stream (VS) Supporting Stakeholder Value (SV)

Then, based on the identified value opportunities, all necessary process steps for the proposed value creation should be determined. This involves outlining the sequence of activities required to achieve the desired value outcomes. Each process step should be clearly defined to ensure a comprehensive understanding of the value creation pathway. Next, the data requirements for these processes should be defined, specifying whether data is desired, used, and how it is acquired (e.g., none, automatically, or manually). This step is essential for ensuring that all necessary data is available and appropriately managed to support the value creation processes. Accordingly, supporting components such as IT systems, resources, and physical evidence should be selected and integrated into the VS. Then, similar to the approach in Section 7.3, all determined VS components should be mapped alongside their impact on the defined SV perceptions. This mapping helps in understanding how each component contributes to or detracts from the overall value creation process, ensuring that the VS is aligned with stakeholder expectations and needs.

Lastly, the proposed new VS should be similarly analyzed as described in Section 7.2.2.2. This analysis phase is crucial for identifying any unforeseen waste or inefficiencies within the newly designed VS. If any such waste is detected, this entire phase should be repeated for initial refinements instead of conducting a new iteration of the method framework (see Figure 7.2). This iterative approach ensures that the VS is continuously optimized and refined before final implementation.

By incorporating these steps, the updated phase provides a structured and thorough approach to creating a new VS that supports Stakeholder Value (SV). The inclusion of an additional analysis phase enhances the robustness of the method, ensuring that potential issues are identified and addressed early in the design process.

7.3. The Updated *its*VALUE Conceptualization

This section presents the updated *its*VALUE notation. First, all updated meta-models are explained in detail. These meta-models provide the foundational structure for the *its*VALUE method, defining the key concepts and relationships that underpin the modeling process. Understanding these meta-models is crucial for effectively applying the *its*VALUE notation.

Next, all visual representations for the concept and relation classes are shown. These visual representations are essential for conveying the various elements of the *its*VALUE method in a clear and intuitive manner. By standardizing the visual language, we ensure that the models are easily interpretable and that users can quickly grasp the relationships and interactions between different components.

Lastly, all four model types are introduced with examples. These model types include the Value Stream Blueprint (VSB), Value Perception Model (VPM), Stakeholder Value Map (SVM), and Process Specification Model (PSM). Each model type serves a specific purpose within the *its*VALUE method, and the examples provided illustrate how they can be applied in practice. By showcasing these examples, we aim to demonstrate the versatility and applicability of the *its*VALUE notation across different scenarios.

Through this comprehensive presentation of the updated *its*VALUE notation, we aim to provide users with a clear understanding of how to effectively utilize the method. The detailed explanations, visual representations, and practical examples collectively ensure that users are well-equipped to apply the *its*VALUE notation in their own projects.

7.3.1. The Updated Meta-Models

The conceptual meta-models of the modeling language of *its*VALUE are represented using the UML standard. Figure 7.8 shows all concept classes and their features by inheritance. Compared to its predecessor, it has remained largely the same. However, *"Affecting Object"* and "Activity / Process" have received new attributes required for the PSM use (R1). Additionally, "Development Action" now inherits from *"Linked Object"* (R11), and "AND", "OR", and "XOR" no longer inherit from an additional abstract *"Decomposition Opbject"* class between them and the *"itsVALUE Object"* for simplicity reasons.

In contrast, the relation meta-model has stayed the same compared to its predecessor and has only been visually improved. Figure 7.9 shows all relation classes and their features by

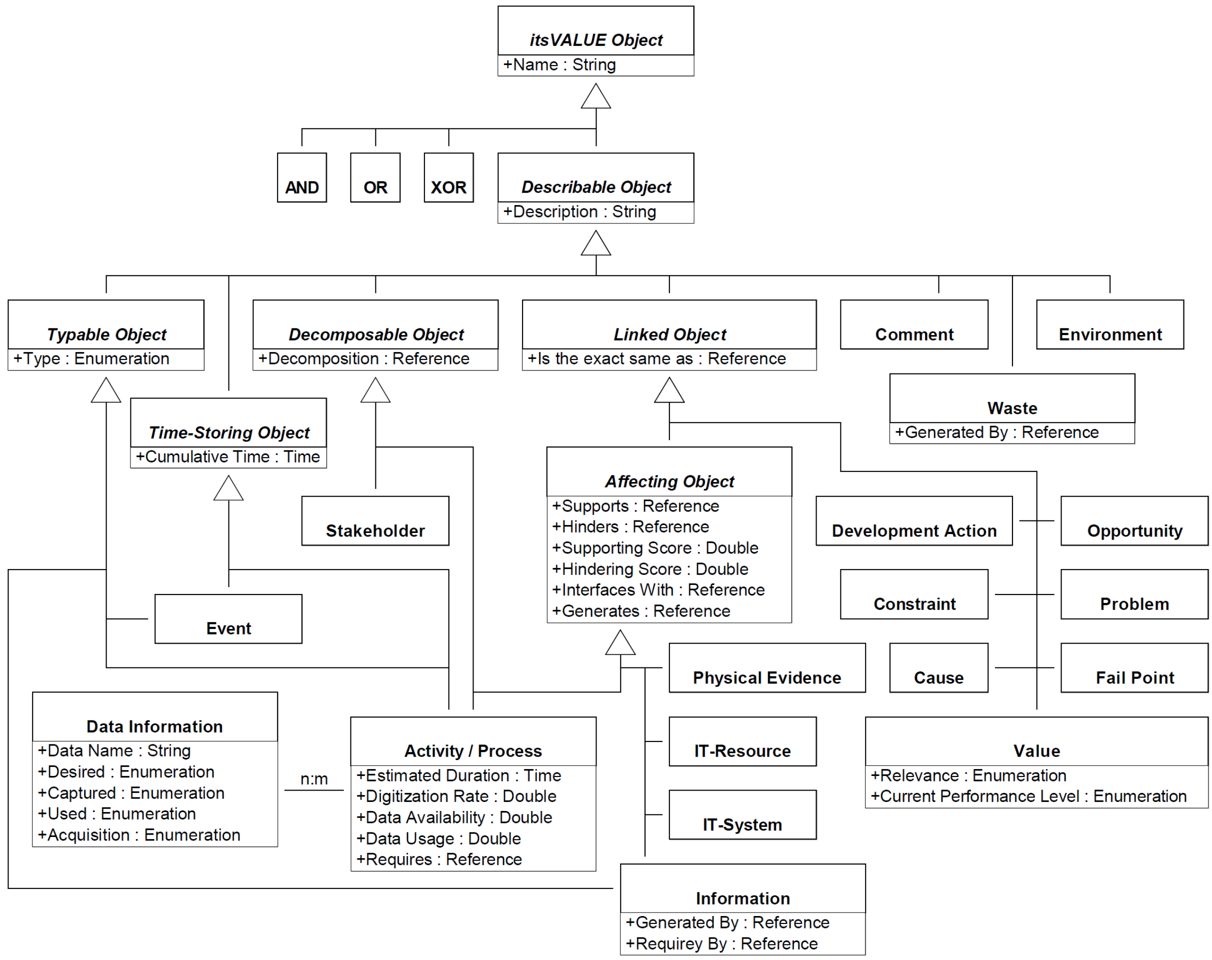


Figure 7.8.: The Updated *its*VALUE Object Metamodel

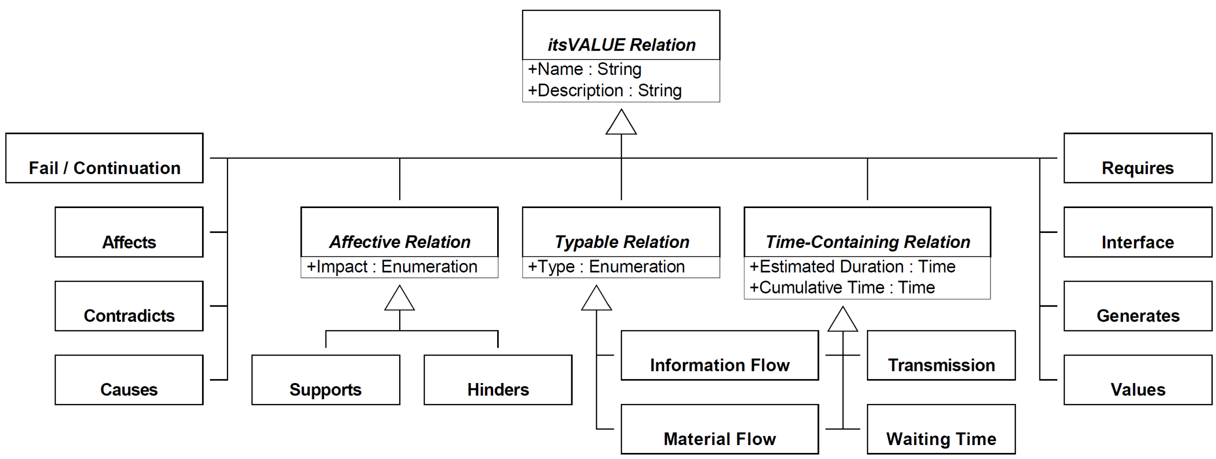


Figure 7.9.: The Updated *its*VALUE Relation Metamodel

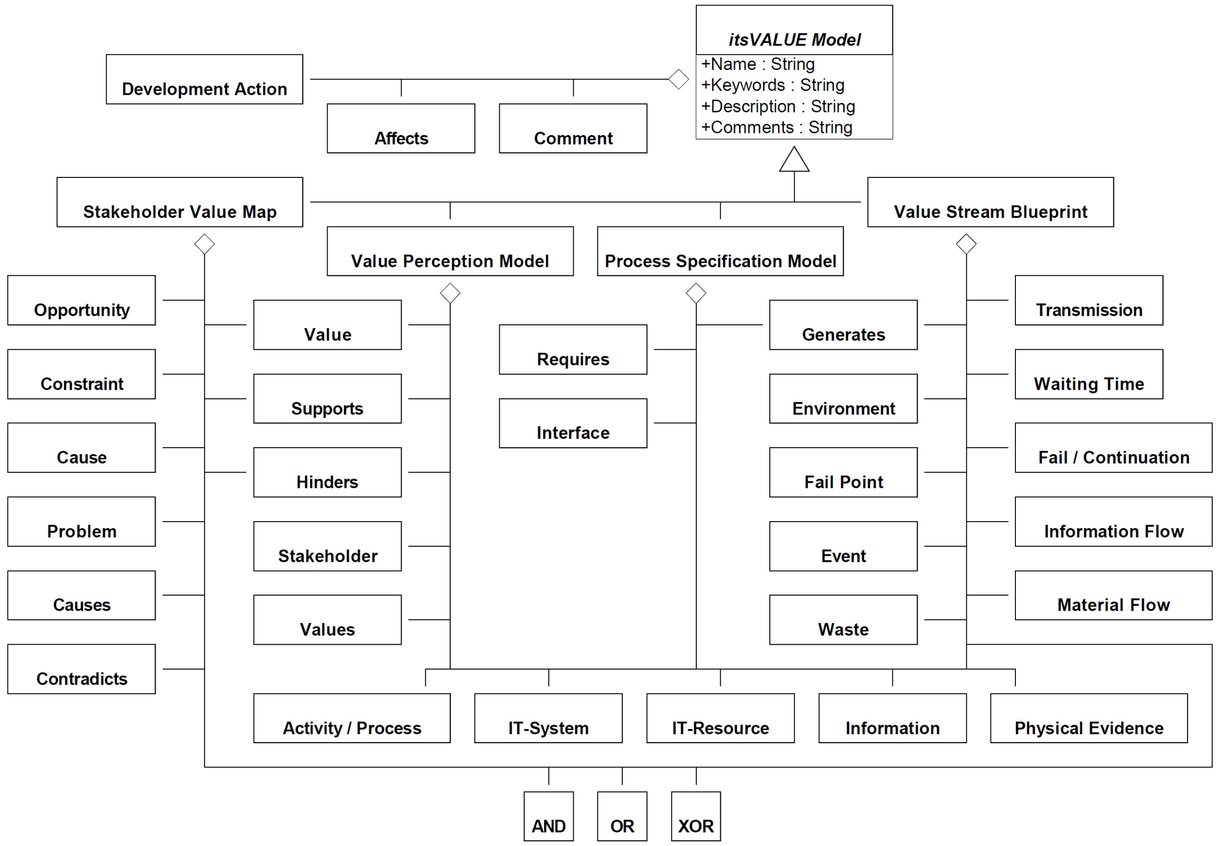


Figure 7.10.: The Updated *its*VALUE Model Metamodel

inheritance. However, their allowed domains and ranges are too complex to be displayed as a figure, as some are not universally generic. In other words, an allowed range is not always valid for its designated relation class. Instead, it is further dependent on the domain together with the relation class it forms a tuple with. To illustrate this compactly, Table 7.1 lists all allowed Relation-Domain-Range (RDR) tuples (R4).

Figure 7.10 presents the model meta-model, showing four different model types and which concept and relation classes they consist of. A class is only a part of a model type if they are connected via a non-downward or just-upward flow. In contrast to its predecessor, the new Process Specification Model (PSM) is introduced (R1). Additionally, the ”AND”, ”OR”, and ”XOR” concept classes have been removed from the VPM (R8).

These updates to the meta-models ensure that the *its*VALUE method remains robust and adaptable to various modeling scenarios. By refining the attributes and inheritance structures, we have enhanced the clarity and usability of the meta-models, making them

Relation Class(es)	**Domain(s)**	**Range(s)**
Values	Stakeholder	Value
Supports, Hinders	Value, Activity / Process, Physical Evidence, IT-System, IT-Resource, Information, AND, OR, XOR	Value
Supports, Hinders	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information
Supports, Hinders	Value	Value, AND, OR, XOR
Supports	Opportunity, AND, OR, XOR	Value, Opportunity, AND, OR, XOR
Hinders	Problem, Constraint, AND, OR, XOR	Value, Opportunity, AND, OR, XOR
Contradicts	Value	Value
Causes	Cause, AND, OR, XOR	Opportunity, Problem, Constraint, AND, OR, XOR
Interface	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information
Requires, Generates	Activity / Process	Information
Generates	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information	Waste
Information Flow, Material Flow, Waiting Time, Transmission	Activity / Process, Event, AND, OR, XOR	Activity / Process, Event, AND, OR, XOR
Fail / Continuation	Fail Point	Activity / Process, Event
Fail / Continuation	Activity / Process, Event	Fail Point
Affects	(any) *its*VALUE Object	(any) *its*VALUE Object

Table 7.1.: All Allowed Relation-Domain-Range (RDR) Tuples

more intuitive for users. The introduction of the Process Specification Model (PSM) and the removal of unnecessary abstract classes streamline the modeling process, reducing complexity and potential errors. These improvements are crucial for maintaining the effectiveness and efficiency of the *its*VALUE method.

7.3.2. The Visual Representations

*its*VALUE consists of 20 different concept and 14 different relation classes, each with further different types. As each requires its unique shape, there are 26 different visualizations for the concept classes (see Table 7.2) and 16 for the relation classes (see Table 7.3). Originally, we adhered to the visualizations of 4EM, BPMN, IT S-SB, and VSD 4.0 to comply with the principles for cognitively effective visual notations by Moody [90].

During the refinement process, we enhanced the visualization for the "Interface" relation class from unidirectional to bidirectional (R13). This change was made as it was perceived as more reasonable during the artificial evaluation, due to the implications of storing its information inside objects caused by the PSM (R1). The bidirectional visualization provides a clearer representation of the interactions and dependencies between different components, improving the overall comprehensibility of the models.

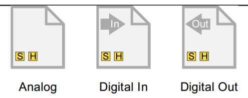
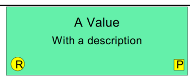
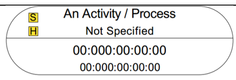
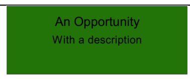
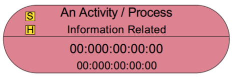
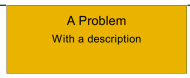
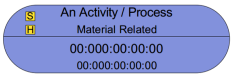
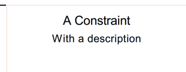
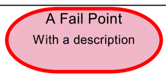
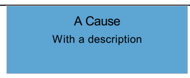
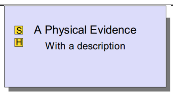
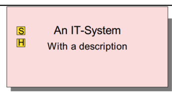
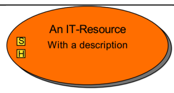
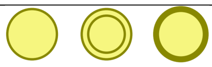
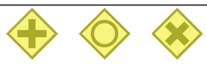
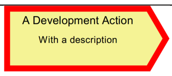
Concept Class	Visualization	Concept Class	Visualization
Information		Stakeholder	
Environment		Value	
Activity / Process		Opportunity	
(Information Related)		Problem	
(Material Related)		Constraint	
Fail Point		Cause	
Physical Evidence		IT-System	
Waste		IT-Resource	
Event (Start/Usual/End)		AND, OR, XOR	
Development Action		Comment	

Table 7.2.: Visual Representations of all Concept Classes and their Sub-Types

Relation Class	Visualization	Relation Class	Visualization
Fail / Continuation	F/C	Affects	A
Transmission		Generates	G
Interface		Requires	R
Material Flow (Push)		Supports	+
Material Flow (Pull)		Hinders	-
(Product) Information Flow		Contradicts	#
(Process) Information Flow		Causes	!
Waiting Time		Values	

Table 7.3.: Visual Representations of all Relation Classes and their Sub-Types

These visualizations are crucial for ensuring that the *its*VALUE models are easily interpretable and that users can quickly grasp the relationships and interactions between different elements. By adhering to established visual standards and enhancing them where necessary, we aim to provide a robust and user-friendly modeling language that supports effective communication and analysis.

The comprehensive set of visualizations for both concept and relation classes ensures that all aspects of the *its*VALUE method are clearly represented. This visual clarity is essential for facilitating the modeling process and ensuring that users can effectively apply the *its*VALUE method to their specific contexts. By continuously refining these visualizations, we strive to maintain the cognitive effectiveness and usability of the *its*VALUE notation.

7.3.3. The Four Model Types & Proof of Concept

The Value Perception Model (VPM) received a minor change compared to its predecessor. The ”AND”, ”OR”, and ”XOR” concept classes were removed, as they caused conceptual errors, especially regarding the calculation of the S Score and H Score (R8). Overall, it retains its purpose of providing stakeholder-centric views where each stakeholder has their own VPM. Inside a VPM, their SV perceptions are made explicit, showing how these are impacted by VS components. Figure 7.11 shows an exemplary VPM.

The Stakeholder Value Map (SVM) did not receive any changes at all. During both the case study and artificial iteration, it served its purpose well: explicitly defining dependen-

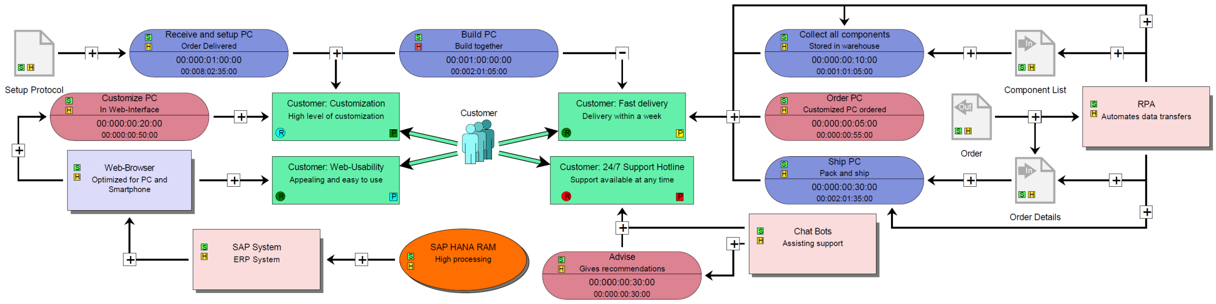


Figure 7.11.: An Exemplary VPM for a Stakeholder called "Customer"

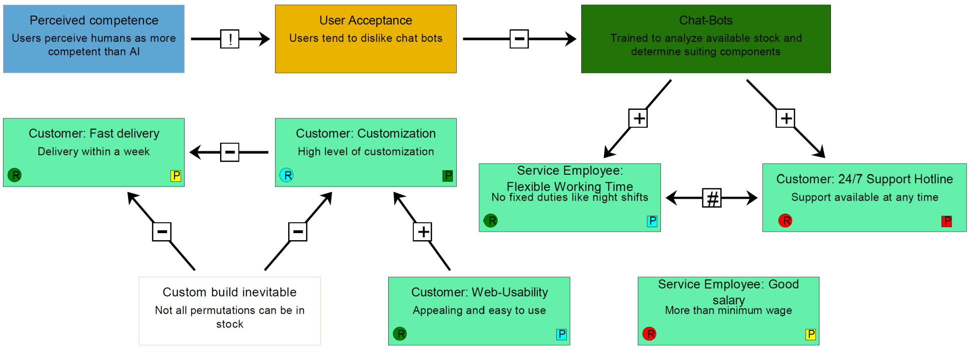


Figure 7.12.: An Exemplary SVM for 2 Different Stakeholders

cies and relations among different SV perceptions, along with opportunities, problems, constraints, and causes. Figure 7.12 shows an exemplary SVM.

The Value Stream Blueprint (VSB) received the most changes of all the original three model types. While its predecessor included every aspect of a VS besides the actual flow, these additional aspects are now outsourced to the PSM (R1). This adjustment allows the VSB to establish a concrete focus on the flow between processes and activities from the initial demand to the final delivery. The VSB still contains all VS components, but the further relations among these components are outsourced to the PSM. Figure 7.13 shows an exemplary VSB.

The Process Specification Model (PSM) is designed to source out additional information from a VSB to keep it comprehensible and not overloaded. Initially, we intended to handle the PSM similarly to the VPM, so that every single process would receive its own model like the stakeholders. However, when conceptually formulating the PSM, we noticed that it would not contain as many relations as a common VPM. Thus, we decided against requiring each process to have its own PSM. Instead, multiple processes are allowed to be

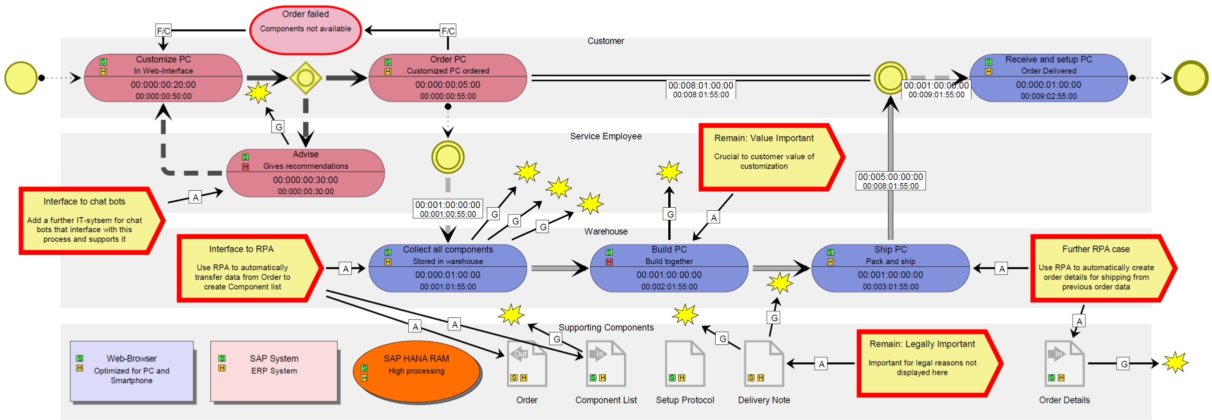


Figure 7.13.: An Exemplary VSB for a Fictional VS

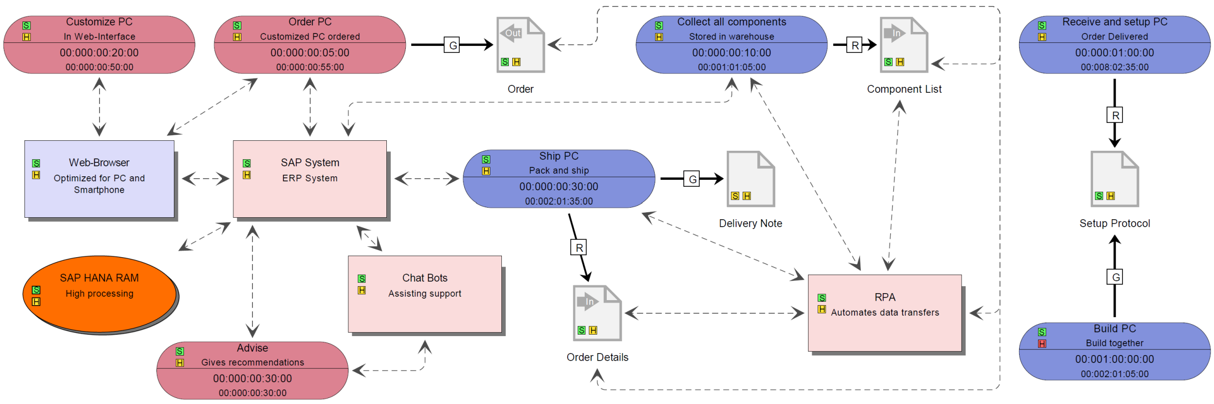


Figure 7.14.: An Exemplary PSM for the VSB from figure 7.13

placed inside a single PSM along with their relations to other components. Figure 7.14 shows an exemplary PSM for the VSB from Figure 7.13 (R1).

These updates ensure that each model type within the *its*VALUE method is optimized for clarity and usability. By refining the VPM, SVM, VSB, and introducing the PSM, we have enhanced the overall effectiveness of the *its*VALUE method. These changes address the feedback from our evaluations and aim to provide a more streamlined and intuitive modeling experience for users.

7.4. The Updated ADOxx Modeler & Manual

The most Requirements (Rs) were conceptually minor and primarily addressed the *its*VALUE ADOxx modeler. Most importantly, we created a supplementary application manual to establish a more seamless connection between the *its*VALUE method framework, its notation, and the ADOxx modeler (R6). Both the manual and the modeler are available for free download via OMiLAB[1]. Further, we published the original source code through Zenodo[2] and the manual at ResearchGate[3] [112] (also attached to Appendix D).

Furthermore, we focused on fixing several bugs that were missed initially and those caused by subsequent ADOxx updates after the initial release of *its*VALUE. The artificial evaluation revealed that our ADOxx modeler, in its current state, does not crash or cause any consistency errors accidentally (R5). Additionally, we added a mechanism to check any relation placed by the user. If it is prohibited, the ADOxx modeler erases it and informs the user of all allowed RDR tuples for the selected relation class (R4).

Moreover, any relation placed inside a PSM is automatically stored in their connected objects. Hence, this information remains accessible via the VSB. Any deleted relation or object also removes any corresponding references (R1, R5). For the VPM, we added automatic assignment of stakeholders and their SV perceptions through their names. This allows those SV perceptions to be distinguished more easily inside a SVM (R3). We also implemented a mechanism asking the user for a "Global" or stakeholder-specific view when calling "Receive Value Information" in a VSB (R2).

In addition, we simplified the use of all user-callable procedures (R12). Instead of requiring manual initiation, the calculation of the DA, DU, and DR is now performed dynamically in the background. Furthermore, any procedure now works on both single and multiple selected objects. The only exception is the "Cumulative Time Calculator", as it inevitably requires a "Start" and "End" event for an entire VS. We also introduced a new callable procedure, "Rename Instance", which is necessary because directly changing names causes crashes due to our custom dynamic environment (which forces consistency automatically) and multiple object-references dependent on the name (R5).

Lastly, we extended the "Waste Calculator" to include a case of waste that was previously overlooked. It now also detects waste if analog information is required but not generated (R10). These enhancements ensure that the ADOxx modeler remains robust, user-friendly, and capable of supporting the comprehensive modeling and analysis required by the *its*VALUE method.

[1] `www.omilab.org/activities/omilab-book-series/volume2/details/?id=42`
[2] `https://zenodo.org/records/15356539`
[3] `http://dx.doi.org/10.13140/RG.2.2.14851.07208/1`

7.5. Discussion of the Second Development

With this Chapter, we introduce an updated version of *its*VALUE based on findings and results primarily derived from the case study presented in Chapter 6. After implementing the relevant Requirements (Rs), we conducted an artificial evaluation on this intermediate state of *its*VALUE using its method framework for a fictional case. This process led to the identification of additional Rs, which we promptly implemented before continuing the artificial iteration. Throughout the refinement of *its*VALUE, we adhered to the AMME methodology by Buchmann and Karagiannis [22, 62–64] and the Design Science Research (DSR) process by Peffers et al [99, 100] for the overall *its*VALUE project.

The current state of *its*VALUE (see sections 7.2 to 7.4) is the result of these evaluations and the implemented Rs defined in sections 7.1.1 and 7.1.2. Compared to its predecessor, *its*VALUE has been updated in all aspects. The method framework was slightly adapted by paraphrasing, re-arranging, and extending the phases for enhancing an existing VS (see section 7.2.3) and defining a new VS (see section 7.2.4). The artificial evaluation demonstrated that these changes were necessary, as both phases now more clearly and comprehensibly outline the required actions.

The most significant update to the *its*VALUE notation is the conceptualization of the Process Specification Model (PSM). Our artificial evaluation, with its resulting models serving as a proof of concept (see section 7.3.3), confirms that the PSM meets its Rs. Comparing the models in figures 7.13 (VSB) and 7.14 (PSM), it is evident that the VSB effectively illustrates its flow, while the PSM clearly shows all further relations and dependencies among the VS components. Including all elements from the PSM back into the VSB (as in the predecessor of *its*VALUE) would significantly impair the VSB's comprehensibility and cognitive fit, as per Moody [90]. This separation into different views (the VSB for flow and the PSM for further relations) allows for high scalability in terms of additional concept or relation classes that may be required. The VSB remains focused on the flow, while the PSM can be easily extended, as it currently contains few concept and relation classes and can be split into multiple models. However, our results so far do not indicate whether any concept or relation classes are missing or complete.

Finally, we implemented various improvements in the ADOxx modeler, enhancing its usability (see section 7.4). These improvements include a more intuitive user interface, better error handling, and enhanced documentation. The most significant extension is the supplementary application manual, which assists and guides users through the various functionalities of the modeler, ensuring a smoother and more efficient user experience.

7.5.1. Limitations of the Second Development

Currently, Algorithm 2 only sums up intermediate results without clarifying whether higher numbers are better than lower ones, and vice versa. It merely indicates that a positive S Score signifies at least one supported SV perception, while a negative H Score denotes at least one hindered perception. Additionally, stakeholders cannot receive a RF similar to their SV perceptions, making it impossible to explicitly rank stakeholders by importance. Consequently, ranking SV perceptions of different stakeholders is left to human discussion.

To address these limitations, future iterations of *its*VALUE should incorporate a more detailed scoring system that clearly defines the implications of higher and lower values. This would enhance the interpretability of the results and allow for a more nuanced understanding of stakeholder perceptions. Furthermore, developing a mechanism to assign RF values to stakeholders could facilitate a more objective ranking system, thereby improving the decision-making process.

Most importantly, the current state of *its*VALUE has only been artificially evaluated. Therefore, a further naturalistic evaluation, as suggested by Venable et al. [140, 141], is necessary to determine its actual and perceived efficacy, in line with Moody's framework [89]. This evaluation should involve real-world scenarios and diverse stakeholder groups to validate the tool's effectiveness and reliability. Additionally, a further artificial evaluation, as per Venable et al. [140, 141], conducted on a real-world scenario under laboratory conditions, may also be beneficial to retrieve further meaningful insights.

In summary, while the current version of *its*VALUE provides a foundational framework, there are several areas for improvement. Enhancing the scoring system, incorporating stakeholder ranking mechanisms, and conducting comprehensive naturalistic or artificial evaluations will be crucial steps in refining *its*VALUE and ensuring its applicability.

7.5.2. Summary and Conclusion

The updated version of *its*VALUE, in combination with our enhanced ADOxx modeler, supports more comprehensive modeling and analysis of IT-Service related VSs than its predecessor introduced in Chapter 5. Additionally, it may better assist practitioners in adopting ITIL 4 concepts. However, as mentioned in the Limitations, this current state of *its*VALUE still lacks adequate empirical evaluations. It is crucial to verify if our proposed changes hold up under naturalistic conditions, or artificial real-world scenarios under laboratory conditions (not just entirely artificial conditions).

For the method framework, each possible path should be investigated over multiple iterations on a single case to ensure robustness. The notation's completeness, particularly regarding all concept and relation classes, should be thoroughly explored. Given that the VSB received major updates and the PSM is entirely new, both components require detailed investigation. The updated VSB should be compared more in-depth with its predecessor to determine if the addition of the PSM effectively resolves previous issues.

Furthermore, the supplementary application manual for the updated ADOxx modeler should be evaluated for its effectiveness in guiding new users independently. This will help assess the manual's utility and the modeler's ease of use. Providing open access to the manual (ResearchGate[4] [112], Appendix D), the source code (Zenodo[5]), and the modeler (OMiLAB[6]) ensures that potential users, developers, and researchers can freely download these resources, thereby promoting accessibility, encouraging engagement, and supporting the achievement of the evaluation objectives.

In summary, while the updated *its*VALUE and ADOxx modeler show promise in enhancing IT-Service related VSs modeling and analysis, comprehensive empirical evaluations are necessary. These evaluations will validate the improvements and ensure that the tools are effective and user-friendly in real-world scenarios.

[4] `http://dx.doi.org/10.13140/RG.2.2.14851.07208/1`
[5] `https://zenodo.org/records/15356539`
[6] `www.omilab.org/activities/omilab-book-series/volume2/details/?id=42`

8. An Evaluation on the Updated Version

The main focus of this Chapter is the evaluation of the updated version of *its*VALUE introduced in Chapter 7. As previously concluded, we aimed to focus on several different aspects. Among these, we wanted to assess the conceptual completeness of *its*VALUE based on a naturalistic or artificial with a real existing case, as per Venable et al. [140, 141]. Furthermore, we aimed to determine if the newly introduced Process Specification Model (PSM) truly enhanced the framework, as per Moody [90]. Most importantly, we sought to understand how different users would perceive the updated version of *its*VALUE independently of our influence. In other words, we wanted to see how users would interact with it using only the supplementary application manual for the updated ADOxx modeler, the modeler itself, and all the already published literature on *its*VALUE. Additionally, we concluded in Section 6.3.1 that a slightly different or more independent evaluation method from the one we performed in Chapter 6 might yield more diverse and broader insights into the perceived and actual efficacy of *its*VALUE, in line with Moody's framework [89].

To achieve these goals, we gave this task to a group of M.Sc. students for an assignment paper during the summer term of 2024. Their objective was to conduct a comprehensive evaluation of the application of *its*VALUE in organizing the Business Informatics Research (BIR) Conference 2022. We instructed them to become familiar with *its*VALUE entirely on their own, using only the provided materials. Moreover, we delegated to them the task of defining their evaluation approach independently. The maximum support we offered our group of students was coaching if they encountered any uncertainties. According to Passmore and Sinclair [97, 98], "Coaching" is a process where a coach helps someone improve and achieve their goals through structured conversations and specific techniques. Wang et al. [144] showed that coaching significantly improves goal attainment and self-efficacy, leads to better performance outcomes, helps individuals define and pursue their goals with precision, and fosters a sense of accountability. Further, Smith and Smoll [123] highlight that coaching can be non-judgmental, reducing the coach's influence on the coachee's decision-making. Additionally, Van et al. [137] state that coaching increases self-awareness and confidence, both of which positively influence the coachee's performance.

Taking advantage of these effects, we aimed to take a supportive background role in this evaluation, providing coaching to our group of students when needed. Our goal was to offer as much help as necessary while minimizing our influence on their approach and results. Thereby, we desired to achieve as uninfluenced and, thus, valuable insights on *its*VALUE as possible. In the end, our group of students decided to conduct interviews with the conference organizers. They intended to use this information to apply *its*VALUE in its updated version. For the evaluation, our group of students chose to use a Balanced Scorecard (BSC) approach. Seigerroth and Sandkuhl [116] demonstrate how this approach can be used for method improvement. Building on that, these BSCs can highlight aspects that might require further refinement and provide suggestions for improving the practical utility and usability of the method. To conclude, we followed an artificial evaluation on a real-world scenario under laboratory conditions, as per Venable et al. [140, 141].

First, we outline the proposed evaluation design selected by our group of students in Section 8.1. This section includes their chosen methods for information and data collection, as well as a description of the specific case they selected. Next, we detail their chosen evaluation method, scope, and criteria in Section 8.2. This section explains the rationale behind their evaluation approach and includes the criteria they established to measure success and identify areas for improvement. Following this, we present the evaluation results in Section 8.3. This section provides a thorough analysis of the data collected, highlighting key findings and insights. Finally, we discuss these results in Section 8.4, including an outline of the limitations, and draw conclusions and provide a summary.

8.1. The Real-World Case Investigated

The evaluation was divided into two main parts: the modeling of the case investigated and its subsequent evaluation. The aim of this approach is to identify potential weaknesses in the *its*VALUE method and to evaluate it based on specific criteria. This entire evaluation, including the selection of the case to be investigated, modeling the *its*VALUE models, selecting the evaluation criteria, and carrying out the evaluation itself, was conducted by a group of M.Sc. students who had no prior experience with *its*VALUE. This allowed them to use and experience the method as typical first-time users would.

For the evaluation, the students chose the organization of a scientific conference (the BIR 2022 at the University of Rostock, Germany). This case was selected to determine if and how *its*VALUE is applicable to non-profit oriented processes. Additionally, having the conference organizers in-house enabled the students to collect the necessary data for modeling in great detail. A semi-structured interview was conducted with the organizers to gather data, as detailed in section 8.1.1. The various *its*VALUE models were created based on the data collected from this interview using the ADOxx Modeler. The results are described in section 8.1.3.

During the application of the *its*VALUE method, only the path for an already existing VS was considered considered. The path for creating an entirely new VS was not followed due to limited resources.

8.1.1. Information & Data Assessment

Our students selected semi-standardized interviews as the primary method of data collection for this study. This decision was guided by the methodological frameworks of Yin [153] and the concepts outlined by Kallio et al. [61]. Semi-standardized interviews enable the collection of detailed information regarding the experiences, opinions, and attitudes of the experts interviewed. The interview guide, further informed by the recommendations of Gläser et al. [47], incorporates both open-ended and targeted questions tailored to the specific objectives of the study. This approach provides the flexibility to adapt to the dynamics of the conversation while ensuring that all relevant topics are addressed. Additionally, semi-standardized interviews offer a balance between structure and flexibility. They allow the interviewer to probe deeper into specific areas of interest that may arise during the conversation, which can lead to richer and more nuanced data. This also helps in building rapport with the interviewees, making them more comfortable and willing to share their insights openly. By following a semi-standardized format, this ensures that while there is a consistent framework for comparison across interviews, there is also room to explore unique perspectives and unexpected findings that may emerge.

8.1.1.1. Development of the interview guide

Following the recommendations of Gläser et al. [47], the students designed the interview guide to allow for open discussion while also including targeted questions geared towards the specific research objectives. This methodological approach promotes effective communication, considers the cultural context of the interviewees, and avoids the uncritical adoption of subjective theories as facts. The development of the guide followed a structured five-phase approach, as outlined by Gläser and Kallio et al. [47, 61]:

Phase 1: Establishing the Basic Premises and Objectives

In the first phase, the main objective was to identify a deep understanding of BIR Conference 2022 organizers' perspectives on their daily interactions with the administrative and organizational processes of the conference. Another focus was on analyzing cost structures and VSs of the conference. The aim of the interview was to document the experiences, challenges, and needs of the organizers and to identify the different VSs of the conference.

Phase 2: Integration and Analysis of Existing Knowledge

The second phase focused on integrating existing knowledge and conducting an in-depth literature review to refine the content and methodological direction of the guide. The aim was to create a sound basis for the development of the guide, including specific questions that encourage open answers. This approach was intended to provide deep insights into the experiences of the organizers and the different aspects of the VSs.

Phase 3: Development of the Structured Interview Guide

In the third phase, the preliminary interview guide was created, divided into several key areas: Introduction, project identification and definition, data collection and analysis, evaluation of benefits, detailed process steps, registration and venue, cost analysis, evaluation of the conference, general questions, final questions, and a debriefing.

Phase 4: Piloting and Ethical Considerations

During the piloting phase of the interview guide, particular attention was paid to ethical aspects to comply with research standards. This included maintaining the confidentiality of the experts and obtaining consent for the use of data. The pilot test was conducted with two individuals who had relevant expertise but were not part of the main study sample. The first participant was a retired expert in event planning with over 30 years of experience, providing valuable insights into the practical aspects of the interview. The second participant was an academic with experience in qualitative research methodologies, allowing us to evaluate the guide from both practical and theoretical perspectives. Several specific adjustments were made to the interview guide based on the feedback from the pilot test:

Flow of the Interview: The sequence of questions within each section was adjusted to improve the logical flow and the rapport-building process with interviewees. For example, questions regarding the project scope were moved earlier in the interview to provide more context before discussing the stakeholders' roles.

Duration of the Interview: It became apparent that the original guide could extend the interview beyond the planned 80 minutes. To address this, several questions were condensed or merged. For instance, in the section on cost analysis, questions regarding the distribution of the total budget and cost distribution over the lifetime were combined into a single, streamlined query, reducing redundancy without sacrificing the depth of the responses.

These refinements, guided by the pilot test as recommended by Yin [153], ensured that the interview guide was both effective in capturing the required data and manageable for the participants.

Phase 5: Finalizing and Conducting the Interviews

In the final phase, the interview guide was carefully prepared for conducting the planned interviews. The interviews, which lasted around 80 minutes, significantly contributed to supporting the objectives of the study and creating a sound data basis for the subsequent analysis.

Furthermore, the structured approach ensured that the interviews were comprehensive and systematic, covering all relevant aspects of the conference organization. This thorough preparation and execution allowed for the collection of high-quality data, which is crucial for the validity and reliability of the study's findings.

8.1.1.2. Selection of experts

The selection of experts is crucial for the quality and type of information collected in an interview. Suitable interview partners were identified based on several criteria, with the most important being their direct involvement in the administrative and organizational processes of the BIR conference 2022. This means that the students primarily used convenience sampling, selecting experts who were easy to access and met the criteria. The availability and willingness of potential interviewees, as well as their ability to provide accurate and relevant information, were also considered to ensure the depth and quality of the data collected, as per Gläser et al. [47].

In addition to convenience sampling, the students ensured that the selected experts had diverse roles and responsibilities within the conference organization. This diversity helped capture a comprehensive view of the processes and challenges involved. This approach not only enriched the data but also provided a more holistic understanding of the conference's organizational dynamics. Furthermore, the students took steps to mitigate potential biases associated with convenience sampling. They cross-verified the information obtained from different interviewees to ensure consistency and reliability. This triangulation of data helped in validating the findings and enhancing the credibility of the study. The careful selection and thorough vetting of experts thus played a pivotal role in the data collection process, ensuring that the information gathered was both relevant and robust.

8.1.2. The Semi-Structured Interview Guideline

The students systematically structured the interview guideline into nine key sections, each designed to guide the interviewer through distinct areas relevant to the research objectives, focusing on BIR 2022. This approach ensures both comprehensive data collection and sufficient flexibility to explore participants' individual experiences and perspectives. Each section is timed and organized as follows:

1. **Introduction (3 min):**

   The interview begins with a brief introduction, outlining the purpose of the research and explaining the significance of the interview. Interviewees are informed about how their data will be used, and consent for recording is obtained. A transparent and open atmosphere is created by allowing interviewees to ask questions or request breaks at any time.

2. **Project Identification and Definition (22 min):**

   This is the longest section, where interviewees discuss the key objectives and scope of the BIR Conference. It begins with questions about the conference's main goals and how they align with the university's broader strategic goals. The scope of the project is explored, including roles, stakeholders, external service providers, and the timeline. Specific focus is placed on stakeholders' involvement and expectations, and the organizers' roles and values are analyzed in depth.

3. **Data Collection and Analysis (10 min):**

   This section examines the financial aspects of the BIR Conference. It includes questions about initial, ongoing, and hidden costs, as well as the expected benefits of the event. The goal is to understand both the explicit and implicit outcomes of the conference and how these benefits will be quantified.

4. **Evaluation of the Benefits (10 min):**

   The interview shifts towards assessing how the benefits of the BIR Conference are measured and evaluated. This section includes questions about the methods used to quantify the benefits, historical benchmarks, and how strategic advantages are evaluated, particularly in relation to the university's long-term goals.

5. **Detailed Process Steps (10 min):**

   The focus here is on the detailed steps of organizing the conference, from planning and registration to peer review processes and session planning. Interviewees are asked to provide a thorough description of the processes involved, including the management of paper submissions and reviews, to capture the operational workflow.

6. **Registration and Venue (4 min):**

   This shorter section looks at the logistical aspects of the conference, such as registration fees and venue arrangements, including any special agreements with local accommodation providers.

7. **Cost Analysis (5 min):**

   Cost-related questions are explored in greater depth, focusing on the distribution of the conference budget, cost reserves, and the technical infrastructure required to support the event. Specific attention is paid to contingency planning for technical failures.

8. **Evaluation of the Conference (8 min):**

   The interviewees are asked to provide insights into the post-event evaluation processes, including the documentation of outcomes, the structuring of results, and recommendations for future actions. The aim is to capture how the success of the conference will be assessed and what improvements can be made.

9. **General Questions (8 min):**

   This final section wraps up with broader reflections, including lessons learned from previous IT projects and the identification of best practices. Success criteria for the BIR Conference are also discussed, along with continuous improvement mechanisms for future events.

This structured approach not only ensures comprehensive data collection but also allows for flexibility in exploring the unique experiences and perspectives of the participants. By timing each section, the interviewers can manage the flow of the conversation effectively, ensuring that all relevant topics are covered within the allotted time. This methodical structure helps in maintaining focus while also providing room for in-depth discussions where necessary. Moreover, the inclusion of both specific and open-ended questions facilitates a balanced dialogue, encouraging interviewees to share detailed insights while also allowing the interviewers to probe deeper into particular areas of interest. This combined approach enhances the richness of the data collected, providing a robust foundation for subsequent analysis and evaluation.

8.1.3. The Creation of the *its*VALUE Models

For modeling, the students focused on one key VS of the case investigated: the conference paper submission process. This process was selected as it provided the richest information from the interviews, allowing for accurate modeling. The paper submission process is central to the case investigated, as it involves a variety of stakeholders and interactions. This focus was strategic, as it is a critical component of the conference's success. By modeling this process, the students were able to capture the intricate details and interactions. The detailed information gathered during the interviews provide a solid foundation for modeling and analyzing this process. Various stakeholders were identified during the paper submission process:

Scientists: The authors who submit their work to the conference.

Host (University of Rostock): The institution that may act as host or co-organizer.

Participants: The conference attendees who will benefit from the work presented.

Review Committee: The reviewers who evaluate the submitted papers.

Conference Organizers: Those who are planning and running the conference.

External Service Providers: Among others, this includes hotels and catering companies that provide services for the conference.

After identifying the stakeholders, their different SVs were determined. Those SVs were then modeled in VPMs for each stakeholder, as well as a VSB and corresponding PSM. In addition to these models, a SVM was created to visualize the relationships of all described SVs within the VPMs. This model provides an overview of the interests and added value that each stakeholder derives from the paper submission process. All *its*VALUE models resulting from this case investigated are attached in Appendix C.

8.2. Evaluation Design

The students chose a Balanced Scorecard (BSC) approach for the evaluation. It was chosen for its comprehensive framework, which allows for a balanced evaluation across multiple dimensions. Seigerroth and Sandkuhl [116] describe in detail the process of developing a BSC and its use as a tool for optimizing specific methods. Four perspectives relevant to the corresponding method were identified for the BSCs. Criteria were defined for each perspective, related to the previously identified goals. Various indicators were then defined and described for each criterion, explaining how they can be measured. The BSC was developed for the ”Method for Information Demand Analysis” and demonstrates its application for various user groups, as per Lundqvist et al. [78]. Furthermore, the transferability of the approach to other methods was investigated by Sandkuhl et al. [117] for their 4EM method.

8.2.1. Evaluation Scope

However, only two of the formerly four perspectives were considered, as the other two perspectives were not applicable. Based on the experiences gained, Seigerroth and Sandkuhl [116] provided recommendations for indicators that can be used with other methods. These two perspectives, namely the quality of the method documentation and process efficiency, were also considered for the BSC in this chapter. Additional perspectives stem from the already conducted case study from Chapter 6. Based on the evaluation, the method results, the ADOxx modeler, and the notation were also included as respective perspectives in the BSC. The inclusion of these additional perspectives ensures a comprehensive evaluation of the *its*VALUE method. By considering the quality of the method documentation, the efficiency of the process, the practicality of the method results, the comprehensibility of the notation, and the perceived benefit of the ADOxx modeler, the evaluation covers all critical aspects of the method's application. Thus, the BSC developed for this evaluation comprises the following perspectives:

- Quality of the Method Documentation
- Efficiency of the Process
- Practicality of the Method Results
- Comprehensibility of the Notation
- Perceived Usability of the ADOxx Modeler

8.2.2. Evaluation Criteria

For each of these perspectives, the students formulated various sub-goals and additional research questions. To make these sub-goals measurable, corresponding indicators were defined for each sub-goal. In the evaluation, each indicator is assigned a value justified by the detailed answering of the associated research question. This helps to understand how the students arrived at the indicators. The evaluation questions, sub-goals, and indicators for the individual points of interest are detailed in this section.

Key	**Sub-Goal**	**Question**	**Indicator**
D.1	Quick Learning	How much time was required to learn the method or to go through the documentation?	Learning time in hours (h)
D.2	Few Perceived Deficiencies	What deficiencies were identified?	Number of identified deficiencies
D.3	Completeness of the Documentation	Was the documentation perceived as complete?	Rating on a scale from 1 to 5
D.4	Correctness of the Documentation	Was the documentation perceived as correct?	Rating on a scale from 1 to 5
D.5	Comprehensibility of the Documentation	Was the documentation perceived as comprehensible?	Rating on a scale from 1 to 5

Table 8.1.: Evaluation Criteria for the Quality of Method Documentation (D)

Key	Sub-Goal	Question	Indicator
P.1	Appropriate Time Investment (in total)	How much time was required to apply the *its*VALUE method to the entire case investigated?	Learning time in hours (h)
P.2	Appropriate Time Investment (per phase)	How much time was required for each section of the *its*VALUE method for the entire case investigated?	Learning time in hours (h)
P.3	Goal-Orientation of the Process	Was the process considered goal-oriented?	Rating on a scale from 1 to 5
P.4	Completeness of the Process	Was the process perceived as complete?	Rating on a scale from 1 to 5
P.5	Correctness of the Process	Was the process perceived as correct?	Rating on a scale from 1 to 5
P.6	Comprehensibility of the Process	Was the process perceived as comprehensible?	Rating on a scale from 1 to 5

Table 8.2.: Evaluation Criteria for Process Efficiency (P)

Key	Sub-Goal	Question	Indicator
M.1	Purpose Fulfillment of the Model Types	How helpful were the model types? Did they meet their purpose?	Rating on a scale from 1 to 5
M.2	Usable Indicators	How well could the metrics be determined and what significance do they have in the case investigated?	Rating on a scale from 1 to 5
M.3	Completeness of the Method	Is the overall result of the method perceived as complete?	Rating on a scale from 1 to 5
M.4	Correctness of the Method	Is the overall result of the method perceived as correct?	Rating on a scale from 1 to 5
M.5	Comprehensibility of the Method	Is the overall result of the method perceived as comprehensible?	Rating on a scale from 1 to 5

Table 8.3.: Evaluation Criteria for the Results of the Method (M)

Each table contains an abbreviation for the sub-goal (e.g., D.1, D.2.1), the corresponding sub-goal, the associated research question, and the respective indicator. Table 8.3.1 presents the selected evaluation criteria for the quality of method documentation, consisting of five identified sub-goals. Table 8.2 shows the evaluation criteria focusing on process efficiency, with six sub-goals and corresponding evaluation questions. Sub-goal P.2 is further divided into the phases of the method to clarify the time required for each

Key	Sub-Goal	Question	Indicator
N.1	Few Perceived Deficiencies	What deficiencies were identified?	Number of identified deficiencies
N.2	Completeness of the Notation	Was the notation perceived as complete?	Rating on a scale from 1 to 5
N.3	Correctness of the Notation	Was the notation perceived as correct?	Rating on a scale from 1 to 5
N.4	Comprehensibility of the Notation	Was the notation perceived as comprehensible?	Rating on a scale from 1 to 5

Table 8.4.: Evaluation Criteria for the Notation (N)

Key	Sub-Goal	Question	Indicator
A.1	Few Perceived Deficiencies	What deficiencies were identified?	Number of identified deficiencies
A.2	Completeness of the ADOxx Modeler	Was the ADOxx modeler perceived as complete?	Rating on a scale from 1 to 5
A.3	Correctness of the ADOxx Modeler	Was the ADOxx modeler perceived as correct?	Rating on a scale from 1 to 5
A.4	Comprehensibility of the ADOxx Modeler	Was the ADOxx modeler perceived as comprehensible?	Rating on a scale from 1 to 5

Table 8.5.: Evaluation Criteria for the ADOxx Modeler (A)

respective phase. Table 8.3 highlights the evaluation criteria for the method, consisting of five sub-goals. Sub-goal M.1 is divided into three subordinate goals corresponding to the three models. Table 8.4 shows the results for the clarity of the notation, identifying four sub-goals. Table 8.5 focuses on the perceived benefits of the ADOxx Modeler, also identifying four sub-goals. Table 8.6 presents meaning of the numeric values from 1 to 5 of the evaluation scale. In addition to those, other scales such as the learning time in hours or the number of identified deficiencies were used where applicable.

The detailed breakdown of sub-goals and evaluation criteria ensures a comprehensive assessment of each perspective. By clearly defining the sub-goals and corresponding evaluation questions, the students were able to systematically address each aspect of the *its*VALUE method. Further, the consideration of learning time and perceived deficiencies adds another layer of depth to the evaluation, highlighting practical aspects that impact the method's usability. However, it should be emphasized that the students selected the numeric values from Table 8.6 based on their subjective perception. As the student

Value	Meaning of the perceived Quality
1	Very Poor
2	Poor
3	Satisfactory
4	Good
5	Very Good

Table 8.6.: Evaluation Scale

assigned them during a joint discussion and thoroughly debated among the students, it is important to note that those values are influenced by their personal assessments and challenges they encountered. Similarly, these circumstances apply to the identified deficiencies, as the students thoroughly decided in discussions, what they perceive as a deficiency and what not.

8.3. Evaluation Results

This section presents the students' results of the evaluation. At first, it shows the results for the quality of the method documentation (Section 8.3.1) and moves on to the process efficiency (Section 8.3.2). Next, it focuses on the method practicality (Section 8.3.3) before continuing with the results on the comprehensibility of the notation (Section 8.3.4). Lastly, in finishes with the perceived usability of the ADOxx modeler (Section 8.3.5).

8.3.1. Quality of Method Documentation

Table 8.7 illustrates the BSC with the corresponding evaluations for the quality of the method documentation. For these investigations (especially on the application manual and the ADOxx installation guide), the students required three hours. The application manual comprises 23 pages, while the Installation Guide is relatively brief. The documentation was generally perceived as complete. The application manual provides a compact overview of the notation and the corresponding meta-models, and in its second part, it details the *its*VALUE method, examining each phase individually. Installation procedures are described in the Installation Guide available on the OMiLAB Community platform.

The content of the application manual was deemed accurate, with no errors found in the method section. It effectively and clearly explains the notation, meta-models, and models,

Key	Sub-Goal	Score
D.1	Quick Learning	4
D.2	Few Perceived Deficiencies	2
D.3	Completeness of the Documentation	4
D.4	Correctness of the Documentation	5
D.5	Comprehensibility of the Documentation	4

Table 8.7.: BSC for the Method Documentation (D)

without going into excessive detail. The table of Visual Representations offers an excellent overview of the available class relations and their associated visualizations. However, the application manual's section "Important Notes on the ADOxx Modeler" seemed not be particularly clear to the students. To enhance understanding, they recommend to improve these notes with the inclusion of relevant screenshots or more detailed descriptions.

The second part of the application manual was perceived as very clear and comprehensible. The exemplary fictional case is well-chosen, and it is particularly helpful that the method is described step-by-step through this case. This approach allowed the students to quickly engage with the method and understand it progressively through a concrete example. Additionally, the language used in the explanations is sufficiently simple to introduce even non-experts to the method effectively. The selected graphics effectively guide the user through the process of the method. However, the students wished for clearer explanation of the calculation of the S Score and H Score. Further, they desire even more detailed information and screenshots from the ADOxx modeler for application manual.

The students perceived the installation guide provided by ADOxx itself as not clear and comprehensible. Currently, it is disorganized and presents ambiguities (e.g., there is an error in the initial paragraph, rendering the sentence incomprehensible). The guide proceeds with a step-by-step explanation for downloading and installing the environment. However, there are critical issues with these instructions. Additionally, the guide references a tutorial on the adoxx.org website, which students could not find. Moreover, the students wished for a modeled exemplary case inside the ADOxx Modeler. This would allow them to familiarize themselves with the corresponding functions inside. They also desired to include a more complex exemplary case in the documentation to demonstrate how the models would appear in a larger and more detailed context. To conclude, the students defined the following two deficiencies: 1) Unsatisfying description of the actual use of the ADOxx Modeler, and 2) unclear and incomprehensible installation guide.

8.3.2. Efficiency of the Process

For the entire process, the students needed 28 hours. Table 8.8 shows how the effort is distributed across the different sections of the method. The phase "Understand and Define SV" took them 6.5 hours. For the second phase, "Understand and Define the CVS", they needed 16 hours. However, the students faced issues and difficulties with installing the ADOxx environment on their local desktop PCs, resulting in limited availability of the provided supporting procedures and automatic calculations of KPIs. Consequently, they spent most of their time calculating the KPIs manually. They concluded that without these disturbances, they might have required significantly less time for this phase. For the third phase, "Enhance SV: Define the FVS", the students needed 5 hours. Considering the successful calculation of the KPIs, the students perceived that effort as satisfactory.

Part	**Time Investment in h**
1. Understand and Define SV	**7**
Gather Information from All Relevant Stakeholders	3
Make These Value Perceptions Explicit for Each Relevant Stakeholder (VPM)	3
Understand and Define the Relations Between All SVs (SVM)	1
2. Understand and Define the CVS	**16**
Collect and Order All Process Steps from Demand to Delivery	1.5
Collect All Supporting Components and Show Where They Interface	0.5
Determine for Each Process its Data Requirements (DA, DU and DR)	4
Map All Components of the CVS to the SVs	2
Detect Waste and How Components Affect SVs	8
3. Enhance SV: Define the FVS	**5**
Define Value Opportunities, Problems, Constraints and Causes	2
Derive Development Actions, Eliminate Media Breaks and Maximize the Flow	1.5
Model the FVS and Affection on the SV	1.5
Total Time Invested	**28**

Table 8.8.: Overview of the distribution of time expenditure by phases of the method

Key	Sub-Goal	Score
P.1	Appropriate Time Investment (in total)	28
P.2	Appropriate Time Investment (per phase)	N/A
P.2.1	Understand and Define SV	7
P.2.2	Understand and Define the CVS	16
P.2.3	Enhance SV: Define the FVS	5
P.3	Goal-Orientation of the Process	4
P.4	Completeness of the Process	5
P.5	Correctness of the Process	4
P.6	Comprehensibility of the Process	4

Table 8.9.: BSC for the Process Efficiency (P)

The process was considered effective, as the various phases and resulting models created a clear and comprehensible structure. This structure allowed the students to gain a comprehensive overview of the entire process. Each phase contributes to capturing and optimizing the VSs in the chosen case. By the end of the process, all VSs deemed essential by the modeler were fully identified and optimized. The process was perceived as correct. Table 8.9 shows the BSC with the corresponding evaluations.

8.3.3. Practicality of the Method Results

Table 8.10 shows the BSC with the evaluations for the practicality of the method results. The students perceived the VPM as extremely helpful in identifying the baseline and the values of the stakeholders. However, they found it difficult to estimate the level of detail at which the corresponding SVs should be identified and incorporated into the model without making the model overly complex and losing its significance. Additionally, the students felt challenged to determine all relevant stakeholders in the analysis. After the second phase, the students became slightly confused with the VPM, as all identified components of the CVS must be mapped with their influence on the SVs.

Further, the students perceived the SVM as very helpful, as it clearly represents all stakeholders, their values, and the relationships and dependencies among them. Overall, the students perceived that the relation class ”Affects” does not provide valuable information as it is theoretically applicable to all objects. Moreover, the students had difficulties distinguishing between the ”Contradicts” and ”Hinders” relation classes. According to the students, the VSB provides a precise overview of the individual steps within a VS, clearly

Key	Sub-Goal	Score
M.1	Purpose Fulfillment of the Model Types	4
M.1.1	Purpose Fulfillment of VPM	4
M.1.2	Purpose Fulfillment of SVM	4
M.1.3	Purpose Fulfillment of VSB	5
M.1.4	Purpose Fulfillment of PSM	4
M.2	Usable Indicators	3
M.3	Completeness of the Method	5
M.4	Correctness of the Method	4
M.5	Comprehensibility of the Method	3

Table 8.10.: BSC for the Practicality of the Method Results (M)

representing the sequence of process steps. This helped them to understand process flows and identify fail points. However, they found it challenging to choose an appropriate granularity for the process. Moreover, the students liked the ”Environments” class, as it effectively groups activities and different actors, which helps to keep the model organized. According to the students, the PSM clearly illustrates how the supporting components support the activities and processes. However, they wished for a clearer definition of what a supporting component is. Additionally, they had difficulties comprehending the distinction between the PSM and the VSB.

Further, the students perceived the S Score and H Score as very meaningful, as they help to analyze the effectiveness and efficiency of the VS and identify targeted improvement measures. However, they faced difficulties in determining and calculating these metrics without taking advantage of the automatic calculations. The method itself was considered complete, comprehensible, and correct. However, the students noted that the models can become very confusing in complex cases. They also highlighted the importance of correct information required for the individual models. Without the automatic calculations and supporting procedures, the students mentioned that *its*VALUE loses significant quality.

8.3.4. Comprehensibility of the Notation

Table 8.11 shows the results in the form of the BSC for the Notation. The students wished the notation to be more comprehensible, especially regarding the visual representations. The ”Constraint” class is shown as a white box on a white background, making it hard for them to distinguish. Many of the classes are differentiated only by color. Hence, according

Key	Sub-Goal	Score
N.1	Few Perceived Deficiencies	3
N.2	Completeness of the Notation	5
N.3	Correctness of the Notation	5
N.4	Comprehensibility of the Notation	3

Table 8.11.: BSC for the Notation (N)

to the students, this may be confusing for someone with little modeling experience. The students desire a greater variety of different shapes or additional symbols to the current representations (e.g., a computer symbol for IT systems). Further, the students perceive the color scale used for the ”Relevant Factor” and ”Current Performance Level” as critical. Green stands for ”High” and Blue for ”Outstanding”, which is not intuitive to them. Additionally, the students perceive the symbols for the ”Relevant Factor” and ”Current Performance Level” as too small. Moreover, they desire the symbols for events (Start, Common, End) and the labels on the arrows of the relation classes to be clearer.

However, the students admit that the notation is comprehensible after some practice. Further, they state that it is correct with no obvious errors and also complete. Moreover, all models and components of the method are well represented according to the students. Because of that, their scores rank from middle to high.

8.3.5. Perceived Usability of the ADOxx Modeler

Table 8.12 shows the results in the form of the BSC for the ADOxx Modeler. The students encountered numerous difficulties with the ADOxx Modeler during the modeling process. The first problems arose during the installation. Only one out of three students was able to successfully install the software. For the other two, the installation was not possible due to an ”SQL database” error. Despite several attempts, they could not resolve that error. They faced further difficulties while working with the Modeler due to the errors in the installation of the ADOxx environment. This resulted in limited availability of the provided procedures and calculations. Hence, the students could not change the names of the components but only their descriptions. This led to perceptual difficulties when viewing the models. Additionally, the students had to calculate all KPIs manually. This was very time-consuming and could only be partially completed. The links between the models, which should have been set automatically, also did not work.

Key	Sub-Goal	Score
A.1	Few Perceived Deficiencies	3
A.2	Completeness of the ADOxx Modeler	5
A.3	Correctness of the ADOxx Modeler	4
A.4	Comprehensibility of the ADOxx Modeler	3

Table 8.12.: BSC for the ADOxx Modeler (A)

Overall, the students perceived the ADOxx user interface as not easy to use. All these small problems led to significant limitations in the application of the method. In this specific case, it is unclear whether the problems arose due to user errors or if they are general issues with the ADOxx Modeler or the ADOxx environment itself. The students still mentioned that when all functions work properly, the ADOxx Modeler is a very useful tool for the method. Particularly, the automatic calculation of the KPIs would be a great help in applying the method. The tool is theoretically complete, as it covers all phases of the *its*VALUE method. All relations and components of the method are also present. However, the students could not fully utilize the provided functionalities. To sum up, due to many errors and questions arising during usage, the students concluded that the overall comprehensibility and operation of the tool need improvement.

8.4. Discussion of the Evaluation

Overall, this approach for the evaluation on the updated version of *its*VALUE provided valuable insights into its practical application in an artificial real-world scenario under laboratory conditions, as per Venable et al. [140, 141]. By involving students with no prior experience, the study simulated the challenges and learning curve that new users might face. Despite limited resources preventing the completion of both paths of the *its*VALUE method framework, the study highlighted areas for improvement and potential adaptations for future applications. The use of the BSC approach enabled the students to conduct a detailed and balanced evaluation, identifying areas for improvement and providing a clear path for optimizing *its*VALUE. By defining specific criteria and indicators for each perspective, the students ensured that the evaluation was systematic and thorough. Insights gained from the students' interviews with the relevant stakeholders not only provided a detailed understanding of the BIR Conference 2022 but also highlighted the practical challenges and opportunities in applying *its*VALUE.

While the application manual is generally well-received for its clarity and comprehensiveness, the installation guide by ADOxx falls short in several aspects. The detailed breakdown of time spent on each phase of the *its*VALUE method framework highlights the challenges and successes encountered by the students. The significant time required for the second phase underscores the impact of technical difficulties on the overall process efficiency. Despite these challenges, the students were able to complete the necessary calculations manually. Still, the clear and comprehensible structure of the process, as noted by the students, facilitated a thorough understanding and optimization of the VSs.

The students' evaluation underscores the practical challenges and benefits of using the *its*VALUE method. While the VPM and SVM were found to be highly useful, determining the appropriate level of detail and identifying all relevant stakeholders posed significant challenges. Moreover, the students highlighted the great comprehensibility of the VSB. Considering the results from the previous case study in Chapter 6, its resulting VSB (cf. Figure B.6), and the VSB from this evaluation (cf. Figure C.8), it is clear that introducing the additional PSM successfully improved complexity management and comprehensibility. However, due to its close nature to the VSB (as it merely outsources certain explicitly made relations between different VS components), the students faced difficulties in clearly differentiating the PSM from the VSB and understanding its purpose. Moreover, the students' experience with the manual calculation of S Score and H Score metrics further emphasizes the importance of having robust automated tools to support the method. Their overall positive perception of the method's completeness and correctness, despite the noted challenges, indicates that with the right support and improvements, the *its*VALUE method can be highly effective.

The students' feedback highlights several areas for improvement in the notation. The difficulty in distinguishing the "Constraint" class and the reliance on color differentiation suggest a need for more distinct visual representations. Incorporating a variety of shapes or additional symbols could enhance clarity and usability, especially for users with limited modeling experience. The critique of the color scale for the "Relevant Factor" and "Current Performance Level" indicates that the current scheme may not be intuitive. Revising the color scheme to align more closely with common conventions could improve user understanding. Despite these challenges, the students acknowledged that the notation becomes comprehensible with practice and is generally correct and complete.

The detailed feedback from the students highlights several critical issues with the ADOxx Modeler. Installation problems, particularly the "SQL database" error, significantly hindered the students' ability to use the tool effectively. Additionally, the inability to change component names and the necessity to manually calculate KPIs added to the complexity and time required for the modeling process. Despite these challenges, the students recognized the potential of the ADOxx Modeler when all functions are operational. The automatic calculation of KPIs and the comprehensive coverage of all phases of the *its*VALUE method are seen as significant advantages. Improving the user interface and resolving the identified issues would greatly enhance the tool's usability and effectiveness.

To verify whether the students' installation issues were general or specific to their setups, we tested the ADOxx Modeler on other systems. We did not encounter any of the reported errors and were able to successfully install and set up the ADOxx environment, including the *its*VALUE Modeler. This enabled us to fully utilize the dynamic modeling environment, including automatic background calculations, instance updates, and the supporting procedures manually callable by the user. Hence, we conclude that the *its*VALUE Modeler works as intended, and the installation issues may only occur on certain systems but not in general. This leaves us with no room for improvement in this regard, as we are only using the ADOxx environment for distributing and publishing *its*VALUE for usage. Therefore, we are not in a position to address its general installation issues.

8.4.1. Limitations of the Evaluation

This study has several limitations that should be considered, as they affect both the execution of the case investigated and the evaluation process. The students did not choose their case with a standardized process, resulting in modeling only being possible at a high level of abstraction. Furthermore, the students lacked expertise in organizing scientific conferences. Their knowledge about the conference and its procedures was based solely on publicly available information and their conducted interviews. Consequently, data collection was relatively challenging and required many assumptions, which may not always accurately reflect actual conditions. Hence, the students considered only the VS for submitting conference papers to limit the scope of the case investigated. A validation of these assumptions with experts and stakeholders did not take place.

Additionally, technical difficulties faced by the students limited their performance and results, as they could not utilize several functions of the ADOxx Modeler. Hence, they had to calculate the KPIs manually. Moreover, the students did not follow the path for creating an entirely new VS.

For the evaluation, the students stated that they are not experts in *its*VALUE. However, this was our main intention with this evaluation: to gather as uninfluenced and neutral opinions and perceptions on *its*VALUE as possible. Further, the students' time for the evaluation and conduction of the case investigated was limited. Additionally, the evaluation was influenced by the technical issues the students had with the ADOxx Modeler, which may have impacted their impressions of *its*VALUE, although they consciously tried to overcome them. The evaluation is solely based on the experiences of the students, who jointly modeled a case example. However, precisely such insights were what we were striving for. Still, the students' rating scores (from 1 to 5) were based on a single evaluation, reducing the evaluation's significance. To decrease the risk of subjectivity, having multiple independent teams conduct the evaluation in parallel would be beneficial. The students tried to enhance their rating with a textual description to better explain the scores. Due to these limitations, the evaluation can only provide limited implications for the evaluation of *its*VALUE and, in turn, does not possess strong evidence.

8.4.2. Summary and Conclusion

The aim of this additional evaluation was to evaluate the *its*VALUE method without our direct influence. Hence, we delegated this task entirely to a group of M.Sc. students as an assignment paper for the summer term of 2024. Our goal was to assess the updated version of the *its*VALUE method from the user's perspective, identify weaknesses, and suggest potential improvements. By involving students with no prior experience, the study effectively simulated real-world challenges and learning curves, providing a fresh and unbiased perspective on the method's usability and effectiveness.

The students chose to investigate the organization of the BIR 2022, a scientific conference held at the University of Rostock. They gathered all necessary information to capture this case in *its*VALUE models by conducting interviews with various stakeholders, including conference organizers, participants, and other relevant parties. This approach ensured that the students had a comprehensive understanding of the conference's processes and requirements, despite their initial lack of expertise.

Significant issues were identified with the ADOxx environment (in general, not specifically with our *its*VALUE Modeler), particularly installation problems that necessitated manual calculations, hindering efficiency. These technical difficulties included errors during the setup process, such as the "SQL database" error, which prevented the students from fully utilizing the tool's automated features. As a result, they had to perform several tasks manually, which increased the complexity and time required for the modeling process.

Despite these challenges, the students found the method's structure clear and its components, especially the VPM, SVM, VSB, and PSM, highly useful. The feedback emphasized the need for better visual representations and automated tools to enhance usability. For instance, integrating more intuitive graphical interfaces and a wider range of shapes could significantly reduce the learning curve and increase user satisfaction.

Overall, the *its*VALUE method was deemed effective, with recommendations for improving documentation, user interface, and notation to optimize its application. The study also underscored the importance of comprehensive and user-friendly documentation. While the application manual was praised for its clarity, the installation guide by ADOxx requires improvements to address common setup issues and provide troubleshooting tips. The detailed breakdown of time spent on each phase highlighted the impact of technical difficulties on process efficiency, revealing areas where the method could be streamlined.

The students' experience with the manual calculation of S Scores and H Scores metrics further emphasized the need for robust automated tools. These metrics are crucial for evaluating the success and impact of the modeled processes. Utilizing the provided automated calculations would have saved time and reduced the potential for errors. The students' overall positive perception of the method's completeness and correctness, despite the challenges, indicates that with the right support and improvements, the *its*VALUE method can be highly effective.

This evaluation provides a clear roadmap for future enhancements, ensuring the method's continued relevance and usability in various contexts. By addressing the identified issues and incorporating the students' feedback, *its*VALUE can be refined to better meet the needs of its users and facilitate its broader adoption in different domains.

9. Discussion

We have addressed the issue of dealing with the challenges in ITSM, particularly the lack of systematic consideration of SV in modeling and analysis activities. To tackle this task, we mainly followed the Design Science Research (DSR) process by Peffers et al. [99, 100]. For our evaluation strategy, we followed a hybrid of the *Technical Risk & Efficacy* and *Quick & Simple Strategy*, as per Venable et al. [141]. This hybrid approach allowed us to rapidly progress to summative and naturalistic evaluations while capturing artificial formative results for iterative refinements. Given the unique and novel nature of *its*VALUE, which conceptually links SV and VSs, it was crucial to adopt a strategy that could handle the technical complexities and demands of the ADOxx development environment. This approach was essential to ensure the system's safe operation and to quickly obtain meaningful results.

First, we gathered an impression of the state of the art in the relevant literature (specifically in the domains of modeling SV, VSs, and SBs) by performing a SLA. During this review, we read 39 documents found via Scopus and two additional promising ones (regarding the VSMN and VDML). Furthermore, we re-ran that query over time. Besides our own publications, we found only five additional contributions, none of which promised valuable additional insights for our objective. Overall, our findings revealed that no method or notation besides *its*VALUE fully addresses the gap in current ITSM approaches concerning the systematic consideration and integration of SV in service modeling and VS design.

Hence, we developed *its*VALUE (a method, notation, and ADOxx Modeler) by following the Method Integration Process (MIP) by Goldkuhl et al. [48]. We integrated VSM 4.0, VSA 4.0, VSD 4.0, VSMN, DVD, VoPM, IT S-SB, 4EM, BPMN, and VDML to create the initial version of *its*VALUE. Its framework supports two paths for different scenarios (enhancing an existing service and designing a new one) as well as multiple iterations. For the *its*VALUE notation, we used visualizations from the methods we integrated into *its*VALUE. With the exception of minor symbols indicating the meaning of a few relation concepts (e.g., the ”R” marker indicating the ”Requires” relation class), we did not create completely new ones. For the creation of our *its*VALUE Modeler, we used ADOxx as a fundamental platform, as it is a meta-modeler that helps users create their own modelers.

To deliver a first evaluation of our initial version of *its*VALUE, we performed a naturalistic ex post evaluation, as per Venable et al. [140,141], to assess perceived efficacy and intention to use, as per Moody [89]. We conducted a case study investigating the perceptions of four employees at the Dräger company. We started with a participatory modeling session followed by a GI with each participant separately. The results indicated that we successfully addressed this gap, at least from a perceptual point of view. All participants showed a high intention to use and perceived *its*VALUE as very powerful and beneficial overall. However, this case study also revealed several areas for improvement.

To address these, we considered the Agile Modelling Method Engineering (AMME) methodology by Buchmann and Karagiannis [22,62–64] for our next steps. Consequently, we carefully derived new Requirements (Rs) from the results of our case study and iterated back in both the DSR process and AMME life-cycle. Starting from there, we revised and updated *its*VALUE, including an additional minor revision and iteration based on findings from following this updated version in an artificial setting. This combined approach, as per Venable et al. [140, 141], created a foundation for motivating our updates to *its*VALUE. Overall, we updated all our artifacts and added an application manual to its updated version, marking it as an additional artifact created throughout this process.

Then, we aimed to evaluate this updated version of *its*VALUE in an artificial setting with a real-world scenario under laboratory conditions, as per Venable et al. [140,141]. However, we intended to gain insights from an entirely uninfluenced and neutral perspective. To achieve this, we delegated the task of evaluating the updated version of *its*VALUE to a group of M.Sc. students, completely handing over all responsibilities in their decision-making on the evaluation process to them. This approach allowed us to gather valuable insights on the challenges and learning curve that new users might face. Moreover, these results strengthened the assumptions drawn from the first evaluation, including that the *its*VALUE method meets its purpose and that the ADOxx Modeler is a powerful tool assisting its users. Considering both results, the updated version of *its*VALUE succeeded in enhancing its notation quality (especially by introducing the PSM and decreasing the VSB's complexity), although the students still identified areas for improvement.

To conclude, *its*VALUE stands out in several ways when compared to other methods. Overall, it offers a unique combination of holistic integration, stakeholder focus, agile development, community orientation, and comprehensive evaluation, making it a robust choice for modeling and analyzing IT services and ITSM:

Holistic Approach: *its*VALUE integrates multiple established methods and notations (e.g., VSM 4.0, VSA 4.0, VSD 4.0, VSMN, DVD, VoPM, IT S-SB, 4EM, BPMN, VDML) to create a comprehensive framework that supports both the enhancement of existing Value Streams (VSs) and the design of new ones. Other methods often focus on specific aspects of service modeling or management, such as BPMN for process modeling or VDML for value delivery modeling, without integrating the broad range of perspectives and requirements emphasized in modern ITSM frameworks, like ITIL 4..

Focus on Stakeholder Value (SV): *its*VALUE emphasizes the creation, consideration, and analysis of SV, ensuring that services align with what stakeholders truly value. It promotes regular collaboration with stakeholders to adapt to evolving requirements and ensure that outcomes meet their expectations. By establishing a unique conceptual link between SVs and VSs, it provides a more explicit and comprehensive focus on the value creation, surpassing the narrower scope of other methods.

Agile and Iterative Development: For the development of *its*VALUE, we closely followed the DSR process and AMME methodology, both of which support agile and iterative development. This approach allows for continuous improvement based on feedback and evolving requirements. Furthermore, the *its*VALUE method framework itself promotes these agile features for the development and enhancement of VSs. In contrast, other methods may not inherently support agile practices or iterative refinement, potentially making them less adaptable to changing needs.

Community-Oriented: *its*VALUE supports collaboration and knowledge sharing within the modeling community, facilitated through platforms like ResearchGate[1], Zenodo[2], and OMiLAB[3]. This promotes further teamwork and collaboration within development teams and with stakeholders. In contrast, other methods may not necessarily have a dedicated platform for community-wide collaboration.

Comprehensive Evaluation: *its*VALUE includes thorough evaluation processes, such as both naturalistic and artificial ex post evaluations and independent assessments by new users, to ensure the method's effectiveness and usability. These feedback loops allow for continuous improvement of the development process and product quality.

[1] `http://dx.doi.org/10.13140/RG.2.2.14851.07208/1`
[2] `https://zenodo.org/records/15356539`
[3] `www.omilab.org/activities/omilab-book-series/volume2/details/?id=42`

9.1. Limitations

For the motivation and definition of important terms in this work, we referred to ITIL 4 as a representative and well-established source within the broader domain of ITSM. ITIL 4 is the fourth version of a widely recognized and appreciated state-of-the-art overview of best practices in the field of ITSM. Thus, ITIL 4 is a reliable and important source for addressing issues in ITSM, especially as it was published in 2019 and still lacks some explicit mechanisms to assist practitioners in achieving its goals. Although we could not cover all potentially relevant documents in our SLA, we discovered that no existing method or notation besides *its*VALUE suitably considers the creation of value as exemplified by guidance in ITIL 4. By considering two additional important documents and re-running our query over time, we believe we achieved good precision and recall in our review set.

With the development of *its*VALUE, we tackled an yet unaddressed research gap. However, this also means there is no fundamentally proven guideline for all pieces of *its*VALUE and their integration. For example, no comparable method explicitly defines the effects of components of a VS on SV. Additionally, calculating the S Score and H Score of a component within a VS introduced new mechanisms without evidence on their expressiveness or potential for misleading results. However, these KPIs can be slightly tuned by the user (using the CPL, RF, and IF) and are intended to support human analysis and decision-making.

We could not provide our ADOxx Modeler with all supporting scripts one might think of (e.g., ensuring consistency between a major VS and its decomposed sub-VSs) or procedures (e.g., storing and calculating monetary costs within the VS) due to limited resources. However, with the revision and update of *its*VALUE, we successfully addressed several requirements derived from the results of our first evaluation and an artificial setting, significantly increasing the overall performance and usability of our ADOxx modeler. Moreover, the participants from our case study and the students from our additional evaluation found the existing procedures and mechanics very supportive and valuable.

Although the use of ADOxx as a fundamental platform can be criticized (due to its hard-to-understand documentation/installation guide and its old-fashioned look and feel), it offers advantages like detailed documentation, up-to-date support, and an active community through OMiLAB. Further, our introduced application manual on *its*VALUE and the provided source code add further value to its comprehensibility and availability.

The notation of *its*VALUE may be harder for inexperienced modelers to understand than for experienced ones. However, the participants from the case study, who considered themselves experienced modelers, were overall very satisfied with the notation. Moreover, the students from the additional evaluation admitted that they became familiar with the notation over time, although they desired more intuitiveness.

Unfortunately, we could not cover all aspects of *its*VALUE during our evaluations (e.g., the path for designing an entirely new service) due to limited resources. Nevertheless, across both evaluations, all involved parties seemed to have a positive impression of *its*VALUE. This includes participants from the case study during the participatory modeling session and the students from the additional evaluation who explored the updated version independently. Hence, we assessed the perceived efficacy of *its*VALUE based on feedback from the case study participants and the results and conclusions drawn by the students in the additional evaluation. To evaluate the actual efficacy, reasonable measurements must be defined. For instance, it remains unclear whether a company truly performs better using *its*VALUE. Such an evaluation was not feasible due to limited resources. Furthermore, this work includes only one pure naturalistic evaluation, alongside other artificial evaluations focusing on real-world scenarios under laboratory conditions. Consequently, this lack of comprehensive validation may reduce and challenge the significance of our results.

Overall, our resources for this work were limited for such an ambitious project of developing an entirely new method, notation, and modeler, due to the author being full-time employed on cruise ships for several weeks and months continuously, with only a few weeks/months of paid leave in between, mostly required to restore health and energy levels. Still, our results are promising and provide good insights for future work to build upon.

9.2. Summary and Conclusion

In this work, we addressed key challenges in the realm of IT Service Management (ITSM), particularly the lack of systematic support for integrating stakeholder value into service modeling and analysis; an issue exemplified in contemporary frameworks such as ITIL 4. To tackle this gap, we developed and evaluated the *its*VALUE method, notation, and ADOxx Modeler. Therefore, we followed the Design Science Research (DSR) process by Peffers et al. [99, 100], the Method Integration Process (MIP) by Goldkuhl et al. [48], and Agile Modelling Method Engineering (AMME) methodology by Buchmann and

Karagiannis [22, 62–64], integrating multiple established methods and notations to create a comprehensive framework for modeling and analyzing SV. Further, we adhered to the Framework for Evaluation in Design Science Research (FEDS) by Venable et al. [141] for our hybrid evaluation strategy throughout the entire project.

Our initial literature review revealed a significant gap in existing methods and notations, which *its*VALUE aims to fill. We conducted a naturalistic ex post evaluation with four employees from Dräger, which indicated high perceived efficacy and intention to use *its*VALUE. Based on these results and a subsequent artificial iteration, we derived further requirements, motivating the development of an updated and enhanced version of *its*VALUE. This updated version was then evaluated through an independent assessment by M.Sc. students, further validating the method's effectiveness and usability.

*its*VALUE distinguishes itself through its holistic integration of multiple methods, focus on SV, agile and iterative development, community orientation, and comprehensive evaluation processes. These features make *its*VALUE a robust choice for practitioners and researchers in the field of ITSM. By integrating methods such as VSM 4.0, VSA 4.0, VSD 4.0, VSMN, DVD, VoPM, IT S-SB, 4EM, BPMN, and VDML, *its*VALUE not only sets itself apart by explicitly addressing the role of SV in the design and analysis of VSs, but also provides a versatile and comprehensive framework that supports both the enhancement of existing services and the design of new ones.

Despite the promising results, our work faced several limitations. These include the lack of a fundamentally proven guideline for all components of *its*VALUE, limited resources for developing supporting scripts and procedures, and challenges in evaluating the actual efficacy of *its*VALUE in real-world settings. The complexity of the notation for inexperienced modelers and the limited scope of our evaluations also posed challenges. Nevertheless, the feedback from both the case study and the student assessment provides a solid foundation for future research and development.

In conclusion, *its*VALUE offers a unique and valuable approach to addressing a critical gap in ITSM; the systematic integration of SV into VS modeling and service design. While ITIL 4 served as a representative example in this work, the *its*VALUE method, notation, and modeler are applicable beyond any single framework in ITSM.

9.3. Implications for Research & Practice

While *its*VALUE was demonstrated and evaluated in a setting informed by the ITIL 4 framework, its foundational concepts are rooted in the broader domain of ITSM and grounded in established theories of value creation. Rather, they represent a broader contribution to the domain of ITSM. The underlying concepts (like stakeholder-centered value modeling, traceable value stream design, and integrated visual notation) are equally applicable to other ITSM frameworks and real-world organizational practices. As such, the implications discussed here extend to research and practice in ITSM at large.

While this research is rooted in method engineering with a strong practical focus, it also makes a conceptual contribution to the field of ITSM by connecting its constructs to established value creation theories. The modeling of SV in *its*VALUE is guided by Vargo and Lusch's [139] Service-Dominant Logic (SDL), which views value as co-created, contextual, and experienced, rather than delivered as a predefined output. This perspective aligns with the dynamic, stakeholder-centric nature of contemporary IT services. Furthermore, the design of VSs in *its*VALUE incorporates principles from Alter's [5] Work System Theory (WST), which posits that value emerges from the interaction of tasks, technologies, and participants within a work system. By operationalizing these theoretical perspectives through a formal method and modeling environment, *its*VALUE bridges the gap between abstract value theories and practical service modeling practices.

Further, this work opens several avenues for future research and practical applications. Key areas for further exploration include expanding the scope of evaluations, integrating identified improvements, and exploring new scenarios for modeling and collaboration. By continuing to build on the insights gained from this research, *its*VALUE can evolve to better meet the needs of practitioners and researchers, ultimately contributing to more effective and efficient ITSM in the context of Industry 4.0.

For instance, future evaluations should involve a larger and more diverse user base to ensure the generalizability of our findings. Conducting evaluations across various case studies will help mitigate the influence of specific contexts on the results. Comparing these extended evaluations with our current findings will provide deeper insights. Additionally, integrating the identified weaknesses and improvement suggestions into *its*VALUE and re-evaluating it using the proposed criteria will help assess the impact of these enhancements. Specific aspects, such as documentation, should be examined in detail. The calculation of

S Score and H Score should be critically reviewed and optimized to enhance the expressiveness of these KPIs. Introducing a weighting variable to account for the importance of different stakeholders could be beneficial. Additionally, the detection of bottleneck processes remains an area for further investigation. Moreover, exploring various scenarios for the modeling and collaboration process, whether digitally or physically, is crucial. For instance, Gutschmidt and Richter [49] identified territoriality issues in collaborative tabletop modeling. To summarize and extend on all of that already mentioned above, future work should consider the following main aspects:

Expand Supporting Scripts and Procedures: To achieve consistency between major VSs and their decomposed sub-VSs, additional scripts could be developed, as well as automate procedures like storing and calculating monetary costs within the VS, as already done for the DR, DA, and DU. Integrating such advanced features and functionalities into the ADOxx Modeler may improve its user experience and efficiency even further.

Broaden Evaluation Scope: To gather a wider range of feedback and insights, more extensive case studies covering all aspects of *its*VALUE should be conducted, including the path for designing entirely new VSs. Further, to assess the long-term impact and efficacy of *its*VALUE in various organizational settings, longitudinal studies should be implemented.

Improve User Experience: To achieve more user-friendliness and accessibility, especially for new users, the documentation and installation guides for ADOxx could be enhanced. Moreover, refining the notation to make it more intuitive and easier to understand should be considered, particularly for inexperienced modelers.

Integration with Other Tools: Other popular ITSM tools and platforms could be investigated to strive for seamless integration with the *its*VALUE ADOxx modeler and, thus, better user experience. Thereby, interoperability with other modeling and analysis tools could be established, enhancing its applicability and usability in diverse ITSM environments, regardless of whether a specific framework such as ITIL, COBIT, or VeriSM is used.

Community Engagement: An actively engaged community around *its*VALUE through platforms like OMiLAB and Zenodo could be fostered, encouraging knowledge sharing and collaboration. Especially our own custom procedures and dynamic modeling environment consist of best practices other ADOxx Modelers and developers might benefit from. Moreover, establishing robust feedback mechanisms to continuously gather user input and incorporating it into future iterations of *its*VALUE may be valuable.

Empirical Validation: The definition and use of quantitative metrics should be done to empirically validate the efficacy of *its*VALUE, such as measuring improvements in organizational performance or stakeholder satisfaction. Therefore, comparative studies could be conducted, benchmarking *its*VALUE against other methods and frameworks, highlighting its strengths and identifying areas for improvement.

Educational Resources: The development of further comprehensive training programs and workshops could be considered, educating users on the effective use of *its*VALUE. To support this, or alternatively, repositories of case studies and best practices to serve as references for new users could be created.

Moreover, the nature of waste, what supports or hinders value creation, and the design principles derived from these conclusions remain unexplored. Future research should investigate the nature of ”value” (i.e., what constitutes value and for whom) and how to effectively support SVs. Additionally, more efficient strategies for gathering stakeholder information than 90-minute interviews should be explored. This would assist potential users of *its*VALUE in better understanding and defining what stakeholders actually value, and in measuring their satisfaction more conveniently.

While addressing any of those aspects mentioned above, future work should consider the questions posed by Lewin et al. [73] regarding VS optimization in Industry 4.0:

1. What design principles should be developed?
2. What does a waste-free Industry 4.0 look like?
3. Which systems or logic actually add value?

Ultimately, the *its*VALUE method contributes to advancing the methodological foundation of ITSM by formalizing how SV can be systematically linked to service VSs; regardless of the specific framework or standard an organization chooses to follow.

A. The Guided Interview (GI) from Chapter 6

This appendix chapter contains the (from German to English translated) GI questions and the memory log of each GI. We assigned the participants from A, B, C to D based on the order their GIs took place. The postscripts for each GI are attached as well.

A.1. Translated Guided Interview Questions (GIQs)

GIQ 1: How did you perceive the general execution of modelling session?

- GIQ 1.1: How did you perceive the modelling session and its objective?
- GIQ 1.2: How did you perceive the length of the modelling session?
- GIQ 1.3: How did you perceive the distribution of tasks in the session? (The host modelling and the participants discussing?)
- GIQ 1.4: How did you perceive the execution via Microsoft Teams?
  - GIQ 1.4.1: Could you keep track of things at any time?
  - GIQ 1.4.2: How did you perceive the collaboration with the other ones?
  - GIQ 1.4.3: Have you known each other already?
  - GIQ 1.4.4: Could you imagine executing such a modelling session in persons in a real room with a similar approach?
- GIQ 1.5: Have you read the introduction to the topic before the session? (If yes, how did you perceive it, e.g., supportive or unnecessary?)

GIQ 2: How did you perceive the graphical visualizations of the method?

- GIQ 2.1: How did you perceive the visual differences of the graphical items?
- GIQ 2.2: How did you perceive the range of different visualizations?
- GIQ 2.3: How did you perceive the intuitiveness of the visualizations?
- GIQ 2.4: How did you perceive the use of text inside the models?

GIQ 2.5: How did you perceive the number of different visualizations?

GIQ 3: How did you perceive the contend-related procedure of the session? (Firstly, collecting the SVs, then the CVS and lastly the FVS?)

GIQ 3.1: How did you perceive considering and defining the different SVs of all participants and especially yours?

GIQ 3.1.1: How did you perceive the VPMs regardingly?

GIQ 3.1.2: How did you perceive the SVM regardingly?

GIQ 3.2: How did you perceive modelling the entire CVS?

GIQ 3.2.1: How did you perceive the VSB regardingly?

GIQ 3.3: How did you perceive the linkage between the different SVs of the stakeholders and the VS?

GIQ 3.3.1: How did you perceive the VPMs regardingly?

GIQ 3.3.2: How did you perceive the VSB regardingly?

GIQ 3.4: How did you perceive the detection of waste?

GIQ 3.4.1: How did you perceive the VSB regardingly?

GIQ 3.5: How did you perceive the linkage between the processes and further graphical items (e.g., IT-systems) of the VS or information?

GIQ 3.5.1: How did you perceive the VSB regardingly?

GIQ 3.6: How did you perceive identifying needs for change and defining development actions as well as a future state?

GIQ 3.6.1: How did you perceive the VPMs regardingly?

GIQ 3.6.2: How did you perceive the SVM regardingly?

GIQ 3.6.3: How did you perceive the VSB regardingly?

GIQ 3.7: How do you view this method regarding its suitability or unsuitability regarding modelling an entirely new service yet unlaunched?

GIQ 3.7.1: How did you perceive the VPMs regardingly?

GIQ 3.7.2: How did you perceive the SVM regardingly?

GIQ 3.7.3: How did you perceive the VSB regardingly?

GIQ 4: How did you perceive the tool prototype for modelling?

GIQ 4.1: How is your impression on ADOxx as a fundamental platform?

GIQ 4.2: How did you perceive the additional procedures?

GIQ 4.2.1: The "Cumulative Time Calculator" procedure?

GIQ 4.2.2: The "Receive Value Information" procedure?

GIQ 4.2.3: The "Data Information Calculator" procedure?

GIQ 4.2.4: The "Waste Detector" procedure?

GIQ 4.3: How do you consider *its*VALUE regarding future usage?

GIQ 4.3.1: How do you feel capable of using *its*VALUE on your own?

GIQ 4.3.2: Could you imagine working with *its*VALUE again?

GIQ 4.3.3: Would you use *its*VALUE independently from ADOxx?

A.2. Memory Log for the GI With Participant A

Date: Thursday the 8$^{\text{th}}$ of April in 2021 / **Start:** 01:33 pm CET / **End:** 02:05 pm CET

Postscript: It was a very enjoyable atmosphere, the participant seemed very relaxed and open to answer all the questions and there were no interruptions at all.

RQ	Corresponding information given by the participant
1	The order of the phases is good.
1.1	The consideration of SVs is very, very good. Considering many different views sets this method apart from other ones.
1.1.1	Therefore, the VPM is super, 1A., completely new and great.
1.1.2	Therefore, the SVM is good and super. However, it may also be too fuzzy or academic from a practitioner's point of view.
1.2	Understanding and defining the CVS is very well supported.
1.2.1	Therefore, the VSB is very good, especially due to it being separated from explicitly defining the SVs in the VPMs.
1.3	Connecting the SVs to the VS is crucially important and uniquely. Although it is super, it still needs further explanations due to being so innovative.

RQ	Corresponding information given by the participant
1.3.1	Therefore, the VPM is optimal and well done.
1.3.2	Therefore, the VSB is top notch and optimal and well done as well.
1.4	The detection of waste works extremely well and is sensational.
1.4.1	Therefore, the VSB is good but not perfect. Too much waste can decrease the readability of a VSB. Thus, an external report could be considered.
1.5	Connecting processes with further objects like IT-Systems or information is very well done and seems to be very intuitive.
1.5.1	Therefore, the VSB suits very well.
1.6	The method is good for defining development actions and needs for change.
1.6.1	Therefore, the VPM is very good.
1.6.2	Therefore, the SVM is very good, as it focuses on different SVs by different stakeholders. This supports defining the most important SVs.
1.6.3	Therefore, the VSB is very good. However, the readability might be decreased for a big VS with many development actions defined.
1.7	The method seems to be unlimitedly well. However, not any process might be well displayable, as it is too extensive. But it definitely suits modelling specific or important VSs.
1.7.1	Therefore, the VPM is of course supportive.
1.7.2	Therefore, the SVM is especially supportive, as it provides the possibility to design a new service with primarily focusing on the SVs.
1.7.3	Therefore, the VSB suits also very well.
2	The visualizations are good.
2.1	The visual differences among the objects is good, whereas it is difficult among the relations.
2.2	It is very much (i.e., the range of visualizations is very high), but this is actually required.
2.3	The notation seems very intuitive and easy to use for a modeller. The colours for the RF, CPL, S Score and H Score remind of traffic lights which supports understanding the meaning they embody. The Environments inside the VSB are similarly supportive as well. Also the Stakeholder for the VPMs.
2.4	The text inside the models is good and always supportive. As it is not too few or too much text, it is a good addition to the visualizations.

RQ	Corresponding information given by the participant
2.5	The Environments in the VSB support the overview and comprehensiveness. However, it is much but still okay and manageable. Decreasing would just be possible when sourcing out some concepts of objects and relations to specific views (i.e., new sub models decreasing the complexity of the original model).
3	The tool prototype is good. However, the mechanics for creating a new VS from scratch are questioned.
3.1	ADOxx is questionable. It was previously unknown and it remains unclear, how it can be integrated into other already existing systems somehow.
3.2	The procedures are all very good and supportive.
3.2.1	The "Cumulative Time Calculator" is very important, good and supportive for decreasing time consumption in a VS.
3.2.2	The "Receive Value Information" very important and expressive.
3.2.3	The "Data Information Calculator" is very good and useful. However, it is limited to the processes. And extension to the entire VS is desirable.
3.2.4	The "Waste Detector" is just superior, makes happy and very supportive.
3.3	The method is very suitable for future applications, as long as it receives maintenance and updates somehow.
3.3.1	The participant does not feel capable of using it on his own. However, would feel so, if he received the correspondingly required knowledge.
3.3.2	The participants wants to use it in the future somehow.
3.3.3	Independently from ADOxx, the participant would use it as well. An implementation in another platform than ADOxx is even desired.
4	Good overall impression on and moderation of modelling session. However, it was too specific at some points regarding how the functionalities are actually working inside the tool prototype.
4.1	The purpose (i.e., slightly following an entire iteration) was perceived positively. Therefore, the duration (2:30 hours) was perceived as perfectly. However, a clearer distinguishment between the different phases during the meeting (and thus a clearer distinguishment of scope and tasks) would be better (i.e., do not switch between different types of tasks and more carefully stick to the procedure).

RQ	Corresponding information given by the participant
4.2	The distribution of tasks was not that clear, as the host was perceived as a part of the discussion due to him guiding through the session. However, the host modelling all alone was good, as the participants are not familiar at all with the notation and would have struggled with it consequently.
4.3	Microsoft Teams suited well. Although the shared screen only delivered a small picture (which is difficult), it was good once the host increased the zoom. As the participants already knew each other, their collaboration was very close and constructive. A similar procedure could work in present as well (and probably even better).
4.4	The preparations were not investigated.

A.3. Memory Log for the GI With Participant B

Date: Friday the 9th of April in 2021 / **Start:** 09:45 am CET / **End:** 10:20 am CET

Postscript: It was a very enjoyable atmosphere, the participant seemed very relaxed and open to answer all the questions and there were no interruptions at all. Further, the participant requested receiving the tool prototype and this work once it was finished.

RQ	Corresponding information given by the participant
1	The order inside the session was good. For investigating the CVS, it is required to investigate the desires and demands by the stakeholders in advance. Afterwards, the connecting the SVs with the CVS is required to define target-oriented development actions.
1.1	Considering the SVs was good, especially setting the priorities (i.e., the RF and the CPL). Everyone seemed to feel properly represented by the defined SVs. Knowing all SVs (i.e., not just those important to oneself) is also important, as this provides a good overall understanding for everybody.
1.1.1	Therefore, the VPM is good and provides a nice overview.
1.1.2	Therefore, the SVM is very reasonable, as it provides detecting and considering important dependencies among different SVs.
1.2	Understanding and defining a CVS is good and enjoyable.

RQ	Corresponding information given by the participant
1.2.1	Therefore, the VSB suits well, is well structured and provides all necessary information to fully understand it.
1.3	Connecting the SVs with the VS works well, is reasonable and important.
1.3.1	Therefore, the VPM is the preliminary work required for the VSB. It works well and is very reasonable. Considering positive affections by components of the VS (not just negative ones) is especially nice.
1.3.2	Therefore, the VSB is good, as it also displays those affections.
1.4	Generally, it is good that detecting different types of waste is supported. This increases the understanding for what can be waste.
1.4.1	Therefore, the VSB suits well and provides a good overview. However, it seems to overwhelm at the beginning (which gets better after investing time).
1.5	The connections between processes and other components (e.g., IT-Systems or Information) is good and very important. It is good, that any *Affecting Object* records its interface relations.
1.5.1	Therefore, the VSB suits well and provides a good overview, as those connections can be easily seen and drawn.
1.6	Identifying needs for change and defining development actions worked well, fast and easy. Investigating the CVS already supported defining improvement ideas (which is perceived as good).
1.6.1	Therefore, the VPM supports understanding, what could be improved. However, it does not perfectly suit explicitly defining development actions.
1.6.2	Therefore, the SVM is perceived similarly to the VPM.
1.6.3	Therefore, the VSB is very reasonable and good. For developers, such a model could significantly support designing user stories. All development actions should be concentratively defined here.
1.7	This method seems to suit modelling an entirely new VS. A second session for carefully analyzing that draft may be reasonable.
1.7.1	Therefore, the VPM is supportive, as it could be firstly used to describe the demands and desires of the stakeholders.
1.7.2	Therefore, the SVM is supportive, as the dependencies between the different SVs could be investigated further.

RQ	Corresponding information given by the participant
1.7.3	Therefore, the VSB is supportive, as it could be used to model a target state of the VS afterwards. However, the duration of a process can only be estimated using experiences.
2	The notation is perceived as very good.
2.1	The visual differences are good and easily to perceive.
2.2	The range of different visualisations is satisfyingly high (i.e., not too similar or too complex). However, the colours of processes and IT-systems could differ more (but this is not crucial at all).
2.3	The colours for the RF, CPL, S Score and H Score remind of traffic lights which supports understanding the meaning they embody. Further, the notation is very intuitive for someone familiar with modelling processes, etc. generally (it might be harder for other people).
2.4	The amount of text inside the models is perfect. It is enough to deliver all information required while not increasing the complexity unnecessarily.
2.5	The VSB seems to easily overwhelm when looking at it the first time but also supports understanding how complex it actually is. However, after spending some time, the understandability drastically increases. Thus, the number of different visualizations is good. Further, the VSB is structured well. The VPM is very good.
3	The tool prototype is good and supportive. Everything looked around and provided a good overview.
3.1	ADOxx looks well and understandable. However, the participants limits his impressions, as he has not used it before on his own.
3.2	The procedures are all very well and supportive.
3.2.1	The ”Cumulative Time Calculator” is cool, as it provides to easily modify a VS while always maintaining an up to date overview on all times inside it.
3.2.2	The ”Receive Value Information” is good, as it enriches the VS with supportive information regarding the SVs
3.2.3	The ”Data Information Calculator” can be good, as it provides supportive Key Performance Indicators (KPIs). But, the participant does not feel capable of evaluating it properly.

RQ	Corresponding information given by the participant
3.2.4	The ”Waste Detector” is very good, as it creates a good overview on what may generates waste and what kind of waste it is.
3.3	The method may suit future cases well.
3.3.1	The participants wants to learn how to use it and feels confident of using it.
3.3.2	The participants definitely wants to work with it in the future and feels even capable of embodying the host of such a modelling session.
3.3.3	The participant can imagine working with it without the prototype. However, it may not be as good as when using the prototype (especially for the VSB due to the considered times of processes and relations). The VPM and SVM could be more easily modelled independently from the prototype.
4	The execution of the session and the guidance through it, especially when jumping between different models, was very good
4.1	The objective of investigating an entire iteration in a single session was good. However, the duration (2:30 hours) was too short, but it was okay due to the in advance prepared models, as they supported the flow of the session. In future, maybe an entire day would suit this purpose.
4.2	The separation of tasks was very pleasing, as the participants did not have to put so much effort in precisely understanding the modelling tool. A similar procedure would suit in future cases as well.
4.3	The execution via Microsoft Teams worked very well (with the exception of incoming emails that distract during the session), especially as all participants shared their cameras. As all participants already knew each other, their collaboration was good and constructive. The shared screen worked out well and provided maintaining the overview at any time. Performing a similar procedure in present would suit as well.
4.4	The introduction to the topic and the prepared models (both in advance to the session) were perceived as a very useful assistance and supportive.

A.4. Memory Log for the GI With Participant C

Date: Friday the 9th of April in 2021 / **Start:** 11:07 am CET / **End:** 11:31 am CET

Postscript: It was a very enjoyable atmosphere, the participant seemed very relaxed and open to answer all the questions and there were no interruptions at all. However, the participant attended to this interview while going by car (but not as the driver).

RQ	Corresponding information given by the participant
1	The order of the method is absolutely correct and reasonable.
1.1	Considering the SVs in the VS is very good, as it provides a new perspective. Especially considering all perspectives was very important and good.
1.1.1	Therefore, the VPM is good.
1.1.2	Therefore, the SVM is good and reasonable.
1.2	Modelling a VS is too complex.
1.2.1	Therefore, the VSB is too complex and incomprehensible. A legend that further explains all symbols might be helpful.
1.3	Connecting the SVs with components of the VS is reasonable.
1.3.1	Therefore, the VPM is appropriate and good.
1.3.2	Therefore, the VSB is not understandable.
1.4	The detection of waste is essentially important and good.
1.4.1	Therefore, the VSB is okay or even good.
1.5	Connecting processes with further objects of the VS (e.g., IT-systems or Information) is essential.
1.5.1	Therefore, the VSB is too complexly structured.
1.6	Identifying needs for change and defining development actions works well. Those mechanics are even comprehensible for uninvolved people.
1.6.1	Therefore, the VPM is good and very comprehensible.
1.6.2	Therefore, the SVM is good and appropriate.
1.6.3	Therefore, the VSB is too complex and incomprehensible.
1.7	The participant does not know, if it suited modelling a VS for a new service.
1.7.1	Thus, the VPM is perceived neutrally.
1.7.2	Thus, the SVM is perceived neutrally.
1.7.3	Thus, the VSB is perceived neutrally.
2	The notation was perceived as difficult to understand. However, the participants limits his perception with individual dissatisfaction with modelling.
2.1	There is no actual preference: Completely neutrally.

RQ	Corresponding information given by the participant
2.2	The range of different visualizations is too complex. For the VSB, the colours of the different objects look to similar.
2.3	The VPM is very intuitive, the SVM and VSB not.
2.4	The usage of text inside the models is on point.
2.5	Too many different objects in the SVM and VSB. The VPM is fine.
3	The tool seems to be powerful and work good.
3.1	ADOxx seems to be useful.
3.2	The procedures are all very well and supportive.
3.2.1	The ”Cumulative Time Calculator” is very good and desirable.
3.2.2	The ”Receive Value Information” important and very useful.
3.2.3	The ”Data Information Calculator” is very good.
3.2.4	The ”Waste Detector” is very, very good. However, calculating the costs of waste (or a VS and its steps) is very desirable.
3.3	*its*VALUE could be used in the future, especially for optimizing already existing VSs (and maybe also for new services)
3.3.1	The tool prototype is too incomprehensible for the participant. Thus, the participant would just feel capable of using it on his own after a workshop.
3.3.2	The participant can imagine working with it again.
3.3.3	Independently from ADOxx, the participant would use *its*VALUE, but only with another software (the best and intuitive one).
4	The execution of the modelling session was good.
4.1	Its objective (following an entire iteration) was important and good. Therefore, the duration (2:30 hours) was absolutely appropriate.
4.2	The separation of work was good (the host modelling and the participants discussing and delivering input).
4.3	Using Microsoft Teams was appropriate and successful. Although the screen was shared, maintaining the overview was very difficult (due to the unknown software of ADOxx). However, sharing the screen was generally good. As the participants already knew each other, their collaboration was good and productive. A similar procedure in present could work.
4.4	The introduction to the topic was not read in advance to the session.

A.5. Memory Log for the GI With Participant D

Date: Monday the 12th of April in 2021 / **Start:** 03:03 pm CET / **End:** 03:32 pm CET

Postscript: It was a very enjoyable atmosphere, the participant seemed very relaxed and open to answer all the questions. Further, the participant requested receiving the tool prototype and this work once it was finished. However, the GI was interrupted from 03:05 pm to 03:07 pm due to technical difficulties.

RQ	Corresponding information given by the participant
1	The contextual order inside the session was good. The techniques of the method are very impressing and good.
1.1	The different perspectives of the stakeholders are very good.
1.1.1	Therefore, the VPM is very good.
1.1.2	Therefore, the SVM is good but maybe overwhelming for someone that is not or just briefly involved.
1.2	Modelling the CVS worked very well and smooth.
1.2.1	Therefore, the VSB is very supportive and suited.
1.3	Connecting the SVs with the VS was very complex but also ingenious.
1.3.1	Therefore, the VPM is super.
1.3.2	Therefore, the VSB is ingenious, as those actual affects on the VS can be immediately displayed.
1.4	Identifying and detecting what generates waste worked very well.
1.4.1	Therefore, the VSB suits well.
1.5	Connecting processes with other objects of the VS (e.g., IT-systems or Information) is very good and ingenious.
1.5.1	Therefore, the VSB suits well.
1.6	Identifying needs for change and defining development actions worked perfectly, as everybody could get encouraged for participating by the method.
1.6.1	Therefore, the VPM is very good.
1.6.2	Therefore, the SVM is difficult to evaluate, as the participants does not feel capable of providing a good answer (she does not know enough about it).
1.6.3	Therefore, the VSB is very important and good, as it provides a global view where everything and everyone is visually displayed somehow.
1.7	This method would perfectly suit designing an entirely new service.

RQ	Corresponding information given by the participant
1.7.1	Therefore, the VPM is good and to cover all involved stakeholders.
1.7.2	Therefore, the SVM is difficult to evaluate and requires more time to gather knowledge about it to understand what it is capable of.
1.7.3	Therefore, the VSB is good. (I forgot to ask explicitly, but the VSB was opened and seen when asking generally)
2	The notation is very good and familiar.
2.1	The visual differences were very good and comprehensible (especially due to good explanations during the session).
2.2	The range of visual differences is very good and surely not too monotonous.
2.3	The visualizations are very well intuitive and convincing.
2.4	The amount of text fits and is not too much or too less.
2.5	The amount of different objects is okay and not too much. However, it could become too much when missing some kind of delicacy of feeling.
3	The tool prototype seems to be good.
3.1	ADOxx seems good but is unknown.
3.2	The procedures are all very well and supportive.
3.2.1	The ”Cumulative Time Calculator” is good, as it covers on time assumptions.
3.2.2	The ”Receive Value Information” is very complex but also supportive.
3.2.3	The ”Data Information Calculator” is very important and good.
3.2.4	The ”Waste Detector” is very supportive and good.
3.3	It could be instantly used in the company and is desired.
3.3.1	The participants does not feel capable to use it on her own but wants a workshop to become capable of.
3.3.2	”It is hard to get better” and should be worked with again.
3.3.3	Independently from ADOxx, *its*VALUE would also be used (but a working with tool is better than using coloured cards for instance).
4	The execution of the modelling session was very good.
4.1	The objective was very good and ”tangible”. Therefore, the duration was a little bit too short. More time would suit better.
4.2	The distribution of tasks was very good (the host modelling and the participants discussing and delivering input)

RQ	Corresponding information given by the participant
4.3	Microsoft Teams suited well and was also already well known. The shared screen provided maintaining the overview at any time very well. As all participants have already known each other, their collaboration was very well and productive. A similar procedure could also work in present.
4.4	The introduction to the topic send in advance to the modelling session was briefly investigated. It was perceived as supportive and good. Further preparations (for the models) were very good and impressing.

B. The Resulted Models from the Case Study from Chapter 6

This appendix chapter contains all *its*VALUE models created during the case study from Chapter 6. This includes VPMs for the following stakeholders: User (cf. Figure B.1), Team Leader (cf. Figure B.2), Service Manager (cf. Figure B.3) and Client Service Team (cf. Figure B.4). Moreover, this includes a SVM (cf. Figure B.5) on all those VPMs and a linked VSB (cf. Figure B.6).

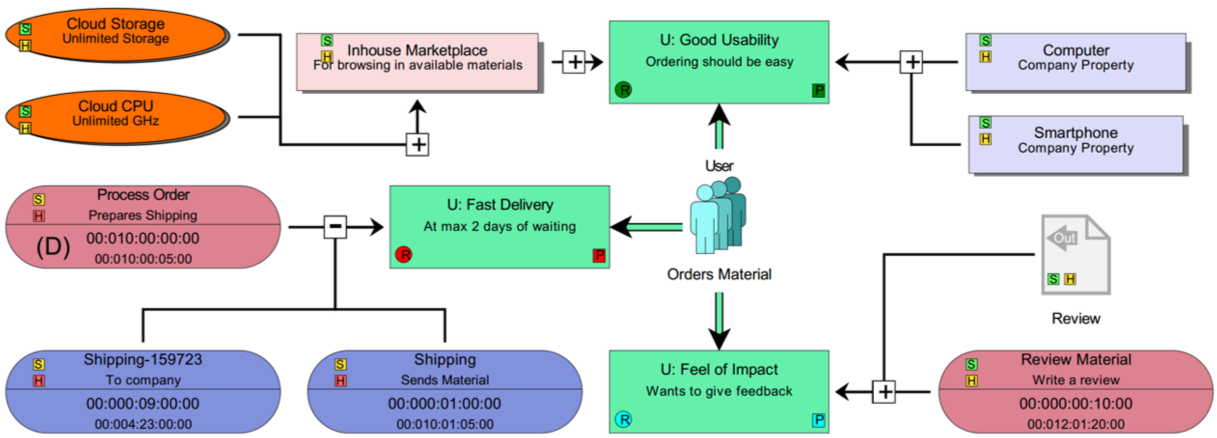


Figure B.1.: The Resulted VPM for the User from the Case Study

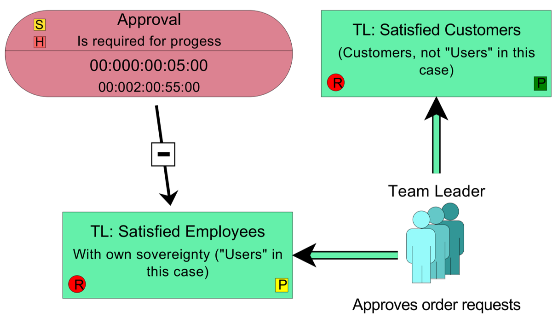


Figure B.2.: The Resulted VPM for the Team Leader from the Case Study

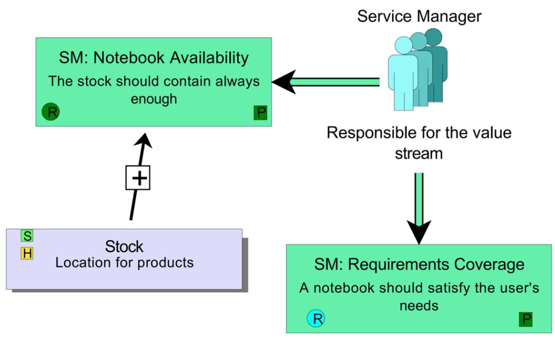


Figure B.3.: The Resulted VPM for the Service Manager from the Case Study

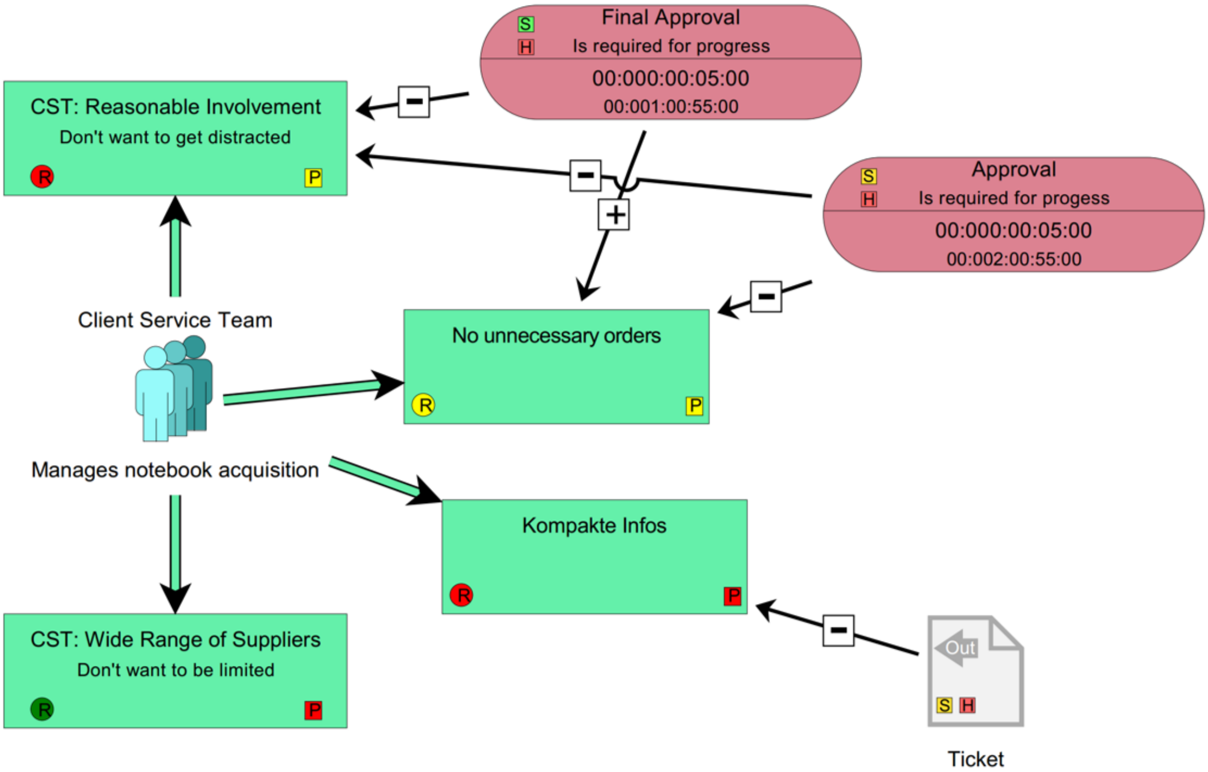


Figure B.4.: The Resulted VPM for the Client Service Team from the Case Study

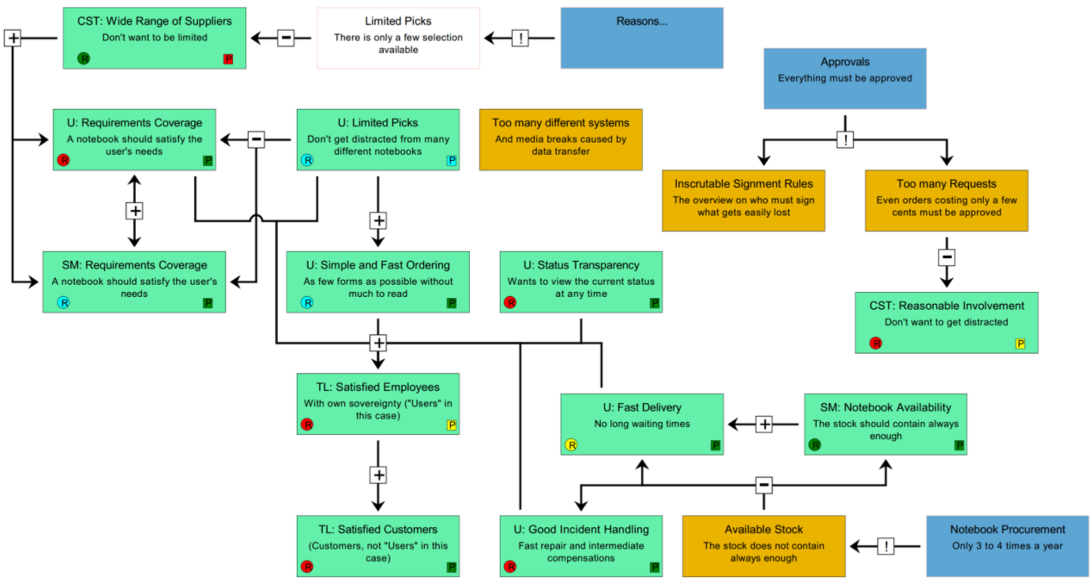


Figure B.5.: The Resulted SVM from the Case Study

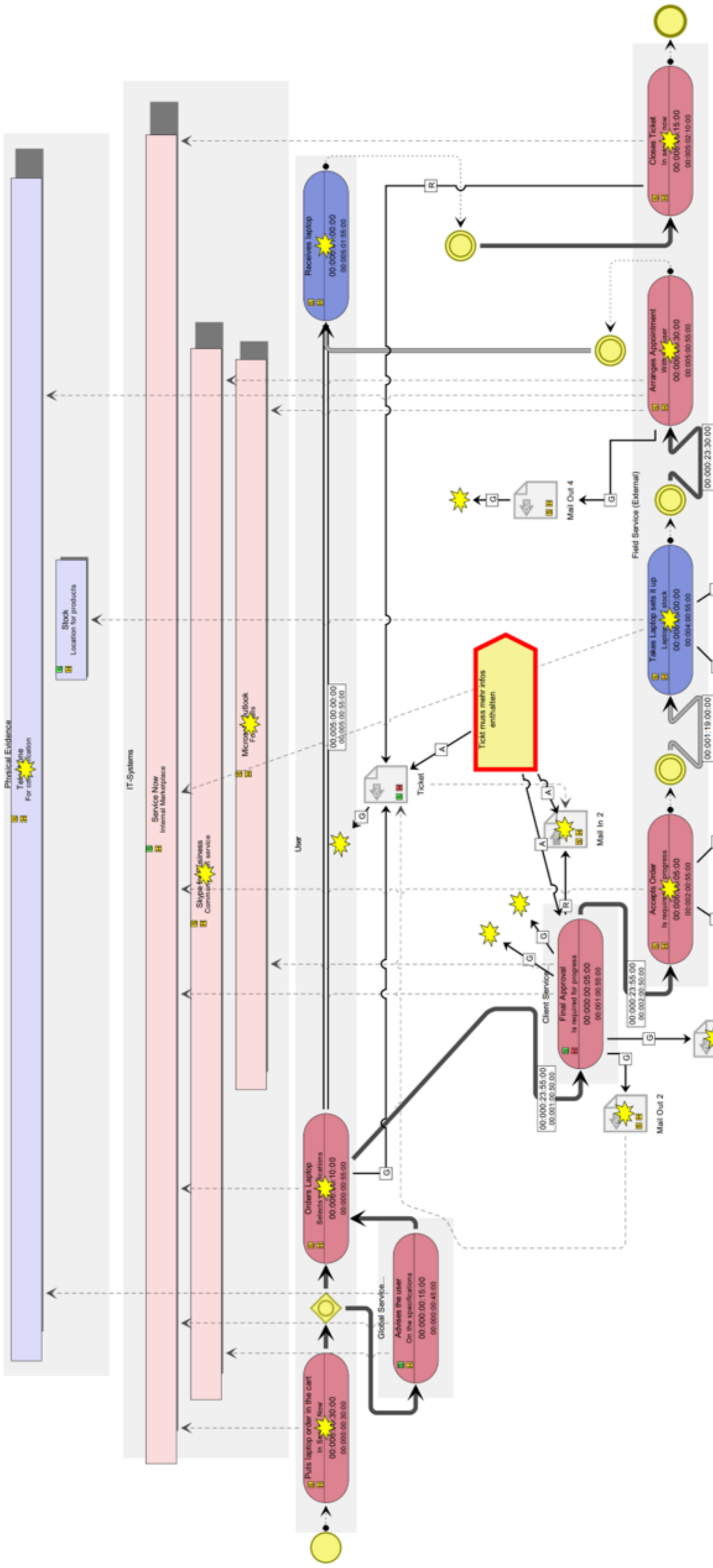


Figure B.6.: The Resulted VSB from the Case Study

C. The Resulted Models from the Evaluation from Chapter 8

This appendix chapter contains all *its*VALUE models created during the evaluation from Chapter 8. This includes VPMs for the following stakeholders: Scientists (cf. Figure C.1), Conference Hosts (cf. Figure C.2), Participants (cf. Figure C.3), Review Committee (cf. Figure C.4), Conference Organizers (cf. Figure C.5) and External Service Providers (cf. Figure C.6). Moreover, this includes a SVM (cf. Figure C.9) on all those VPMs and both a linked VSB (cf. Figure C.8) and PSM (cf. Figure C.7).

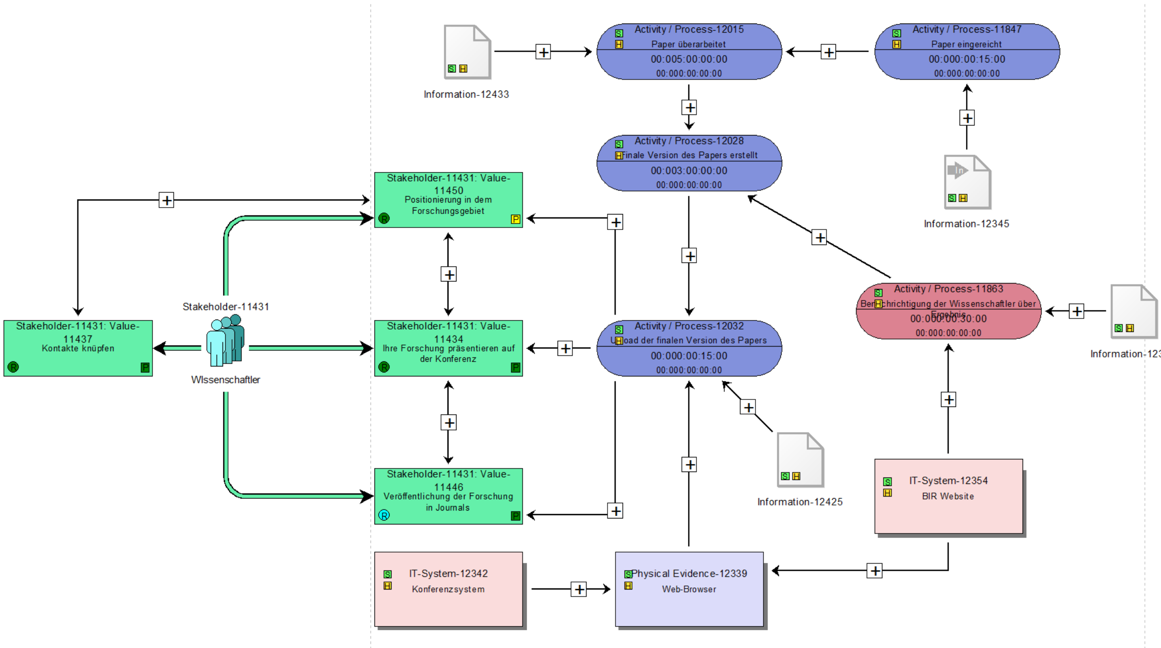


Figure C.1.: The Resulted VPM for the Scientists from the Evaluation

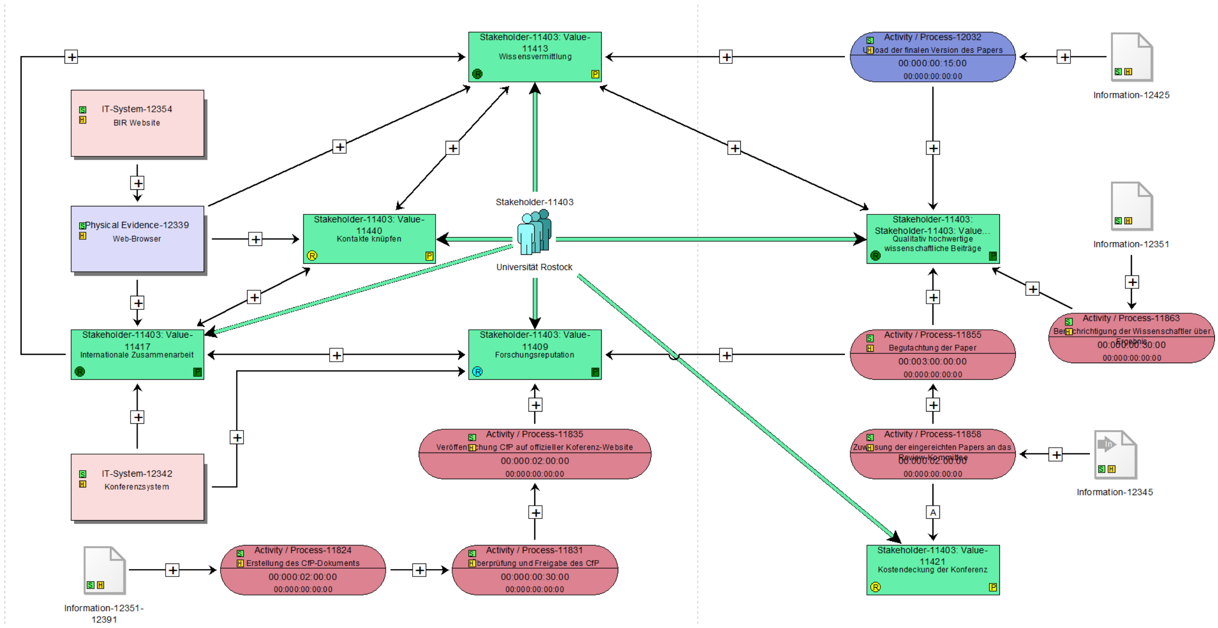


Figure C.2.: The Resulted VPM for the Conference Hosts from the Evaluation

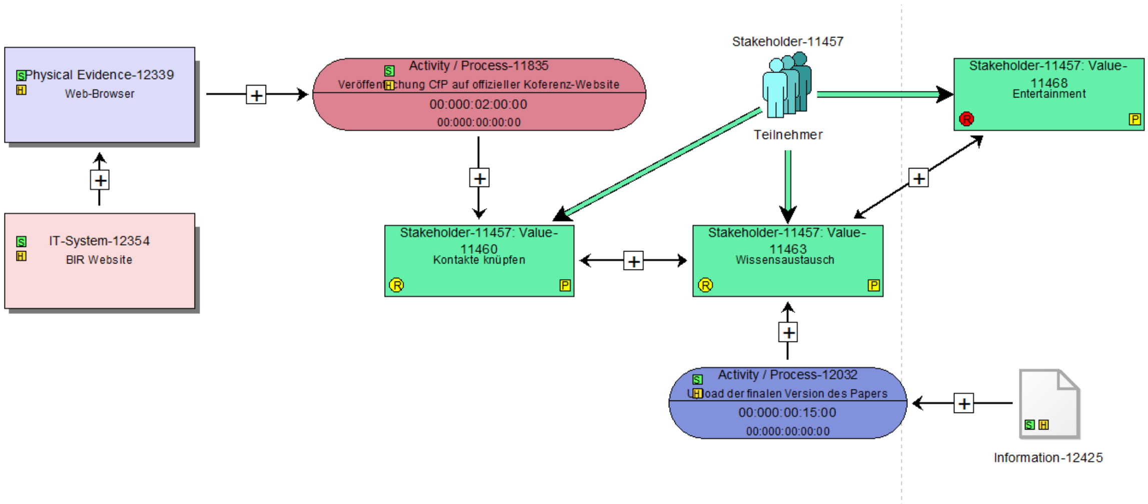


Figure C.3.: The Resulted VPM for the Participants from the Evaluation

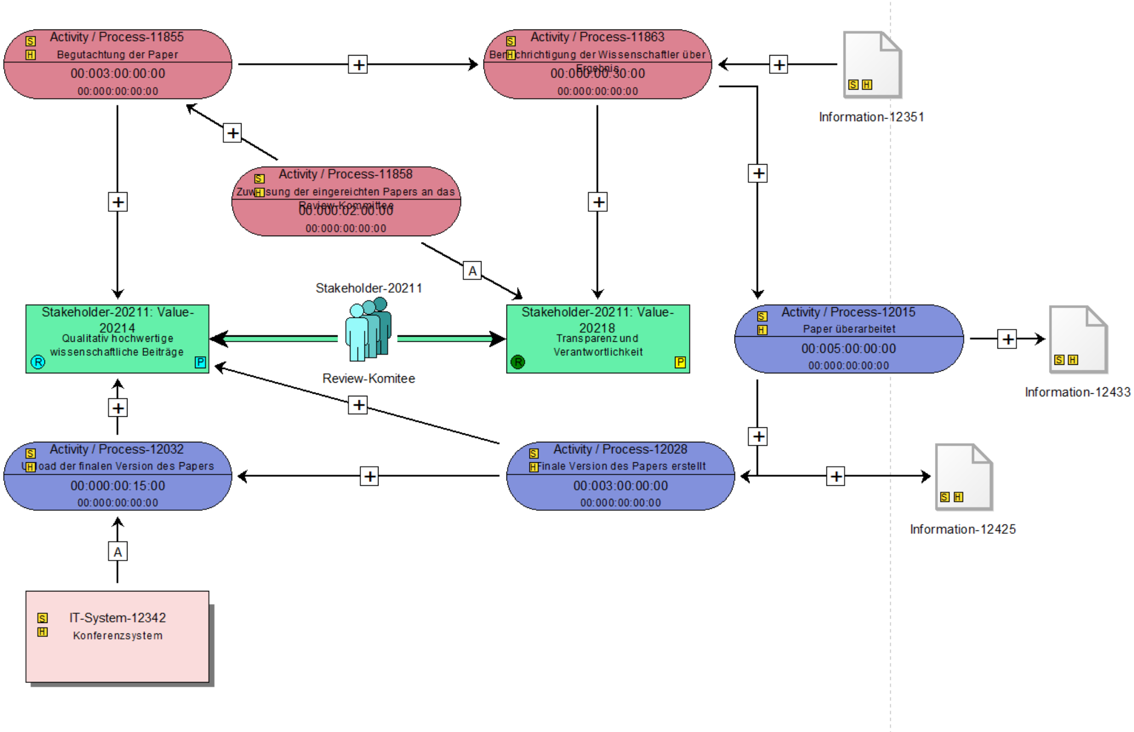


Figure C.4.: The Resulted VPM for the Review Committee from the Evaluation

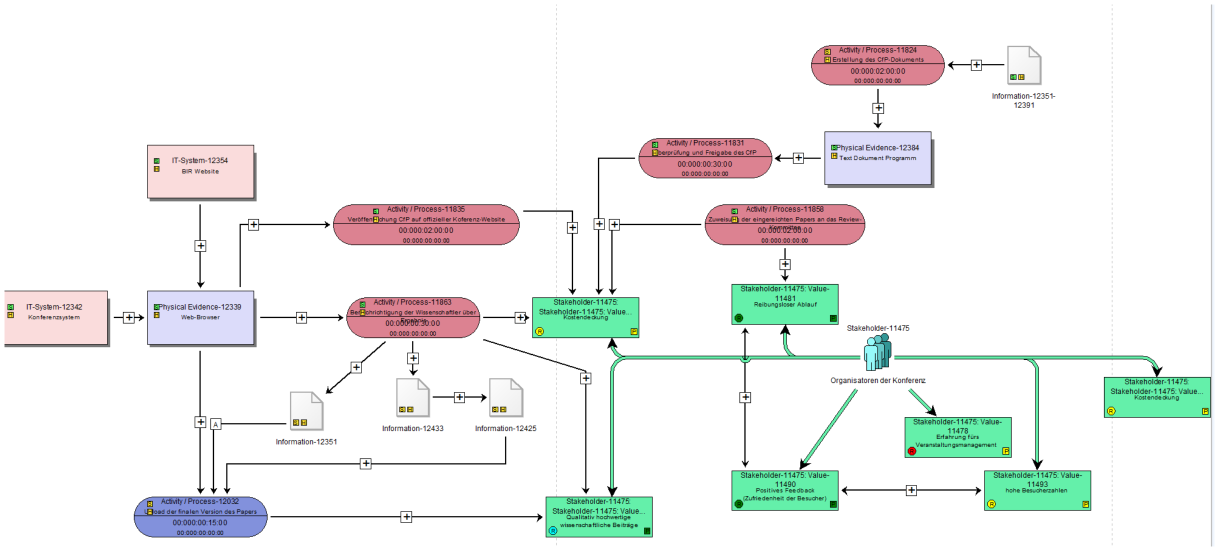


Figure C.5.: The Resulted VPM for the Conference Organizers from the Evaluation

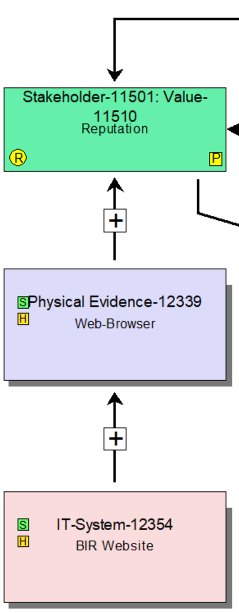


Figure C.6.: The Resulted VPM for the External Service Providers from the Evaluation

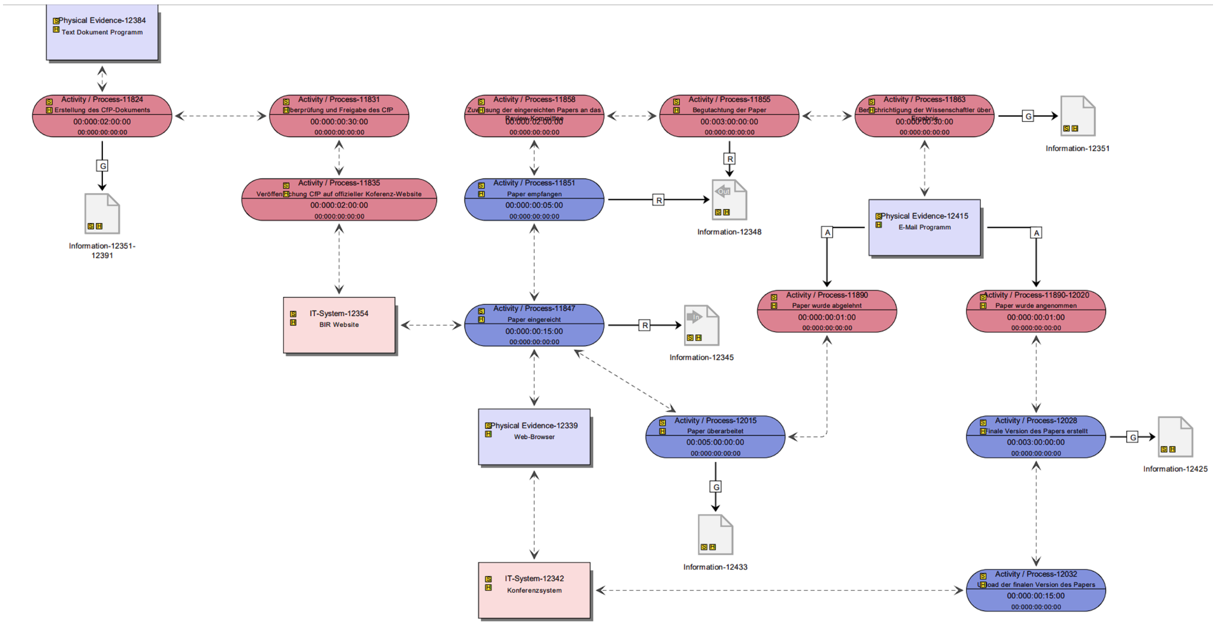


Figure C.7.: The Resulted PSM from the Evaluation

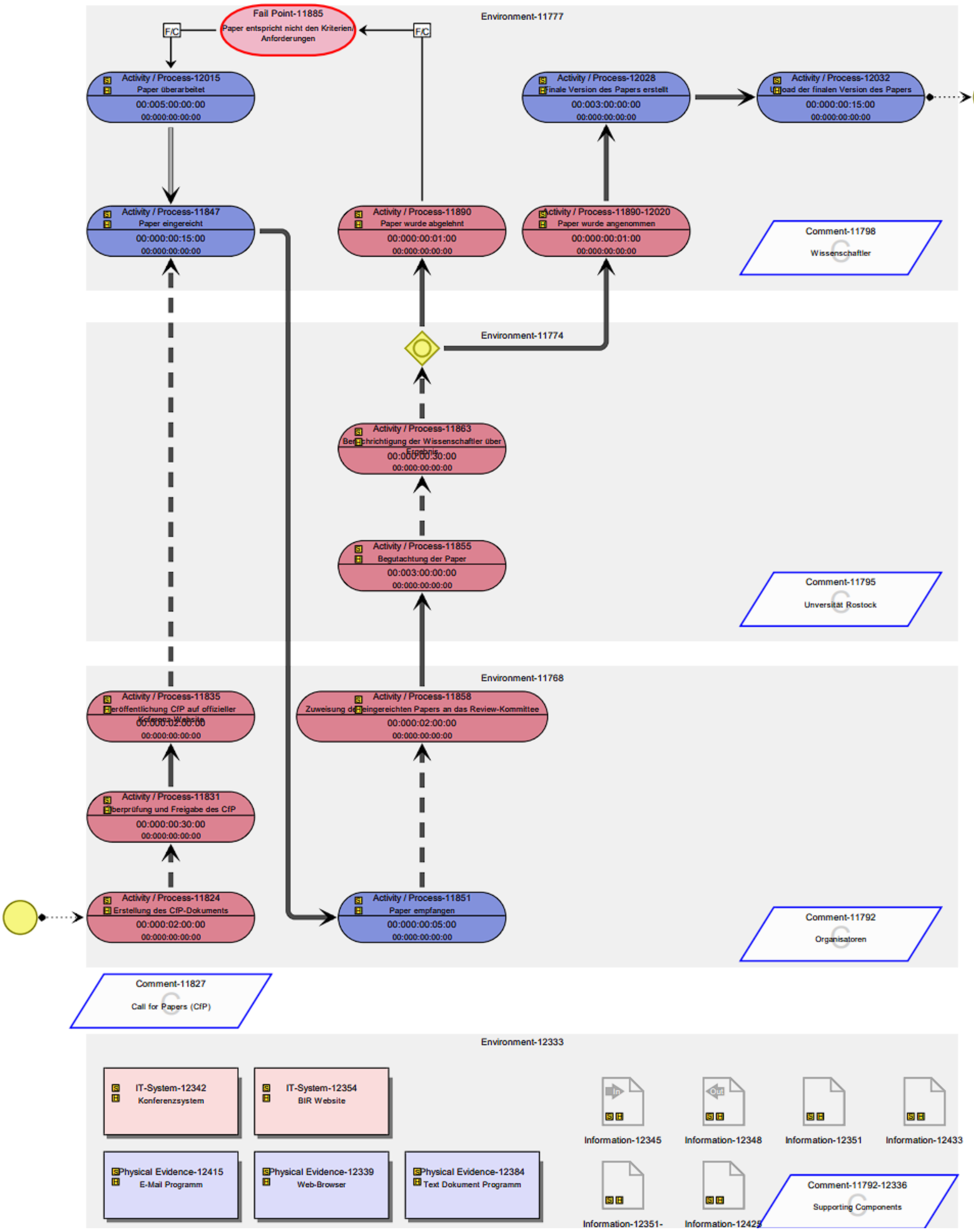


Figure C.8.: The Resulted VSB from the Evaluation

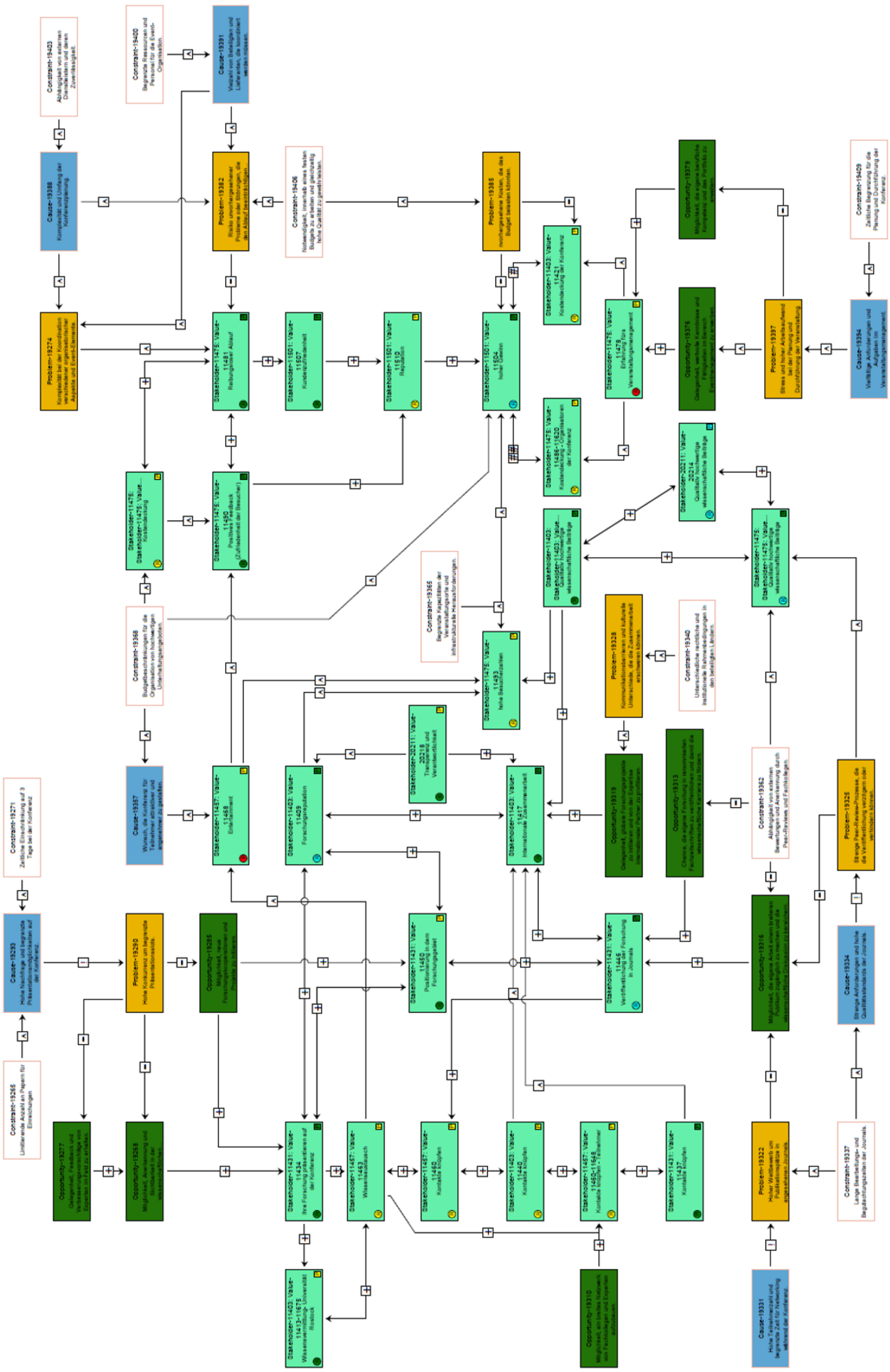
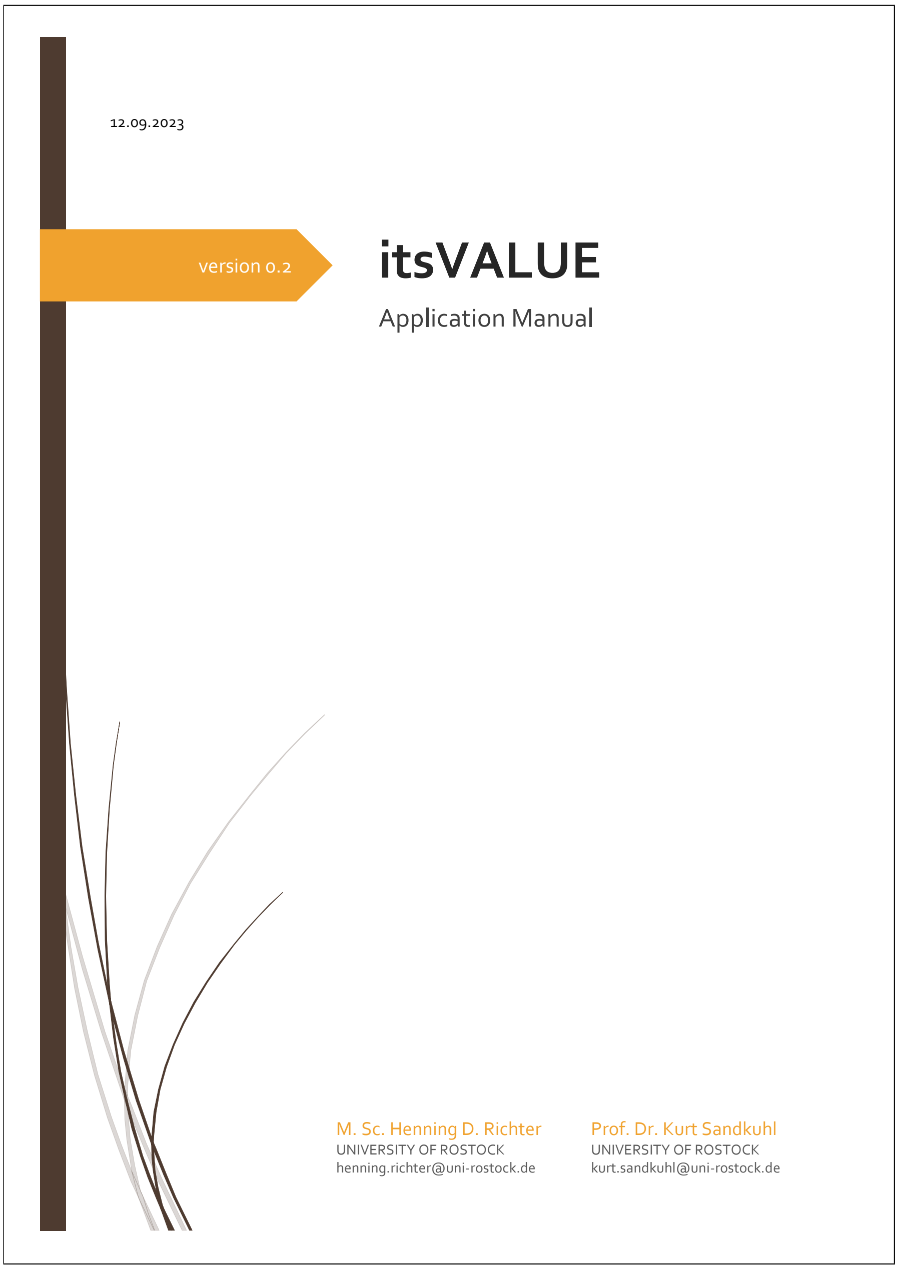


Figure C.9.: The Resulted VSM from the Evaluation

D. The *its*VALUE Application Manual

This appendix chapter contains the *its*VALUE application manual published at OMiLAB[1] and ResearchGate[2] [112].



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version 0.2

itsVALUE

Application Manual

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[1] `www.omilab.org/activities/omilab-book-series/volume2/details/?id=42`
[2] `http://dx.doi.org/10.13140/RG.2.2.14851.07208/1`

Table of Contents

Abstract

Traditionally, value stream modeling or mapping only focused on displaying and optimizing explicit forms of values (e.g., maximizing revenue, minimizing costs, resources, time, etc.). Hence, any tacit form of values was left unconsidered (in other words, perceived values such as employee satisfaction, ease of use, sustainability, etc.). To address this research gap, we invented *its*VALUE: a combined package consisting of a method framework, notation and an ADOxx modeller. It aims at considering any value perceived by any stakeholder explicitly and quantifiably when dealing with value streams.

In this regard, this application manual establishes a more seamless connection between the itsVALUE method framework and its notation with its supplementary ADOxx modeller. To achieve this goal, it is divided into two parts. The first provides an overview on the underlying *its*VALUE notation and its metamodels. Additionally, it introduces important notes on the ADOxx modeller. The second part of this manual follows the *its*VALUE method framework for its structure and different sections. Thus, its sections are specifically designated to a certain phase of the *its*VALUE method framework and extends it with recommendable guidance. This guidance illustrates how to use the *its*VALUE notation with the ADOxx modeller properly. In other words, this second part of the application manual explains explicitly, when and how which parts of the *its*VALUE notation and thus ADOxx modeller should be used when following the *its*VALUE method framework.

Furthermore, this application manual follows the version "v0.2" of the ADOxx modeller. Compared to the previous version "v0.1", there are multiple conceptual changes in "v0.2" (some re-adjustments of the method framework, an entirely new model type and thus updated meta models and some new functionalities inside the ADOxx modeller alongside with several bug-fixes). The ADOxx modeller is accessible for download via: https://www.omilab.org/activities/projects/details/?id=148#page_title

Part 1: The *its*VALUE Notation and its Metamodels

At first, this part provides an overview on the *its*VALUE metamodels. Further, it introduces all visual representations followed by specific information on the ADOxx modeller.

The Metamodels

Three metamodels are presented: Each one for all the objects, relations and model types that are part of *its*VALUE. Further, we present an exhaustive list of all allowed domains and ranges for the relations

The Object Metamodel

By inheritance, figure 1 shows all features possessed by the objects. All the italic classes are abstract and not actually implemented. They only reduce complexity inside figure 1 by condensing redundant information. All remaining classes are actually implemented and thus accessible by the user. In total, *its*VALUE consists of 20 different classes, where some are furtherly dismountable into different types. However, the *"Data Information"* class represents a record table part of the *"Activity / Process"* class.

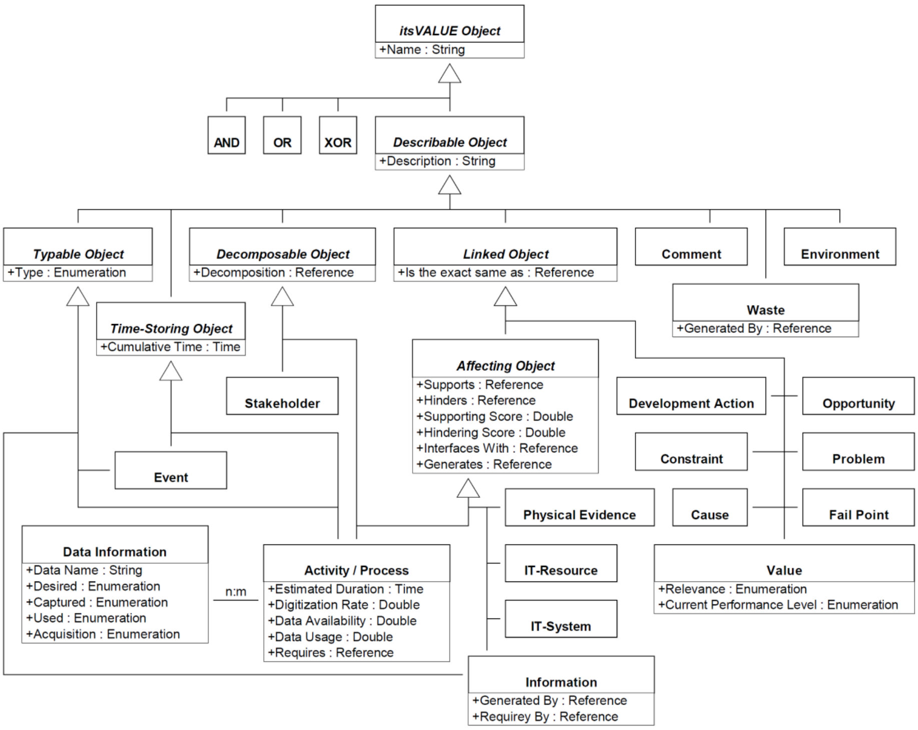


FIGURE 1: THE OBJECT METAMODEL

The Relation Metamodel

By inheritance and non-implemented italic abstract classes, figure 2 shows all features possessed by the relations as well. In total, *its*VALUE consists of 14 different relation classes, where some are also furtherly dismountable into different types.

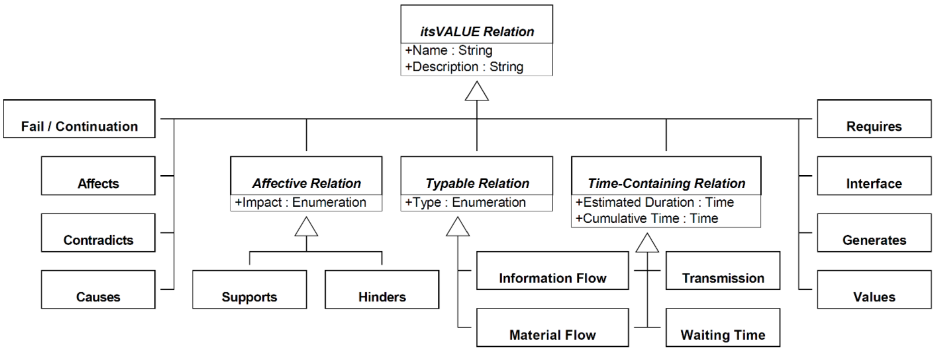


FIGURE 2: THE RELATION METAMODEL

Domains and Ranges for Relations

The allowed domains and ranges for the *its*VALUE relation classes are too complex to be displayed as a figure, as some are not universally generic. In other words, an allowed range is not just always valid for its designated relation class. Instead, it is furtherly dependent on the domain together with the relation class it builds a tuple with. To illustrate this compactly, table 1 lists all collections, where any given relation class can connect any given domain with any given range. Additionally, the *"Affects"* relation class is designed to be universally used when any other relation class does not fit.

TABLE 1: COLLECTION OF ALL ALLOWED RELATION-DOMAIN-RANGE TUPLES

Relation Class(es)	Domain(s)	Range(s)
Values	Stakeholder	Value
Supports, Hinders	Value, Activity / Process, Physical Evidence, IT-System, IT-Resource, Information, AND, OR, XOR	Value
Supports, Hinders	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information
Supports, Hinders	Value	Value, AND, OR, XOR
Supports	Opportunity, AND, OR, XOR	Value, Opportunity, AND, OR, XOR
Hinders	Problem, Constraint, AND, OR, XOR	Value, Opportunity, AND, OR, XOR
Contradicts	Value	Value

Relation Class(es)	Domain(s)	Range(s)
Causes	Cause, AND, OR, XOR	Opportunity, Problem, Constraint, AND, OR, XOR
Interface	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information
Requires, Generates	Activity / Process	Information
Generates	Activity / Process, Physical Evidence, IT-System, IT-Resource, Information	Waste
Information Flow, Material Flow, Transmission, Waiting Time	Activity / Process, Event, AND, OR, XOR	Activity / Process, Event, AND, OR, XOR
Fail / Continuation	Fail Point	Activity / Process, Event
Fail / Continuation	Activity / Process, Event	Fail Point
Affects	(any) *itsVALUE Object*	(any) *itsVALUE Object*

TABLE 1: COLLECTION OF ALL ALLOWED RELATION-DOMAIN-RANGE TUPLES

The Model Metamodel

An addition to inheritance and one single italic abstract class defining the features of models, figure 3 mainly describes which classes and relation classes are actually part of the four different model types. A class is only a part of a model, if it is connected with the model following the connection upwardly.

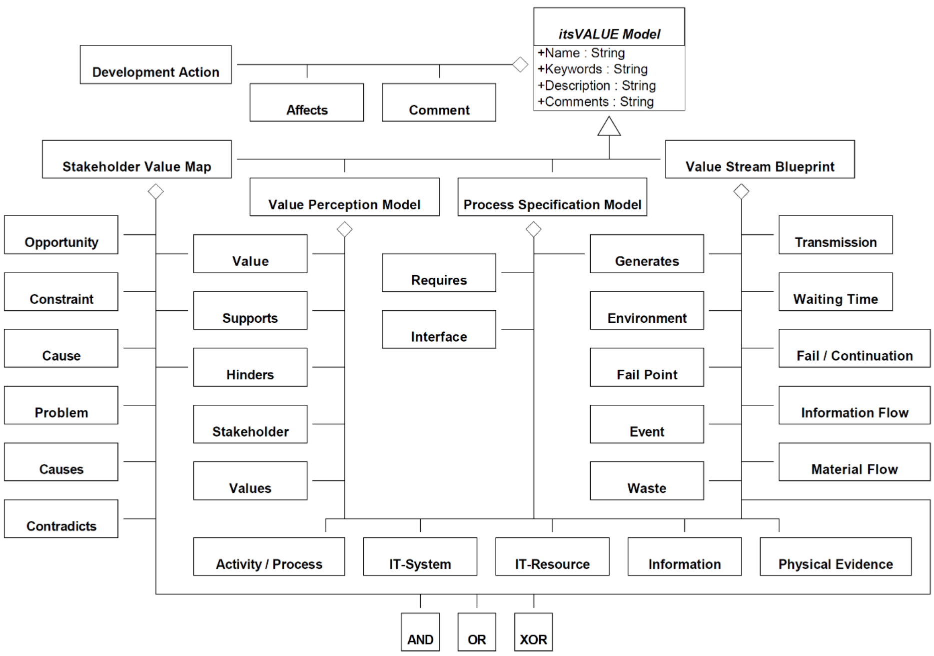


FIGURE 3: THE MODEL METAMODEL

5

The Visual Representations

In total, *its*VALUE consists of 20 different classes and 14 different relation classes, where some are furtherly dismountable into different types. As each requires its unique shape, there exist 26 different visualizations for the classes and 16 different visualizations for the relation classes. Whereas table 1 lists all 26 visualizations for the 20 *its*VALUE classes and their particular sub types, table 2 does the same for the 16 visualizations for the 14 *its*VALUE relation classes and their particular sub types.

TABLE 2: VISUAL REPRESENTATIONS OF ALL CLASSES AND THEIR SUB-TYPES

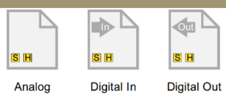
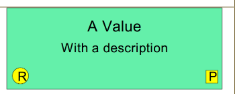
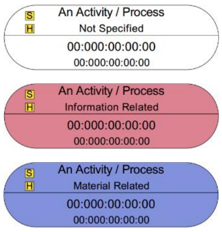
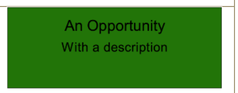
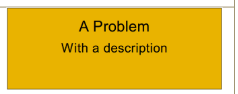
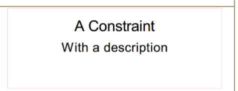
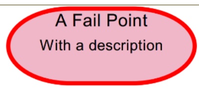
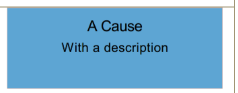
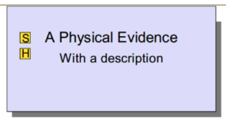
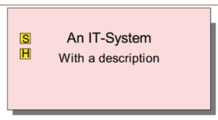
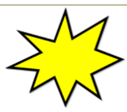
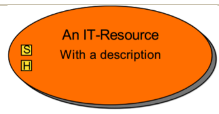
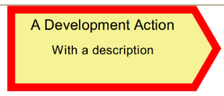
Class	Visualization	Class	Visualization
Information (Analog, Digital Input, Digital Output)		Stakeholder	
Environment		Value	
Activity / Process (Information Related) (Material Related)		Opportunity	
		Problem	
		Constraint	
Fail Point		Cause	
Physical Evidence		IT-System	
Waste		IT-Resource	
Event (Start, Common, End)		AND, OR, XOR	
Development Action		Comment	

TABLE 2: VISUAL REPRESENTATIONS OF ALL CLASSES AND THEIR SUB-TYPES

6

TABLE 3: VISUAL REPRESENTATIONS OF ALL RELATION CLASSES AND THEIR SUB-TYPES

Relation Class	Visualization	Relation Class	Visualization
Interface		Affects	A
Transmission		Generates	G
Material Flow (Push)		Requires	R
Material Flow (Pull)		Supports	+
(Product) Information Flow		Hinders	-
(Process) Information Flow		Contradicts	#
Waiting Time		Causes	!
Fail / Continuation	F/C	Values	

TABLE 3: VISUAL REPRESENTATIONS OF ALL RELATION CLASSES AND THEIR SUB-TYPES

The Four Different Model Types

The Value Perception Model (VPM) serves defining value perceptions by stakeholders explicitly and showing how any component of a value stream affects them both directly and indirectly through other components. Per VPM, there is only one stakeholder allowed. Further, this stakeholder is the core of any VPM from whom are all value perceptions connected outgoingly via the *"Values"* relation class. From there, the value perceptions are connected to components via either the *"Supports"* or *"Hinders"* relation classes. Moreover, these components can be supported or hindered as well.

The Stakeholder Value Map (SVM) serves defining relations and dependencies among several value perceptions by multiple stakeholders. They can either *"Support"*, *"Hinder"* or *"Contradict"* each other. Moreover, it serves defining value *"Opportunities"*, *"Problems"*, *"Constraints"* and *"Causes"*. The core intention of the SVM is providing a goal-oriented overview on all value perceptions to reasonably start defining development actions and weighting between different value perceptions.

The Value Stream Blueprint (VSB) serves defining the entire flow of the value stream from the initial demand to the final delivery. Moreover, it contains all components that are somehow part of the value creation, such as *"Activities / Processes"*, "Events", *"Fail Points"*, *"Physical Evidences"*, *"IT-Systems"*, *"IT-Resources"* and *"Information"*. All of these components can be grouped in different horizontally arranged *"Environments"*. In addition, waste can be placed wherever it occurs. Moreover, estimated durations, cumulative times and waiting times can be displayed and calculated for processes and events. This directly serves the core intention of a VSB: showing the flow compactly.

The Process Specification Model (PSM) serves defining further relations and dependencies that are important for a value stream. These are all outsourced to the PSM to reduce the complexity of a VSB which tends to increase easily. Thereby, the PSM supports the VSB in its core intention. Thus, inside a PSM, most components that are part of the VSB can be placed as well. If they interface, generate or require each other can be defined in the PSM. Unlike for the VPM, where every stakeholder receives its own VPM, multiple processes can be placed inside a PSM.

Further, the VSB and VPM are decomposable into sub-models (the VSB through the decomposition of processes and the VPM through stakeholders). This is recommended to do, if a higher granularity is required which would lead to too complex VSB or VPM models. Oppositely it is suggested, if a SVM or PSM becomes too complex, to split them up into multiple models where each model just contains grouped objects that are disjunctive sets of each other. Some visual examples of all different model types can be found later in part 2.

Some Important Notes on the ADOxx Modeller

The ADOxx modeller provides a dynamic modelling environment allowing multiple instances of the same object to exist in multiple different models and remain updated at any time. However, if a user copies any linked object, the ADOxx environment asks, if all references should now be re-adapted to the new copied instance. This must always be denied, as custom procedures in the background take care and ensure consistency at any time. Further, some relations are also tracked and automatically stored inside an object. If any object or relation is deleted, the ADOxx modeller automatically restores consistency across all models by deleting any remnants of this deleted information automatically (e.g., links to this non-existing object or of a non-existing relation). Moreover, the ADOxx modeller automatically checks any placed relation. If it is prohibited, the ADOxx modeller immediately erases this relation and informs the user of all allowed domains and ranges for this type of relation class. Unfortunately, there is a bug in displaying the S score of any affecting object. If $0 < S < 1$, it is still marked as yellow, although it should be green (when eliminating this bug, there is another marking the S score always as green, even if $S = 0$, which is even worser). Moreover, there are four custom procedures callable by the user: *"Rename Instance"* (required instead of usual renaming due to internal ADOxx environment feature leading to a bug for *its*VALUE), *"Receive Value Information"* (gathering and calculating complex value information), *"Waste Detector"* (detecting waste through pre-defined patterns) and *"Cumulative Time Calculator"* (calculating times in a value stream and for single objects).

Part 2: Following the *its*VALUE Method Framework

This second part examines an exemplary fictional case for applying the *its*VALUE method framework and its suggested approach. In this regard, it follows carefully any step furtherly described in the sub-parts. Additionally, each one of those is supported by showing how the ADOxx modeller could be used regardingly for our fictional case. This fictional case deals with a value stream for ordering customized PCs. Moreover, it is specifically designed to illustrate the use of every single class and relation class.

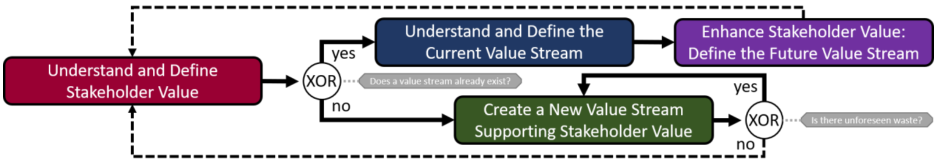


FIGURE 4: THE ITSVALUE METHOD FRAMEWORK

Figure 4 shows the underlying *its*VALUE method framework consisting of four different parts / phases. In any case, it starts with *"Understand and Define Stakeholder Value"* to initially focus on what must be accomplished and considered. Then, the proposed path splits up into two different directions: Either design an entirely new value stream from scratch or focus on an already existing value stream. At first, the path for an already existing value stream *("Understand and Define the Current Value Stream")* will be followed. The other path for creating an entirely new value stream *("Create a New Value Stream Supporting Stakeholder Value")* will be revisited at the end. Once an existing value stream is determined and analyzed, it should be enhanced by drafting a proposed future value stream *("Enhance Stakeholder Value: Define the Future Value Stream")*. Depending on which actual part was followed, an iteration of the *its*VALUE method framework comes now to an end. Still, conditions (e.g., value perceptions) may change over time. Further, it is important to monitor how well the proposed value creation actually works and how effective it is, especially in the beginning when setting up a new value stream for the first time (in this case, this particular phase could kick-off again, if there is any unforeseen waste detected). Due to all these issues, it is recommended to perform multiple iterations of the *its*VALUE method framework and for all value streams on a regular basis to catch up with the increasing dynamics of modern markets.

> *Please note, that **every** company or enterprise **has** value streams. They are maybe just not aware of it due to misconceptions on how to define the term "value stream". If you do produce any outcome for anybody, **your way of generating it is a value stream**.*

Understand and Define Stakeholder Value

In the beginning, all different value perceptions by all different stakeholders somehow involved must be assessed, understood and explicitly defined. Figure 5 shows all three steps that must be conducted.

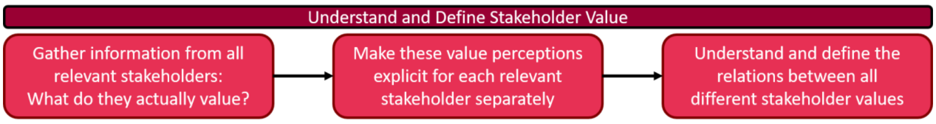


FIGURE 5: UNDERSTAND AND DEFINE STAKEHOLDER VALUE

Gather Information from All Relevant Stakeholders

At first, it must be assessed, what all relevant stakeholders actually value. If possible, this assessment should be carried out by directly asking the stakeholders themselves, as there may be a bias when just assuming what all these stakeholders value. Because, "value" is a highly subjective matter. A "value" can only exist as long as there is someone valuing something. However, a direct communication with all stakeholders is not always possible. In such cases, there must be an assumption which should originate reasonably and carefully (e.g., when legal authorities are also considered to be important stakeholders, their legal texts can be considered for assuming their possible value perception). In addition, it is important to analyze the nature of each value perception. In other words, how important it actually is and how well it is currently fulfilled. To sum up, there are some rules of thumb to consider when assessing value perceptions of stakeholders:

1) What "value" is, is highly subjective and thus dependent on the valuing one's perception.
2) The more direct your source for a value perception is, the more authentic and thus "true" it is.
3) The importance and current level of fulfillment of a perceived value must be determined.

Additionally, there are some recommended methods for accessing the value perceptions: *interviews, questionnaires, tracking and analyzing behavior, analyzing and forecasting markets, taking published or even legal texts into account (also online forums, blogs, social media, etc.), similar experiences/data, etc.*

Make These Value Perceptions Explicit for Each Relevant Stakeholder

Next, these assessed value perceptions must be made explicit. At this point, the VPM can be used: Each relevant stakeholder receives its own distinct VPM. For the exemplary case, there are only two different stakeholders considered to make the explanation as lean and focused as possible. Figure 6 and 7 show the resulting VPMs to this stage of the method framework. For each placed *"Value"*, its relevance factor (RF, bottom left, marked as "R") and current performance level (CPL, bottom right, marked as "P") can be defined. The RF can be *"Mandatory"*, *"Moderate"*, *"High"* or *"Outstanding"* and the CPL *"Poor"*, *"Moderate"*, *"High"* or *"Outstanding"*. Depending on the selection, the corresponding marker changes its color, where red stands for *"Mandatory/Poor"*, yellow for *"Moderate"*, green for *"High"* and sky-blue for *"Outstanding"*. To define which stakeholder is valuing these value perceptions, they are connected by the relation class *"Values"* and thereby automatically assigned in their name.

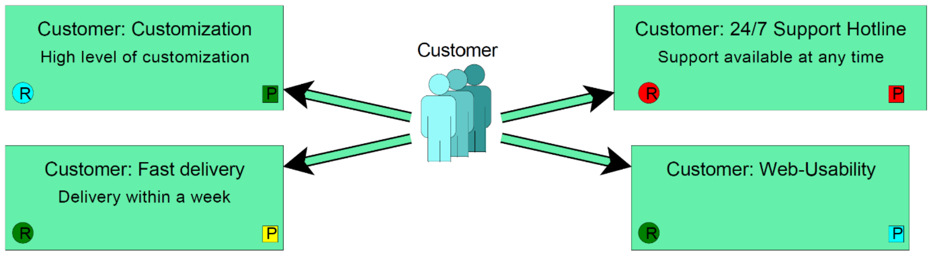


FIGURE 6: THE CUSTOMER VPM AFTER THE 1ST PHASE

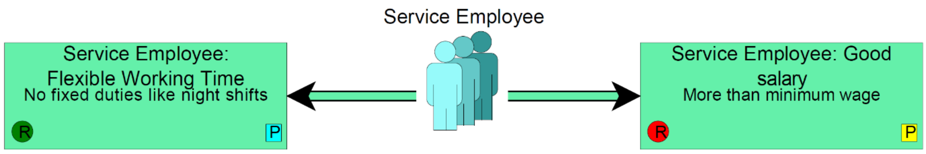


FIGURE 7: THE SERVICE EMPLOYEE VPM AFTER THE 1ST PHASE

Of course, it is possible to use the VPM in some cases (e.g., an interview) directly when assessing the value perceptions from the stakeholders. Thereby, the resulted VPM can be directly discussed which ensures the displayed information to be as correct as perceived by the stakeholder. Furthermore, a stakeholder can be decomposed into several sub-stakeholders which may be reasonable when having multiple different kind of customers sharing both identical and different values.

Understand and Define the Relations Between All Stakeholder Values

Lastly for the first phase, all the previously defined value perceptions must be furtherly investigated to define their dependencies and relations among each other. Here, the SVM should be used. To start, all values created in the VPMs can be copied to the SVM. Then, they should be linked to their pendants by using the attribute *"Is the exact same as"*. Thanks to the automatic assignment of the stakeholder in the value name, their origin is clearly determined in the SVM, where all different values are now collected. Following table 1, the relation classes *"Supports"*, *"Hinders"* and *"Contradicts"* (*"Affects"* as well, but this is generally applicable to all objects) can be used to connect the different values. This act depends on the modelling person who decides or identifies which relations are the most reasonable between two value perceptions. It is recommended, to follow easy reasoning here. For instance, if an appealing web-interface generally enhances the user experience, it supports any further value that is only accessible to the user via this web-interface as well. Moreover, if there are two different values that aim at contradictory goals, it can be assumed that they are contradictory to each other or at least hindering each other. Of course, a *"Value"* can also exist without any relevant dependencies to other value perceptions. Continuing the fictional case from figure 6 and 7, figure 8 shows the resulting SVM

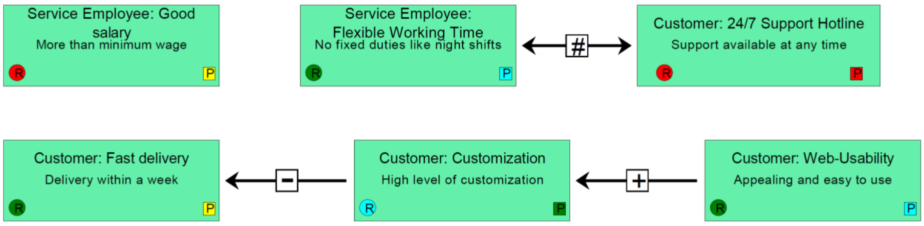


FIGURE 8: THE SVM AFTER THE 1ST PHASE

in this phase. Moreover, it is important to acknowledge, that there is no "true" SVM for a specific case. It depends always on the interpretation of the modelling person. The SVM should just serves as a visual support in reasonable decision making when weighting up between values.

Understand and Define the Current Value Stream

Following the path for an already existing value stream, it must be investigated. Therefore, it must be modeled before it can be analyzed. Figure 9 shows all regarding steps that must be carried out.

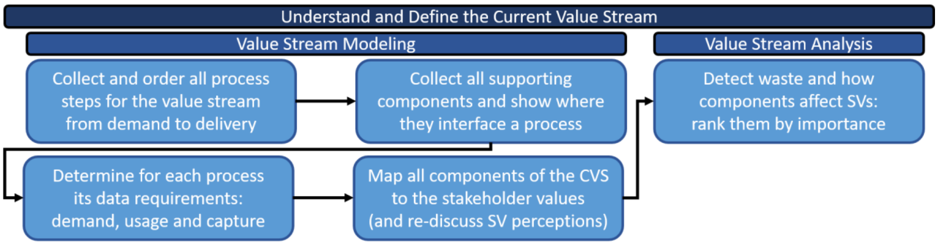


FIGURE 9: UNDERSTAND AND DEFINE THE CURRENT VALUE STREAM

Collect and Order All Process Steps from Demand to Delivery

To begin with, all process steps that are part of the value stream must be collected and ordered. Here, the VSB can be used to show this flow entirely from the initial demand to the final delivery. To cover this wide range, the granularity of processes is recommended to be rather broader than specific. Still, it is possible to achieve a high-level granularity by decomposing processes into other sub-VSB models. When determining the order of the processes, the type of flow must be defined and reasonable events must be placed. Any VSB starts with a starting event, ends with an ending event and is likely to have common events reasonably placed in between (e.g., for indication a change for the type of flow). If an information is the good that flows, an *"Information Flow"* is used. If this flow is directly dedicated to the final product that is delivered, the sub type *"Product Information Flow"* should be used. If this flow only influences the final product in a supportive manner, the sub type *"Process Information Flow" must*

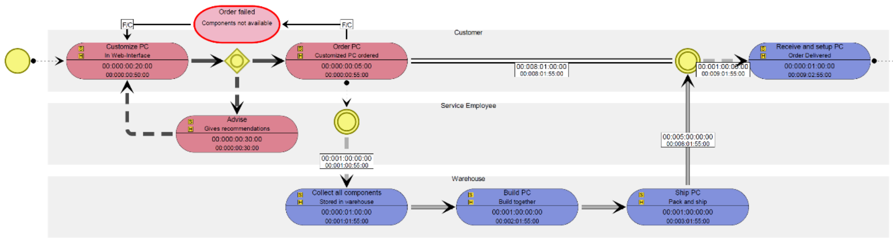


FIGURE 10: THE VSB AFTER THE 1ST STEP OF THE 2ND PHASE

be used. If any material goods flow, a *"Material Flow"* that can be sub-divided into a *"Push"* and *"Pull"* sub-type should be used. Moreover, *"Environments"* can be placed horizontally to visually group different activities for different actors that are involved. For those actors, waiting times can be placed to show a period of forced breaks before they can continue. Moreover, a *"Transmission"* must be used wherever a flow shifts from material to information or vice versa. Further, they should be used after a starting event and before an ending event. In addition, the estimated durations of any activity or flow can be entered. Using the function *"Cumulative Time Calculator"* in the ADOxx modeller, all waiting and cumulative times can be calculated automatically. This step can either be carried out right away or later during the analysis phase. Further, potential *"Fail Points"* must be identified and connected via the *"Fail / Continuation"* relation class showing, showing where such a failure occurs and where it is handled. Figure 10 shows how a VSB for the fictional case looks like.

Collect All Supporting Components and Show Where They Interface

To define further information for the VSB regarding supporting components that interface with or are generated or required by processes, the PSM is needed. At first, all *"Activities / Processes"* should be copied from the VSB to the PSM and then linked via the attribute *"Is the exact same as"*. Next, any supporting components such as *"Physical Evidences"*, *"IT-Systems"*, *"IT-Resources"* and *"Information"* that are part of the value creation must be identified. All of these must be placed both inside the PSM

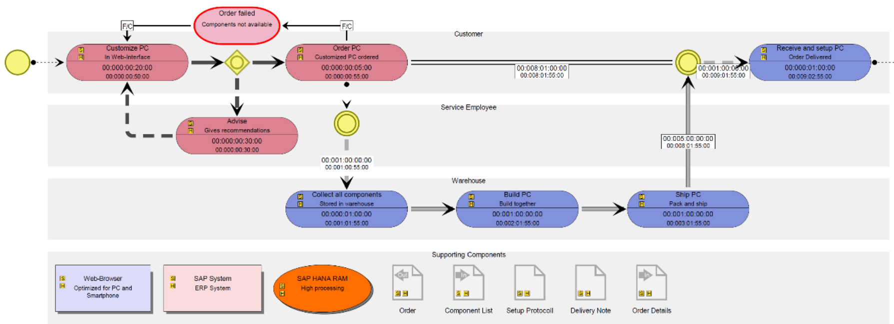


FIGURE 11: THE VSB AFTER THE 2ND STEP OF THE 2ND PHASE

13

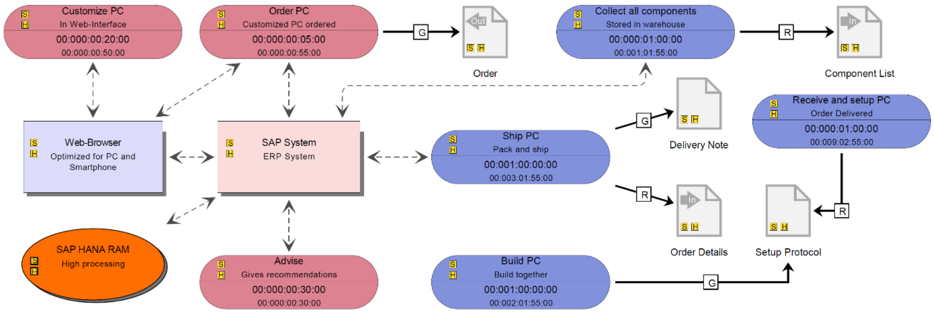


FIGURE 12: THE PSM AFTER THE 2ND STEP OF THE 2ND PHASE

and the VSB and furtherly linked via the attribute *"Is the exact same as"* as well. For the VSB, a new *"Environment"* for all those supporting components is suggested to group and distinguish them from the process flow visually. Hence, it is recommended to either place this new environment either above or below the all-other environments and their grouped process steps. Figure 11 illustrates, how such an updated VSB may look like for the exemplary scenario. Inside the PSM, all *"Interface"* relations are created, wherever supporting components interface with each other or with an *"Activity / Process"*. In addition, the *"Generates"* and *"Requires"* relation classes can be placed, wherever it is applicable to an *"Activity / Process"* in combination with an *"Information"*. These declarations allow automatic media break detection at a later stage. Thus, it is important to use the *"Information"* correctly: If there is no interface between a *"Digital Input"* and *"Digital Output"* (types of *"Information"*), the ADOxx modeller considers the required *"Digital Input"* as to be not automatically created from a given *"Digital Output"*. In other words, it must be transformed manually which is a media break. Further, an *"Analog"* creates a media break, if it is either generated without being actually required or vice versa. Moreover, all relations created inside the PSM are also stored inside the objects and thus accessible in the VSB.

Determine for Each Process its Data Requirements (DA, DU and DR)

Next, for each *"Activity / Process"* that is part of the value stream, its *"Data Availability (DA)"*, *"Data Usage (DU)"* and *"Digitization Rate (DR)"* must be determined by using the "Data Information" record

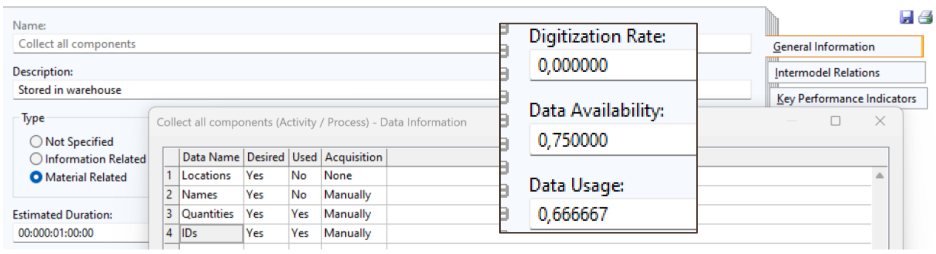


FIGURE 13: ENTERING THE DATA INFORMATION FOR "COLLECT ALL COMPONENTS"

14

table, a feature inside the *"Activity / Process"* class. Thanks to the *"Is the exact same as"* attribute, it does not matter, in which model these entries are made, as every instance is constantly updating its clones after every change. Further, all of those Key Performance Indicators will be instantly calculated while editing the record table. Moreover, they will be only considered for detecting waste later on, if there is at least one row entered. Thus, it is not necessary to insert entries for all *"Activities / Processes"* objects. In other words, the modelling person is not forced to do this step, although it is suggested. In figure 13, this step is exemplary shown for the process called *"Collect all components"*. The following formulas show, how the DR, DA and DU are calculated:

$$DR = \frac{\sum automatically\ acquired\ data}{\sum acquired\ data}; \quad DA = \frac{\sum acquired\ data}{\sum desired\ data}; \quad DU = \frac{\sum used\ data}{\sum acquired\ data}$$

For the DR and DU, the ADOxx modeller always ensures that there is no dividing by 0. For any row, where the *"Acquisition"* is *"None"*, the column *"Used"* cannot be turned into *"Yes"*. For any row, where the *"Acquisition"* is not *"None"*, it is considered as *"acquired data"* making it always at least as big as both all *"automatically acquired data"* and *"used data"*. In case, that there is no *"desired data"*, instead of dividing by 0, the ADOxx modeller assigns the $DA = -1$ portraying the same meaning as $DA > 1$ (indicating, that there is more data acquired than actually desired, which is a form of waste). To sum up, the closer the DR, DA and DU are to 1, the better this process is optimized.

Map All Components of the Current Value Stream to the Stakeholder Values

Afterwards, all components that are part of the value stream and were previously identified must be mapped with the value perceptions inside the VPMs. For any object that is already linked with a clone of itself in another model, it is possible to just by copy and paste it into another model. Thereby, the ADOxx modeller ensures that the pasted version is automatically linked with all clones (although note, that pasting multiple linked instances at a time, the ADOxx modelling environment might take some time to process the copying and pasting. Of course, if a component of the value stream has no impact on any value perceptions of a specific stakeholder, this component does not require a clone of itself inside the regarding VPM. Generally, the determination whether a component supports or hinders a

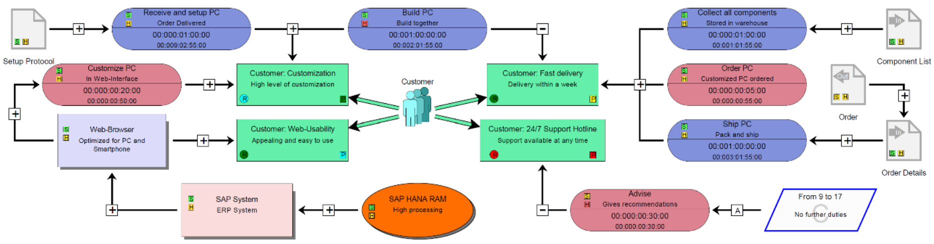


FIGURE 14: THE CUSTOMER VPM AFTER THE 2ND PHASE

15

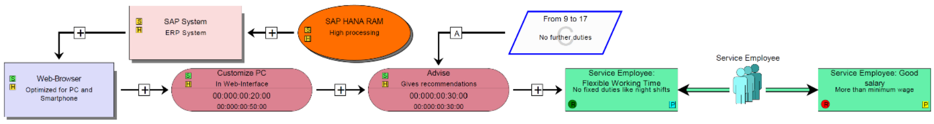


FIGURE 15: THE SERVICE EMPLOYEE VPM AFTER THE 2ND PHASE

stakeholder's value perception is left to the modelling person. However, transitive relations are also considered. In other words, if a component supports or hinders another component having an impact on a value perception, this first component also receives a *"Supporting Score (S)"* or *"Hindering Score (H)"* (these scores are explained in the next section). Further, an *"Impact Factor (IF)"* can be specified for the *"Supports"* and *"Hinders"* relations with either a *"Low"*, *"Moderate"*, *"High"* expression. Figure 14 and 15 both show the updated VPMs after this phase.

Detect Waste and how Components Affect Stakeholder Values

Before waste can be detected, the impacts of the value stream components on the value perceptions should be investigated. Therefore, figure 16 provides formulars on how to calculate the S and H of any component. These calculations can be called from the VSB (see figure 11, for the exemplary case) and

$$RF: \begin{cases} 3 & \text{if } „Mandatory“ \\ 1 & \text{if } „Moderate“ \\ 2 & \text{if } „High“ \\ 3 & \text{if } „Outstanding“ \end{cases} \qquad CPL: \begin{cases} -3 & \text{if } „Poor“ \\ 1 & \text{if } „Moderate“ \\ 2 & \text{if } „High“ \\ 3 & \text{if } „Outstanding“ \end{cases} \qquad IF: \begin{cases} \frac{1}{2} & \text{if } „Low“ \\ 1 & \text{if } „Moderate“ \\ \frac{3}{2} & \text{if } „High“ \end{cases}$$

$$VW = RF \times CPL$$

set $S, H: 0$
foreach $affectedObject$ **do**
  if $(affectedObject \in Value)$ **then**
    set $eachResult: VW_{affectedObject}$
  if $(relationType \in Supports)$ **then**
    if $(affectedObject \notin Value)$ **then**
      set $eachResult: S_{affectedObject} \times \frac{1}{2}$
    if $(eachResult < 0)$ **then**
      set $eachResult: eachResult \times -\frac{1}{3}$
    set $S: S + (eachResult \times IF_{relationType})$
  else if $(relationType \in Hinders)$ **then**
    if $(affectedObject \notin Value)$ **then**
      set $eachResult: H_{affectedObject} \times \frac{1}{2}$
    if $(eachResult > 0)$ **then**
      set $eachResult: eachResult \times -\frac{2}{3}$
    set $H: H + (eachResult \times IF_{relationType})$
end
return S, H

FIGURE 16: HOW TO CALCULATE THE S AND H SCORE OF A VALUE STREAM COMPONENT

16

are carried out for each VPM distinctively. In other words, the final S and H (see figure 16) are not shown inside a VPM. Instead, only the local dependencies valid for the VPM's stakeholder are taken into account. The final or global score can be shown in any other models than the VPM. However, this decision is left to the modelling person. Beside the global scores, also the local stakeholder-specific scores can be loaded into all other models than the VPM. Moreover, this procedure might take some time to calculate everything, as it consists of many complex operations. For the RF in the calculations, both *"Outstanding"* and *"Mandatory"* are assigned as 3 to highlight that hygienic factors are as important as critical success factors, because they are fundamentally required. Further for the CPL, *"Poor"* is assigned as -3 to really highlight poor performing value creation and thus waste. For the IF the result is either halved (for *"Low"*) or added by its half (for *"High"*) to only have an equally linear influence. In addition, if component just transitively impacts a value perception, its S and H are only the half of the component's S and H that the first component has an impact on. Further, the signs are always aligned. In other words, supporting components never receive a negative result and hindering ones never receive a positive result. For instances, if a component supports a *"Value"* whose CPL is assigned as *"Poor"*, that component still receives $+\frac{1}{3}$ of the *"Value Weight (VW)"* (a specific value that allows weighting value perceptions differently), to its S score. Oppositely, if a component hinders a *"Value"* whose CPL is assigned as *"High"*, that component still receives $-\frac{2}{3}$ of the VW to its H score.

Following the exemplary case, figure 17 shows the resulting VSB with a global value view on it. This means, that both VPMS (see figure 14 and 15) were considered to calculate any component's S and H score. Further after this calculation, the *"Waste Detector"* procedure has been run on this VSB to detect pre-defined patterns of waste automatically. Of course, adding own impressions of waste is also possible by manually assigning waste via the *"Generates"* relation class to any object. Next, all waste that was created should be ranked by importance to determine which is the most urgent to be solved and which can be postponed (especially, when there are not enough resources to solve all).

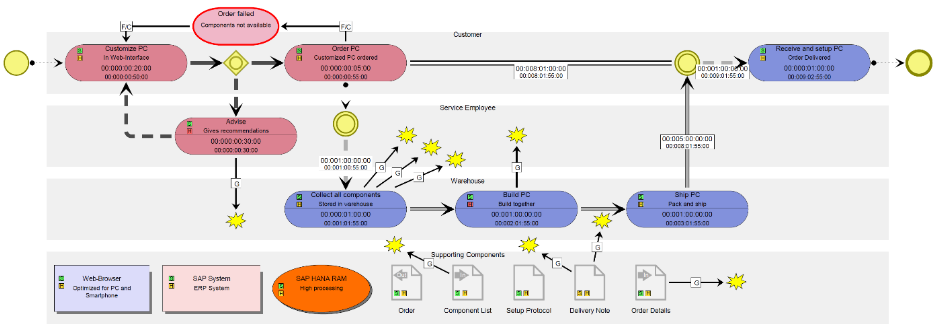


FIGURE 17: THE VSB AFTER THE 5TH STEP OF THE 2ND PHASE (GLOBAL VALUE VIEW)

17

Enhance Stakeholder Value: Define the Future Value Stream

After an already existing value stream has been investigated by modelling and analyzing it, it should be enhanced. This phase consists of five different parts (see figure 18). Compared to the two previous ones, there is no further model created. Instead, the existing ones are edited in compliances with the changes or development actions decided during this phase.

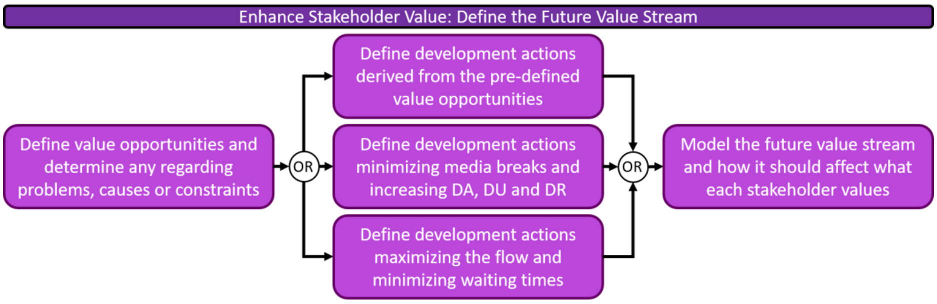


FIGURE 18: ENHANCE STAKEHOLDER VALUE: DEFINE THE FUTURE VALUE STREAM

Define Value Opportunities, Problems, Constraints and Causes

To begin with, the SVM must be updated by defining value *"Opportunities"*, *"Problems"*, *"Causes"* and *"Constraints"*. These should be derived by the results of analyzing the value stream beforehand. Figure 19 shows the resulting SVM for the exemplary case after this step.

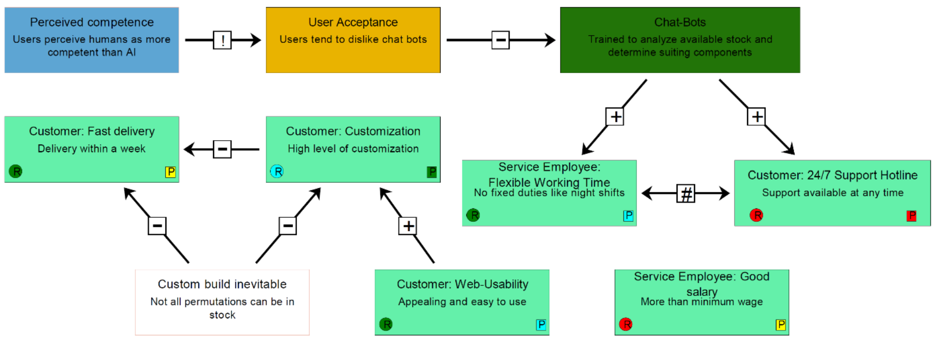


FIGURE 19: THE SVM AFTER THE 3RD PHASE

Derive Development Actions, Eliminate Media Breaks and Maximize the Flow

As figure 18 shows, the next three steps can be done in any order and some of them can even be left out, if it is decided they are not required. All over any model, *"Development Actions"* can be placed and connected via the *"Affects"* relation class to any object. Further, these development actions can also be linked via the *"Is the exact same as"* attribute. Thus, the same development action can be referred to in multiple models and stays updated wherever it is edited. As the first part suggests, the modelling person should derive development actions from the opportunities defined in the SVM. Further, the second part recommends to define development actions addressing media breaks and generally the DA, DU and DR of a process (which are all detected by the waste detector). If possible, any analog information should be eliminated and digital input automatically generated by another digital output. Further, for all processes, any desired data should be provided and not used data left out. In addition, the third part recommends to maximize the flow and eliminate waiting times as much as possible. To tackle this issue, is defining development actions either enhancing he estimated duration of a process (achieved by eliminating media breaks and optimizing the process itself on a more granular level) or even cutting out entire processes (which is especially important to discuss, if a process does not create any value or has a way bigger H score than its S score). For the exemplary case, figure 20 shows the updated VSB added with in total three defined development actions motivating change. In contrast, two development actions were defined to show, that some waste is remained. In both times, because it is crucial to some value perceptions: one for the user and one for legal authorities not considered in the exemplary case (however, they could have received their own VPM as well).

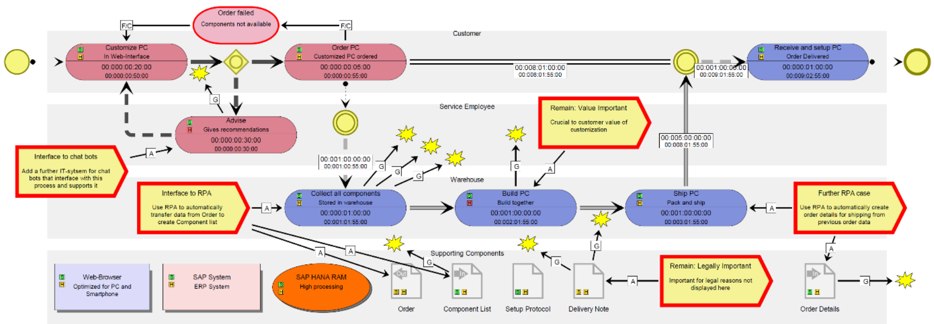


FIGURE 20: THE VSB AFTER THE THREE 2ND STEPS OF THE 3RD PHASE (GLOBAL VALUE VIEW)

Model the Future Value Stream and Affection on the Stakeholder Value

Before transforming all models into their future state, it is suggested to export a save of all existing models to preserve a view on the current stage. If the modelling person is not satisfied with the edits done, these saved models can be restored to start re-editing them again without having to recreate them manually again. Anyway, all models must be updated in accordance to the previously defined development actions. For the exemplary case, two additional IT-Systems are introduced: a chat bot (assisting advising users and service employees, due to ensuring 24/7 support while remaining flexible working times) and an RPA system (automatically transforming digital output into digital input data).

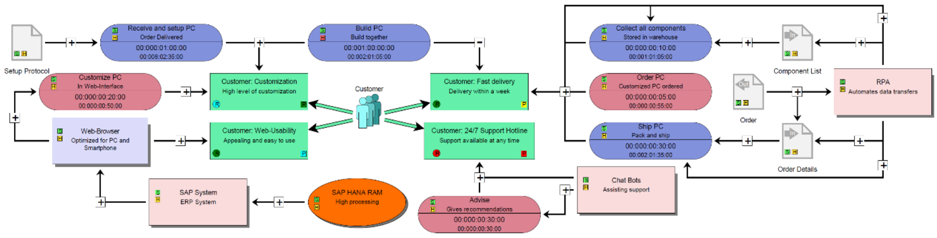


FIGURE 21: THE CUSTOMER VPM AFTER THE 3RD PHASE

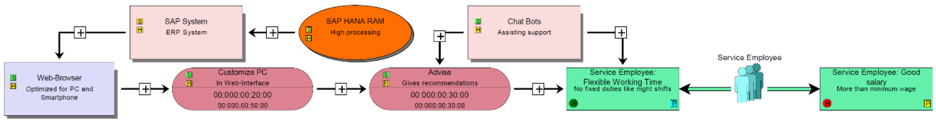


FIGURE 22: THE SERVICE EMPLOYEE VPM AFTER THE 3RD PHASE

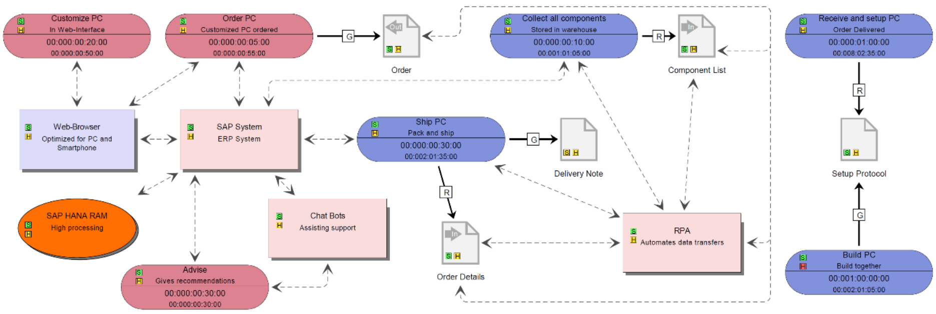


FIGURE 23: THE PSM AFTER THE 3RD STEP OF THE 3RD PHASE

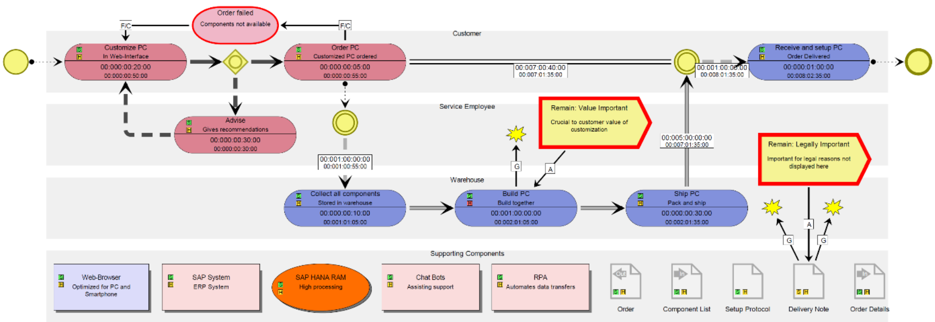


FIGURE 24: THE VSB AFTER THE THREE 3RD STEP OF THE 3RD PHASE (GLOBAL VALUE VIEW)

While the chat bot system solves a contradictory relation between two different value perceptions, the RPA system eliminates two media breaks and saves through automation working time. This leads to faster processing, which decreases the waiting time for the customer in turn as well. Through these effects, both new IT-systems support value perceptions directly and indirectly through supporting other components. Figure 21, 22, 23 and 24 all show the resulting future VPM, PSM and VSB models. However, it is recommended to check these assumptions in another iteration of the itsVALUE method framework. But, next time all previously created models can be re-used and taken into account when investigating the new current value stream (e.g., for collecting all processes, components, etc.).

Create a New Value Stream Supporting Stakeholder Value

If an entirely new value stream is supposed to be created, there are five steps to follow which are very similar to some parts of the second and third phase for investigating and enhancing an existing value stream. Figure 25 shows those five steps and their order.

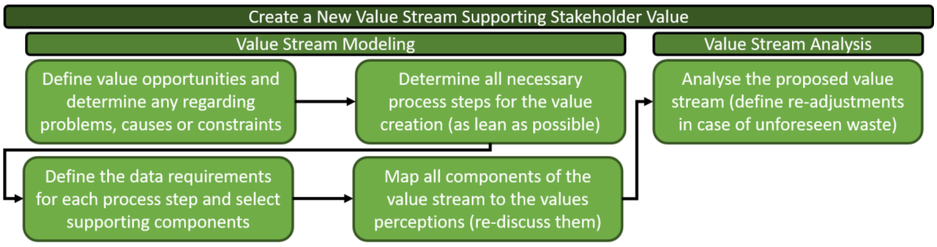


FIGURE 25: CREATE A NEW VALUE STREAM SUPPORTING STAKEHOLDER VALUE

Define Value Opportunities, Problems, Constraints and Causes

The first step is actually the exact same step as the first step for enhancing an existing value stream. Thus, a SVM should be updated by determining several value *"Opportunities"*, *"Problems"*, *"Causes"* and *"Constraints"* as well. In contrast to deriving those by results of analyzing an (in this case none-existing) value stream beforehand, the focus for deriving should be on the value perceptions and more underlying conditions (e.g., what IT-Systems are already available, affordable with regard to the budget, etc.). A resulting SVM could be very similar to figure 19.

Determine All Necessary Process Steps in the Value Creation

The second step is very similar to the first step for investigating an already existing value stream. Thus, a new VSB is also supposed to be created. However, instead of collecting (in this case none-) existing process steps, new ones have to be determined. To keep the value stream already as lean as possible, each proposed process step should be immediately discussed whether it inevitably necessary for the value creation or not. Then, all proposed process steps should be ordered with reasonable events set in between, at the start and at the end to illustrate the flow. Moreover, they all should be grouped in environments. A resulting VSB could be very similar to figure 10.

Define Data Requirements and Select Supporting Components

The third step is very similar to the second and third step for investigating an already existing value stream. Thus, for each process step, its data requirements alongside with its DA, DR and DU should be determined. Additionally, a new PSM should be created. In contrast to determining all supporting components at first, it is suggested to start with defining for each proposed process steps its data requirements. If these are precisely understood, they can be used for reasonably determining which supporting components are actually required to avoid any media breaks and to directly optimize the DR, DA and DU. Inside the PSM, any dependencies and relations among the proposed value stream components should be modelled (e.g., "*Interface*", "*Generates*" and "*Requires*"). A resulting PSM could be very similar to figure 12 and defining a process step's data information may be very similar to figure 13. Furthermore, the proposed VSB must be updated as well which could result in a similar model like shown in figure 11.

Map All Components of the Proposed Value Stream to the Value Perceptions

The fourth step is very similar to the fourth step for investigating an already existing value stream. Hence, the VPMs from the initial first phase should be updated as well by adding the value streams component to it and assuming their impact. This assumed impact on the value perceptions should be in accordance to the initial purpose of the value stream components. However, the modelling person should assume any potential impact reasonably and critically. In other word, if there is a potential hindering impact of a proposed value stream component, it should be modeled. Some resulting VPMs may be very similar to figure 14 and 15.

Analyze the Proposed Value Stream

The last step is very similar to the last step for investigating an already existing value stream. Thus, the proposed value stream is also analyzed to calculate any S and H score and to detect any occurring waste. A resulting VSB may be very similar to figure 17, although it should contain no or at least fewer waste. If there is any unforeseen waste detected, re-adjustments measures should be defined particularly eliminating this unforeseen waste. A resulting VSB may be very similar to figure 20. Then, this entire phase is restarted with every aspect previously introduced re-discussed again under the light of the defined re-adjustment measures. A final resulting VSB should then be similar to figure 24.

Concluding Remarks

This application manual provided an overview on *its*VALUE and its belonging method framework, notation and ADOxx modeller for the version "0.2". It was divided into two parts. The first introduced the general *its*VALUE notation alongside with its meta models, visual representations, explanations to the four different model types and further information on the ADOxx modeller. The second part focused creating a more seamless connection between the *its*VALUE method framework and how to use the ADOxx modeller (and thus apply the *its*VALUE notation) accordingly. To achieve this purpose, an exemplary case was followed through any phase and sub-step of the *its*VALUE method framework. However, this case was entirely fictional and designed to comprehensibly illustrate when and where which parts of the *its*VALUE notation (and thus also the ADOxx modeller) are used when following the method framework. Additionally, further background information was explained regarding the calculation of important KPIs, such as the S and H score and the DR, DA and DU.

This contribution should assist any kind of newcomers to *its*VALUE (both practitioners and scientists) in understanding its key ideas and mechanics. If these people desire a completely unique and different approach to value stream modelling and analyzing by focusing explicitly and mainly on the value perceptions of their stakeholders, this application manual shall provide them enough guidance to become confident to use and apply *its*VALUE on their own.

The ADOxx modeller is accessible for download via:

https://www.omilab.org/activities/projects/details/?id=148#page_title

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Publications from this Work

1. Richter, H., Lantow, B. (2022). IT-Service Value Modeling: A Systematic Literature Analysis. In: Abramowicz, W., Auer, S., Stróżyna, M. (eds) Business Information Systems Workshops. BIS 2021. Lecture Notes in Business Information Processing, vol 444. Springer, Cham. DOI: 10.1007/978-3-031-04216-4_24

2. Richter, H.D., Lantow, B., Pröpper, T. (2022). itsVALUE: Modelling and Analyzing Value Streams for IT Services. In: Karagiannis, D., Hinkelmann, K., Lee, M., Utz, W. (eds) Domain-Specific Conceptual Modeling. Springer, Cham. DOI: 10.1007/978-3-030-93547-4_8

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Professional Experience

Training Manager
AIDA Cruises | Oct 2023 – Present
Design and deliver training programs for onboard staff; coordinate learning initiatives aligned with organizational goals.

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Scout
AIDA Cruises | March 2023 – May 2023
Consultant and guide for shoreside excursions.

Host / Entertainer
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Engaged with guests and managed onboard entertainment programs across multiple roles.

Scientific Employee
University of Rostock | Jul 2021 – Sep 2022
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Intern (E-Commerce)
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Assisted with content and process optimization in online sales operations.

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Publications

1. Gutschmidt A., Richter H.D. (2021) Personal Space and Territorial Behavior – Sharing a Tabletop in Collaborative Enterprise Modeling. In: Aveiro D., Guizzardi G., Pergl R., Proper H.A. (eds) Advances in Enterprise Engineering XIV. EEWC 2020. Lecture Notes in Business Information Processing, vol 411. Springer, Cham. https://doi.org/10.1007/978-3-030-74196-9_7

2. H. D. Richter and N. Shilov, "Impact of COVID-19 on Customer's Perception About Purchasing Digitizable Products," 2021 30th Conference of Open Innovations Association FRUCT, 2021, pp. 207-215, https://doi.org/10.23919/FRUCT53335.2021.9599997

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9. Wilken, J.R., Guckenberger, L., Löser, N., Rittelmeyer, J.D., Richter, H.D., Sandkuhl, K. (2024). A Case Study on itsVALUE with an Exemplary Case. In: Hacks, S., Roelens, B., Kirikova, M., Reinhartz-Berger, I. (eds) Companion Proceedings of the 17th IFIP WG 8.1 Working Conference on the Practice of Enterprise Modeling Forum, M4S, FACETE, AEM, Tools and Demos, Stockholm, Sweden. Springer, Cham. https://ceur-ws.org/Vol-3855/forum15.pdf

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Statutory Decleration / Eidesstattliche Erklärung

I, Henning Dirk Richter, hereby declare that I have completed this present dissertation with the title *”Contributions to Stakeholder Value-Oriented IT Service Management: The Development of the itsVALUE Method”* independently. Only the sources and aids expressly named in the work were used. I have made known as such any ideas that I have taken over literally or analogously. As an aid, I have used Microsoft Copilot to review my texts, help me correct my spelling, and improve the flow, readability, and comprehensibility of my texts. Furthermore, Microsoft Copilot assisted me in unifying a pleasant style for all my tables. I did not use Microsoft Copilot to violate any copyright, cause any plagiarism, or generate entirely new content.

Hiermit erkläre ich, Henning Dirk Richter, dass ich die vorliegende Dissertation zum Thema *„Contributions to Stakeholder Value-Oriented IT Service Management: The Development of the itsVALUE Method“* selbständig angefertigt habe. Es wurden nur die in der Arbeit ausdrücklich benannten Quellen und Hilfsmittel benutzt. Wörtlich oder sinngemäß übernommenes Gedankengut habe ich als solches kenntlich gemacht. Als Hilfsmittel habe ich Microsoft Copilot verwendet, um meine Texte zu überprüfen, meine Rechtschreibung zu korrigieren und den Fluss sowie die Lesbarkeit und Verständlichkeit meiner Texte zu verbessern. Außerdem hat mir Microsoft Copilot geholfen, einen einheitlichen und angenehmen Stil für alle meine Tabellen zu schaffen. Ich habe Microsoft Copilot nicht verwendet, um Urheberrechte zu verletzen, Plagiate zu verursachen oder vollständig neue Inhalte zu generieren.

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