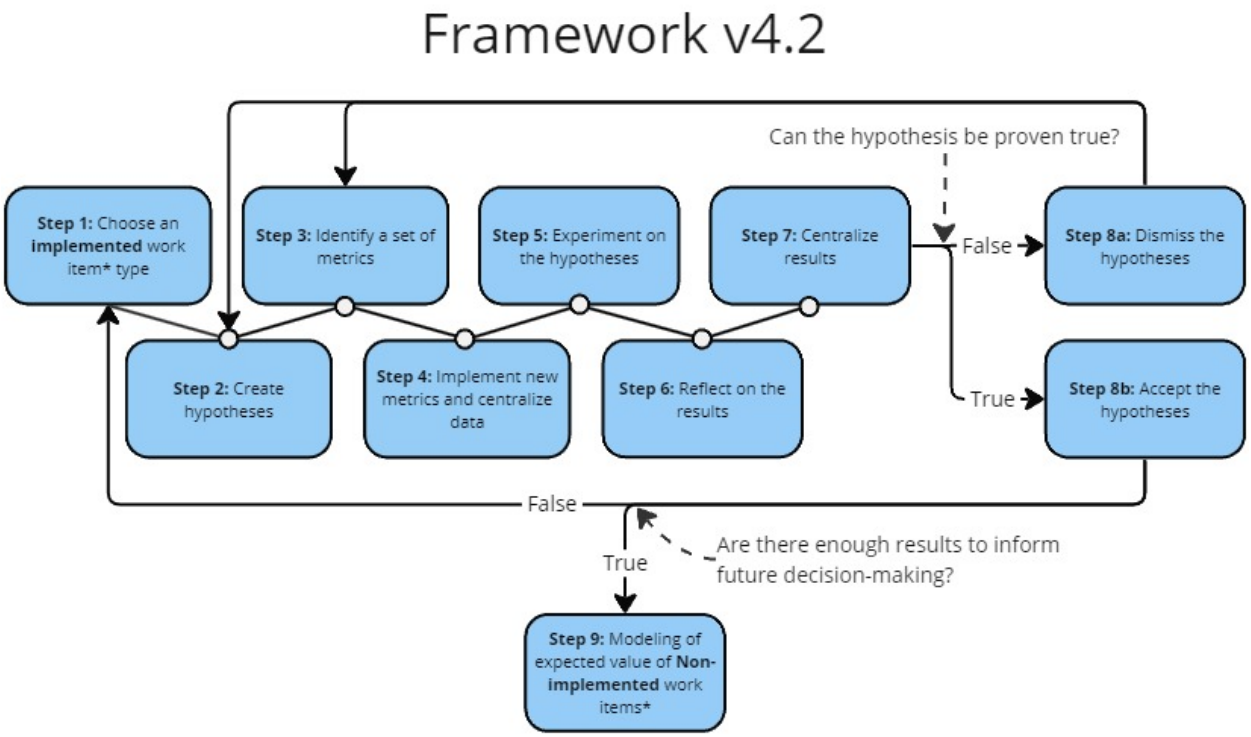

Understanding Customer Value

Identify Customer Value in Existing Features, Products and Systems to Inform Decision-Making

Master's thesis in Software Engineering and Technology

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Gothenburg, Sweden 2024
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Abstract

This thesis presents the development and validation of a new framework aimed at addressing the challenges in the field of customer value and product management. Through a comprehensive literature review and interviews with industry professionals multiple key challenges were identified that formed the basis of for the framework. The framework itself focuses on understanding what constitutes value in existing features, products, or systems utilizing hypotheses and metrics to conduct experiments. The experiment results are then used to predict and calculate the expected value of new features. Conducting a validation workshop demonstrated the effectiveness of the framework, guiding the participants to a better understanding of value and successfully mitigating some of the identified challenges. Despite the successes of the framework, it also acknowledges certain limitations and presents opportunities for refinement and future research. Nevertheless, the frameworks accessibility and potential for practical applicability in industry highlights the contributions it brings to the field. The framework presents a practical solution to challenges in the field of customer value and product management, with its potential benefits recognized and validated by industry professionals.

Keywords: Customer Value, Product Management, Framework Development, Modeling of Value, Digitalization, Data-Driven Development, Experiment-Driven Development

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Felix Holmesten and Lukas Thim, Gothenburg, May 2024

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

FDD	Feature-Driven Development
JIT	Just In Time
MVF	Minimal Viable Feature
NSM	North Star Metric
QCD	Qualitative/Quantitative Customer-driven Development
R&D	Research and Development
SAFe	Scaled Agile Framework
SE	Software Engineering
VBSE	Value Based Software Engineering
WIP	Work In Progress
XP	Extreme Programming

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1
Introduction

In an increasingly digitalized world, data has become an integral part of *software engineering* (SE). For many years data driven development has been seen as a valuable tool for delivering continuous value to customers and as a way of moving from opinion-based to data-driven decision making [1]. A problem that persists however, is that many features that are developed remain unused or are used so infrequently that the *research and development* (R&D) investments cannot be justified [2]. There are multiple different methods and practices such as data-driven development, value modeling or the HYPEX model that tries to mitigate those problems. However, most of these are not yet fully utilized in industry. There are many reasons to why this is the case. First and foremost, most companies have limited ways of collecting customer feedback [1]. When an integral part such as data gathering is lacking, companies struggle with validating their development decisions. Another problem is that simply having data does not guarantee effective utilization of data [3]. A third problem is how to define, utilize, and understand customer value in order to more efficiently and continuously deliver value [2][4][5].

1.1 Statement of the Problem

Companies stand to gain significant benefits by adopting a framework that quantifies customer value. However, the complications associated with the adoption process of these frameworks are many. In the early stages of planning and evaluating new features, products, and systems, there is difficulty in defining customer value [2]. Adding to this complication, each company has multiple stakeholders on separate levels of the hierarchical company structure. Each of these levels brings a contrasting perspective of what is valuable according to their current interests. The consequence of these issues is that the prioritization of features and products that truly yield customer value becomes troublesome [2]. As a result, features with no proven value are often developed when they should be abandoned [6]. Unfortunately, due to the lack of customer data, abandoning a feature is a rare occurrence. This is a result of not working with continuous validation cycles. Value changes over time, highlighting the need for continuous validation of hypotheses throughout the development cycle to mitigate losses in R&D.

Data gathering is a big part of the digitalization of a company, but it also comes with an ample amount of challenges. One of the biggest challenges is determining what data is applicable to the validation of features and products, which involves

understanding user behavior, usage analytics, and discerning how features are being used [2]. This data is needed for improving existing features and making decisions about abandoning or changing features or products that do not accommodate the users needs. Consequently, customer value is often based on assumptions and experience rather than tangible data [4]. While companies realize this they struggle with the transition towards continuous practices and new ways of working with data [7]. In the field of customer value and product management, there exists many different frameworks for product development such as the *large scale agile framework* (SAFe) and the Kano model [8][9]. There also exist many methods explaining how to transition a company to a more data-driven, experiment-driven or value based company [10][11][12]. However, despite the existence of these frameworks and methods, companies continue to struggle with challenges in delivering and validating customer value. Among these challenges are: long feedback cycles, defining what constitutes value is, finding key metrics, and the adoption of frameworks [1][2][4]. As to why this is the case, the reason remains unknown. Consequently, the outcome of these issues are sub-optimized solutions, the inability to validate new features, wasted time and resources in R&D etc [2]. The fact is that existing frameworks are too difficult for companies to fully understand and adopt and they are too general for some company domains. The research field is outpacing the industry progress with frameworks that often overlook the prerequisites for the initial stages of the framework. This highlights the insufficiency of existing frameworks, emphasizing the necessity for new innovative solutions.

1.2 Purpose of the Study

This study intends to refine the process of defining, working with and validating customer value. The initial stage involves performing a comprehensive literature review to gather academic insights and understand the research field and its objectives. By doing a literature review the researchers can increase the quality of the interviews. The purpose of the interviews is to gather industry-specific information and to understand the current development status of different companies. By combining the insights gained from both the literature review and the interviews the researchers intend to provide a new framework for modeling value.

The goal of the new framework is to more effectively guide companies in their process of adopting new ways of modeling value as well as improving their methods of working with customer value. The researchers intend to reach this goal by having the new framework focus more on the early stages of working with customer value to make the adoption process easier for companies. It is important to create a standard of how to approach working with value definitions and determining what constitutes value. Lastly, the goal is to ensure that the framework is not overly general, to accommodate for certain domains. When the proposed framework has reached a sufficient level of development the researchers intend to validate the new framework. This is accomplished by re-engaging with some of the interview participants as well as some new participants to get feedback on the proposed solution. This phase of

the study can allow for further iteration as long as time allows. The main beneficiary of this study are organizations that are interested in understanding customer value and adopting frameworks that help work toward enhancing customer value delivery. Additionally, the intention is for other companies, organizations and researchers to benefit from the general principles and steps outlined in the report.

1.3 Research Questions

This section will explore the research question that form the basis for our study. The questions serve as guiding principles to steer the study towards a better comprehension of the topic at hand. Framing the study in this way will aid in systematically investigating the topic and making contributions to the field.

- **RQ1:** How do stakeholders, if they model value, define and validate customer value? Considering both challenges in achieving consensus within the team and the existing obstacles in data utilization for customer value definition in software development.
  - **Hypothesis 1:** Stakeholders face challenges in reaching consensus on what qualifies as customer value when adopting the process of modeling value.
  - **Hypothesis 2:** Stakeholders face challenges in utilizing data effectively to define customer value, this leads to sub-optimized solutions, resulting in the development of low-impact features and products.
- **RQ2:** What are the key aspects that should be considered in a process of defining a comprehensive model of value, specifically addressing the definition of customer value?
- **RQ3:** How effective is the proposed process in mitigating the challenges associated with defining and validating customer value in the process of modeling value?

1.4 Report Outline

The report is divided into eight sections. After the introduction the theory of the thesis and the base concepts that the thesis builds on are introduced and explained. The method section outlines the process of the study including the study design, the data gathering and analysis, and the validation of the data. The empirical findings sections presents the outcome of the case study. The framework section presents the developed framework based on the challenges found in the empirical findings. The validation workshop chapter presents the results and feedback from the workshop. The discussion section discusses the results of the study, the choices made in the study are evaluated, and alternatives are presented. Lastly, the report is concluded with a summary of the findings.

2
Theory

In this chapter the key theoretical concepts found in the literature review are presented. Firstly, the chapter delves into the digitalization efforts that companies of today undergo and the complications that follows. Next, the importance of data and key practices such as data-driven development and experiment-driven development as well as their challenges and the adoption process, is described. Additionally, the chapter describes some useful tools and methods such as DevOps and agile frameworks and how these facilitate an easier workflow. Lastly, this chapter explores *value based software engineering* (VBSE), the definition of value, how to work with customer value and some existing frameworks to model value.

2.1 Digitalization

Today's companies are undergoing a transformation in their traditional business models. The integration of innovative digital technologies and data-driven services are gradually increasing and starting to complement physical products [13]. New technologies such as software, autonomous data gathering and AI allow for business opportunities to appear more frequently than ever before. To utilize these technologies companies need to transform not only their relationship to customers and the response time-to-market but also their revenue models.

By working towards digitalizing a company one gets access to a number of new opportunities. In particular, data is recognized as a vital part of facilitating continuous value delivery to customers [13]. Data can be used as an asset and enable new revenue streams. By utilizing continuous integration and continuous deployment practices, companies has come a long way towards improving products over time. Although the benefits are many the transformation of a company is no easy task. In an article published in Wiley, Bosch and Olsson present a model that outlines the typical evolution path companies undergo when transitioning from being a traditional to a digital company. [3]. The model comprises of four dimensions, the product upgrade dimension, business model dimension, data exploitation dimension and the AI/ML/DL dimension [13]. Bosch and Olsson showcase the four dimensions in figure 2.1 where the evolution path from a traditional to a digital company can be seen.

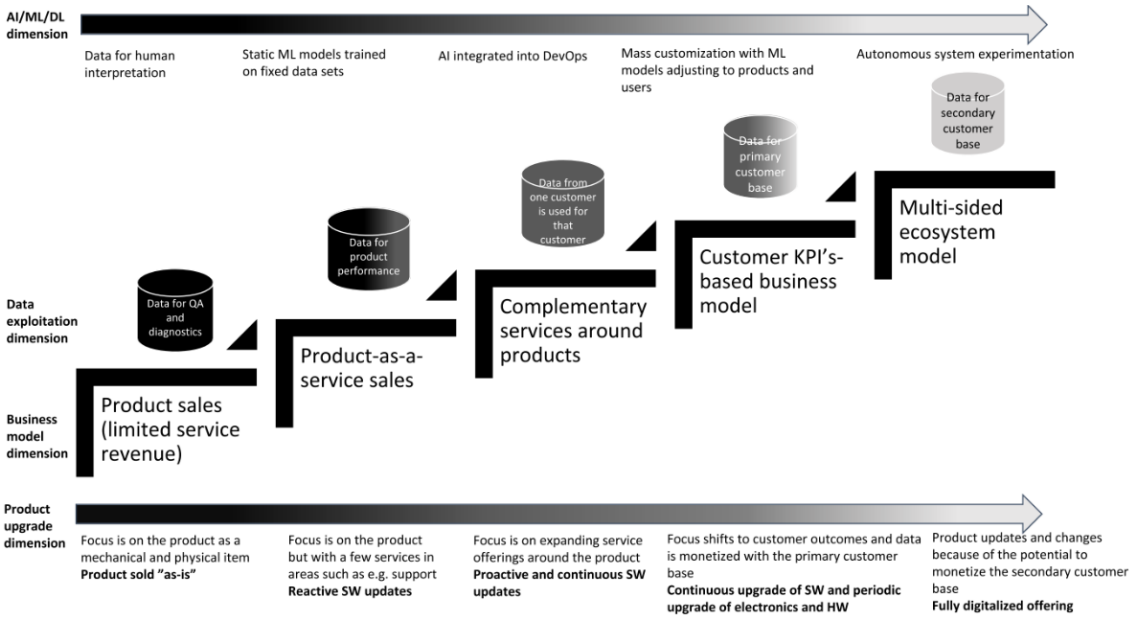

Figure 2.1: The suggested evolution path for moving from a traditional company to a digital company [13].

The dimensions are then all divided into five additional steps which are all critical for the transition to be successful. Delving deeper into the data exploitation dimension there are enormous efforts done to improve the use and effectiveness of data. The five steps that companies undergo when moving from a reactive use of data towards proactive use of data are shown specifically in the data exploitation dimension, which can be seen in figure 2.2. The first step is to (1) use data as the basis for quality assurance and diagnostics. Using data this way can help with troubleshooting and error-correcting activities as well as helping development teams by continuously monitoring system behaviors. Following this companies start (2) using their data for internal improvements of features, functionality and product performance. In the next step companies start (3) using data as a new asset to monetize with existing customers. The collected data from one customer is being processed and analyzed and then returned to the same customer in order to provide new insights to them. This is built upon in the next step (4) where data from more than one customer is accumulated and then used to compare, analyze and give insights. In the last step data can finally be used to (5) monetize a second customer base by utilizing data from the original customer base. It should be emphasized that the goal is to extend the company's use of data and companies should therefore strive to be at multiple steps at the same time. As mentioned the data exploitation dimension plays a crucial role in the transitioning of a company from a traditional to a digital one. However, it is essential to note that to fully capitalize on the benefits of accumulated data and new practices it is important to establish a culture centered around data-driven development practices [3].

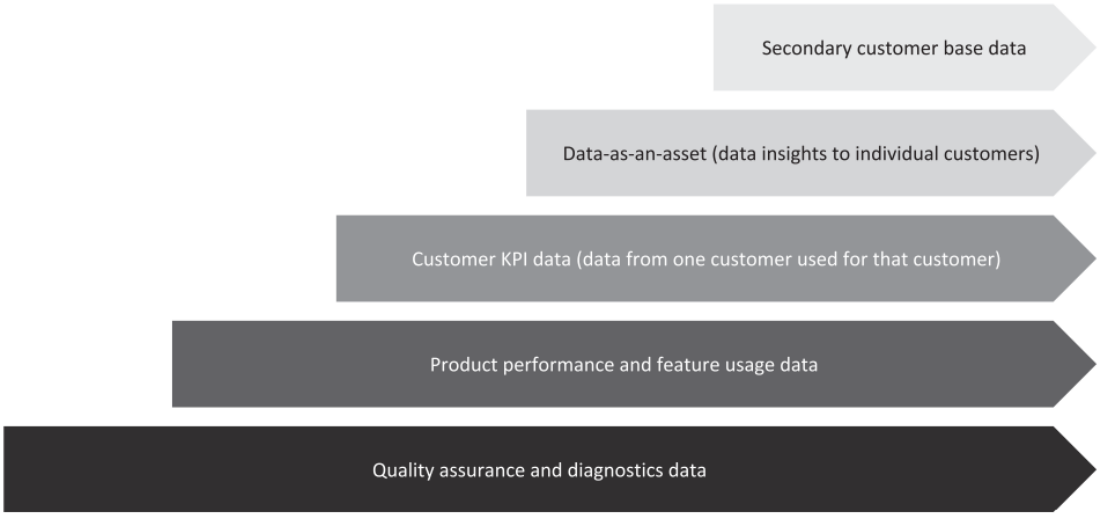

Figure 2.2: The data exploitation dimension of the evolution from a traditional to a digital company [13].

2.2 Data-Driven Development

Companies of today have access to more data than ever before. They also possess the ability to utilize that data. Therefore the digitalization of a company provides the perfect opportunity to introduce data-driven development and move from opinions-based decision-making towards data-driven decision-making [10]. Data-driven development aims to improve effectiveness and to ensure value delivery to customers.

Data-driven development and the new opportunities it provides are already well established in online companies. However, it is now becoming increasingly recognized by companies working on-premise and with embedded systems as well. Despite the newly found recognition, the transition from opinions-based decision-making to data-driven decision-making is no easy task. Collecting customer feedback is complex and many companies have few mechanisms in place to do so [1]. Additionally, many struggle with validating their decisions before the finalized product has been deployed to its customers. This problem is called the "open loop" problem. The "open loop" problem indicates that there is no efficient way for data that is generated by the customers to affect the product development process, this will be presented in 2.2.5. Another issue is the fact that possessing data does not necessarily translate to successful utilization of that data. Organizations need strategies in place on how to transform their raw data into valuable insights otherwise the competitive advantages of data could be lost [3].

While data-driven development poses numerous challenges, it also offers a multitude of advantages. Utilizing data-driven development enables companies to continuously monitor the usage of features in a system and asses customer value. Based on recent findings the practices of data-driven development has been proven to improve

product performance and evaluating new product concepts [10]. Consequently, companies that are able to leverage their use of customer and product data increase their profitability by consistently evaluating customer value, as it can significantly influence annual revenue. Bosch and Olsson mention that the use of data can help question, challenge, complement and confirm existing assumptions within the organizations as opposed to accepting the opinions of senior managers [1].

2.2.1 Data-Driven Development Adoption Process

When adopting data-driven development there are five more typical stages that companies usually go through [10]. These stages consists of: (1) modeling the expected value of a feature by initiating metric creation and data collection to improve features. Following this is stage (2), establish an infrastructure for data gathering and storage to make data available for analysis. In the subsequent stage (3), development teams enhance their effectiveness through the adoption of iterative development approaches. With faster feedback loops development teams can more easily guide their future development. This is essential to be able to continue to (4), shorten the feedback loop. By minimizing the time between development and deployment the team can use the collected data to more efficiently guide their development. The last stage is (5), to develop a hierarchical value model. The purpose of this is to guarantee the alignment and connection of feature-level and high-level business metrics, ensuring coherence across teams, systems, and business levels.

In addition to the five stages mentioned above there are many software development practices with the same goals of the data-driven development adoption process which can simplify the transition. An example of this is the "stairway to heaven" model [1]. This model describes a pattern that companies commonly follow while evolving their software development practices in similar ways as the five stages outlined in the last paragraph. Most companies start out as a traditional company with slow development cycles and poorly integrated customer feedback. The fist step for many companies is to adopt agile development where the cycles are shorter, however, the product management and system verification need more improvements to move on from the traditional development model. The next two practices that are commonly integrated are continuous integration and continuous deployment. To establish continuous integration, a company must create a comprehensive test suite and execute automated tests integrated with system validation. Further progress towards continuous deployment involves active participation from product management in delivering features to customers and consistently deploying features. This enables a continuous loop of customer feedback and the opportunity to gain insights from customer usage data. The final stage is to reach a phase where the organization can act based on customer data using data-driven decision-making. Subsequently, deploying new functionality allows for the evaluation and validation of customer needs.

Besides the broader software evolution practices, there are four specific practices that are widely employed in data-driven development. Some are integral to the five stages of the adoption process detailed in section 2.2.1, while others work as direct

extensions or new additions. Modeling of expected outcome is the first practice. It translates to a company's ability to define and model the expected value of a new feature, with a focus on pre-development [4][10]. As a result companies can more easily track the performance of new releases and guide their experimentation based on their proactive use of metrics. In a case study by Bosch and Olsson they saw few attempts to proactively, rather than re-actively, guide experimentation on new features [4]. Among the 12 case companies examined, only four of them worked with the practice re-actively, whereas two did not utilize modeling of expected value at all. The six remaining companies did apply it, however, in an ad-hoc or non systematic way, or both.

The next three practices are feature experimentation, post-experimentation reflection and generalized use of experiment results practices [4]. What these practices lead to will be discussed further in section 2.2.2. However, what they represent are a companies ability to work with different versions of a software, how to adapt development based on the results of experimentation and how to accumulate knowledge from different experiments. Although, to fully transition towards experiment-driven development, companies must adapt their practices to reduce the length of the feedback loop.

2.2.2 Experiment-Driven Approaches

Experiment-driven development is one way to continuously expand on what is known about a product. By identifying, prioritizing and validating product assumptions throughout the development cycle it is possible to prevent risks during development [11]. These product assumptions are transformed into hypotheses that are then tested in experiments [14]. The results from the experiments can then inform which product decisions should be made. Experiment-driven development can be seen as a subset of the data-driven decision making practice where companies conduct experiments to verify data based decisions [11]. Although there are many different methods of conducting experiments they are in general mostly used in companies with a cloud computing environment and a software as a service. Although it is starting to affect other software product development areas as well.

Experiments can be conducted with different goals in mind for example, generating insights about a topic, a new product, or customers needs. Experiments can be used to better understand the correlation of specific actions, implementing a feature, or achieving objectives such as providing monetizable value to users [11]. It should be mentioned that the validation of product assumptions through experimentation can and should be combined with agile methodologies and continuous deployment strategies to fully bring forth the benefits of all three. While agile methodologies focus on the building aspects of software, the experiment-driven development focuses on testing and learning outcomes. Combining agile methodologies, experiment driven development, and continuous deployment of software to the customer allows for changes in behavior to be observed. This means that the development efforts can be fully dedicated to delivering customer value.

2.2.3 A/B Testing in Experimentation

A/B testing is the most common way to design experiments [15] and has become a standard method of evaluating product change. By utilizing A/B testing developers are able to make more data-driven decisions [16]. A/B tests enables a comparison of two versions of a product with different functionality, and the results are then used to understand how users react to new changes done in a product. The 'A' in A/B testing refers to the original testing variable whereas the B refers to the variation or the new version of the original version. The product is then "tested" on the two different versions to see how customers interact and respond to it. The version with the most positive outcome is the version that will go forward. This process can then be repeated until a satisfactory result has been reached. The ultimate goal is to be able to make data-driven decisions during development as well as deliver more value to customers with thought-through features, designs, bug fixes etc. [17][18]. However, running few isolated experiments through A/B testing in is relatively easy and the problem lies in expanding the capabilities of the experiments [19]. To be able to systematically run experiments at large scale that give trustworthy results requires a transformation in a company that can be very challenging.

2.2.4 Experimentation at Scale

Numerous models and frameworks have been developed with the aim of accomplishing systematic experimentation at large scale. One of those models is the *Hypothesis Experiment Data-Driven Development model* or the HYPEX model [20]. According to Fabijan et al. this model was one of the first attempts to support companies in working with feature experiments. The HYPEX model focuses on closing the open loop and addresses six important practices to facilitate feature experimentation [1]. (1) *Feature Backlog Generation*, to generate features that may bring value to customers that can be used in experiments. (2) *Feature Selection and Specification*, a prioritized feature is selected and expected behaviors are defined in a way that allows for quantitative analysis. (3) *Implementation and Instrumentation*, by identifying the *minimal viable feature* (MVF) the first part of a feature that adds value can be implemented. The instrumentation then allows for data to be gathered on the actual behavior of the feature in the hands of the customers. (4) *Gap Analysis*, the expected behavior is compared to the actual behavior to ascertain if the feature implementation is achieving the desired outcome. If the gap is small the feature can be finalized. However, if the gap is significant then hypotheses are made that serve as the foundation for iteration and tuning of the experiment. The feature could also be abandoned at this stage if the results are negative or have no impact. (5) *Hypothesis Generation and Selection*, if development is continued then the multiple hypotheses created in step 4 are prioritized and the most promising ones can be further explored in experiments. In this stage, two categories of hypotheses' are mentioned. Firstly, the MVF that was developed is not ample enough for the user to receive the benefits and therefore it does not live up to user expectations. Secondly, the first implementation of the MVF is of low quality and a different implementation could return a better result. (6) *Alternative Implementation*, if the leading hypothesis from the prior step suggests that the current feature implementation fails to

meet customer needs, then an alternative solution can be created and experimented on. One way to perform those experiments can be through A/B testing, either in parallel or sequentially, and once data gathering has been done then the last three steps of the process can be iterated.

In this stage, two categories of hypotheses' are mentioned. Firstly, the MVF that was developed is not ample enough for the user to receive the benefits and therefore it does not live up to user expectations. Secondly, the first implementation of the MVF is of low quality and a different implementation could return a better result.

The next model brings emphasis to the importance of combining quantitative and qualitative techniques for customer feedback. The model is called *Qualitative/quantitative Customer-driven Development* or the QCD model [21]. The combination of the two techniques are important since both techniques reinforce each other. Qualitative techniques can be used to understand quantitative data while quantitative techniques can be used to validate qualitative data. The model allows for practitioners to test hypotheses and derive future development, based on both qualitative and quantitative data [20]. The third model discussed is the *Rapid Iterative value creation Gained through High-frequency Testing* or the RIGHT model. In order to continuously use empirical feedback from users the model integrates different phases of software development such as requirements, design, implementation, testing, deployment and maintenance [22][21]. The model offers an overview of the experimentation process along with the necessary infrastructure. The last model discussed in this section is the *continuous* framework*. This framework calls for a continuous loop involving Business Strategy, Development, and Operations, promoting the significance of information exchange throughout the organization [20][23]. The framework talks about development and operations (DevOps), business strategy and development (BizDev), and the integration between them to enable new ways of working with improving software projects.

2.2.5 Shortening the Feedback Loop

The so called open loop problem that was mentioned earlier refers to the gap between customer feedback and product management decisions [1]. This results in an inefficient use of customer data to inform the product development process, resulting in an opinions-based process rather than a data-driven process. For many years the goal in data-driven development has been to reduce the feedback loop to customers [10]. One important factor to being able to shorten this slow feedback loop is being able to work in shorter development cycles. Meaning that the time between development of a feature and deployment is being accelerated, allowing for more frequent feedback to validate decisions made. Various methods can be integrated into the workflow to transition the development into shorter cycles. In this section two of those will be presented, the first one is DevOps and the work with continuous integration and continuous deployment. The second one is agile methodologies and common practices.

In a systematic mapping study of DevOps definitions and practices Jabbari et al. provides a synthesised definition as follows: "DevOps is a development methodology aimed at bridging the gap between Development and Operations, emphasizing communication and collaboration, continuous integration, quality assurance and delivery with automated deployment utilizing a set of development practices." [24]. This is done by integrating the development and operations of a company through automated development, delivery and monitoring [25]. DevOps share many aspects with agile methodologies and can be seen as an extension to the process [24]. As an example, both agile methodologies and DevOps work towards continuous integration, deployment, and rapid customer feedback while agile methodologies focuses on tools and processes, DevOps is more centered on developers and operators and the communication and collaboration between them.

Adopting and using DevOps practices helps companies shift the company culture to improve collaboration between development, operations, and quality assurance [25]. Adoption is done in part by utilizing cross-functional teams that work on delivering features continuously. This increases the speed of value delivery, reduces issues that may stem from miscommunication, and expedite problem solving. Developers are directly affected by the adoption of DevOps practices, for instance, developers need to work with verification of systems, continuous deployment, management of configurations, and new architectural structures [26]. Some of these require specialty tools to work properly. Additionally, tools are needed for processes such as container management, deployment, testing, monitoring, and continuous integration. The adoption of DevOps practices does not only entail positive consequences, the adoption may introduce organizational stress and require a culture shift [25][26]. In addition, there are three other main challenges associated with DevOps projects which are: dividing architectures and features into independent chunks that can be individually deployed, visibility of deployments and version control, and introducing a development and production environment that is tailored and based on legacy applications [25].

Agile methodologies have many important characterizations and puts emphasis on iterative development, continuous feedback, adaptability to change, customer involvement and much more [27][28]. These methodologies focuses on delivering software in short iterations, fostering collaboration between cross-functional teams and promotes a culture of continuous improvement. Teams regularly reflect on their processes and adapt to changing requirements therefore reducing and eliminating uncertainty [29]. The result is a flexible methodology that has the ability to adjust to changes in project requirements. Although there are many different ways of working with agile methodologies some of them has become more popular than others.

The first commonly used agile methodology is Scrum. Scrum is a method focusing on software project management and how team members should function together to be able to produce software in an environment that is constantly changing [27][28]. Scrum consists of three phases: The pre-game phase, development phase and post-

game phase. The pre-game phase consists of planning and high level design. Here, a product backlog, a list containing all the known requirements is created. In this phase the requirements are prioritized and the effort associated with the requirement is estimated. Next, the development phase consists of the agile part of the approach. Different environmental and technical variables such as time frame, quality and resources etc. are taken into consideration throughout the complete development process. In this phase the development is divided into sprints. These are iterative cycles where development or enhancement of functionality is produced. One such sprint is commonly 1-4 weeks long and a project consists of multiple sprints. A sprint includes traditional phases of software development such as requirements, design, analysis and delivery. In each sprint, items from the product backlog is moved into the sprint backlog to match the estimated time frame of the items to the sprint, ensuring that the time estimation of items align with the duration of the sprint. The last phase, the post-game phase concludes the project and no more changes should be made, the system is now ready for release. Two important roles in a scrum team is the scrum master and the product owner [27][28]. The scrum master is responsible for making sure that the correct practices, values, and rules of scrum are carried out. The scrum master interacts with the scrum team as well as the customer and management. The product owner makes the final decisions of tasks related to the product backlog and turns issues into features to be developed. Scrum also includes certain management practices such as daily scrum meetings, sprint planning meetings and sprint review meetings.

The second commonly used agile methodology is Kanban. Kanban can be defined as a *work in progress* (WIP) limited pull system that can be visualized with a Kanban board. Kanban is an approach to scheduling and visualizing work, reducing waste and maximizing customer value [30]. In this way Kanban works in a similar way as scrum. Both methodologies expresses features as user stories and work items etc. that is to be implemented incrementally. In the same way, both chooses features from a backlog that can be developed and shipped in one iteration. The biggest difference between Scrum and Kanban is that scrum helps teams structure and work with the help of set values, principles and practices while Kanban relies solely on visual representation to manage workflows [30][27]. By making use of the *Just In Time* (JIT) approach Kanban helps limiting WIP resulting in a better balance between demand and throughput of delivered work but it also yields higher quality work. This combination results in shorter lead time and more regular releases [31].

There are many more existing agile methods that has been thoroughly researched including Crystal, *feature-driven development* (FDD) and *extreme programming* (XP) [27]. However, as the popularity of agile methods increases the question goes from why and which to adopt, to how to adopt and how to scale these practices [32]. This is where the Scaled Agile Framework(SAFe) becomes pivotal. SAFe offers structured approaches to scaling agile practices in large organizations. SAFe introduces new concepts such as a program backlog representing business and architectural features, a release train introducing synchronization to different teams and a system team in charge of establishing infrastructure and to support continuous integration. A new

level called the portfolio level is also created. Here the programs are aligned with an enterprise business strategy along multiple value streams. These value streams are built out of system definitions and deployment steps to provide a continuous flow of value. However, as with many other frameworks in SE, adopting SAFe is no easy task. The framework focuses more on describing practices, roles, and artifacts of agile principles but does not outline any implementation strategy. This leads to the industry experiencing challenges with the adoption process of SAFe [32].

2.3 Value Based Software Engineering

Throughout the field of VBSE there is no standard definition of what constitutes value. In a mapping study performed in the field of VBSE it was found that the majority of the studies refer to value as it was defined in Boehm's paper in 2003 [5][12]. Which is that: "Value is defined at broader level as: 'relative worth, utility or criticality' or 'something intrinsically desirable'". While the economic perspective of value certainly is important, many researchers seem to focus more on the multi-dimensional perspectives of value instead.

Before the concept of VBSE, SE was done in value-neutral contexts where equal importance is put on each requirement independent on what value it brings [12]. When working in this context, the measurement systems track resource costs instead of the value delivered to customers and stakeholders, and software engineers are used for the purpose of turning requirements into delivered code. This method is useful when the resources required to deliver new systems are low as they were in the past. Another issue with value-neutral SE is that it does not contain the means to resolve the most common reasons that software projects fail. Even if VBSE is implemented there are still problems in how companies define value. In contrast with the academic definition presented in the last paragraph, the most common way of defining value in companies is a subjective assignment done by managers and other decision makers [33]. Developing systems in a value-neutral context contributes to the problem of wasted resources, without VBSE there is no data that can provide direction towards valuable features that will be used [12].

Companies have tried to move from value-neutral towards value-based SE for the last 15 years to increase the total value delivery of the company [33]. With the recent mass-adoption of agile processes in software companies the relevance of VBSE has increased since value is a vital part of the process. In the article by Boehm, in which the term VBSE was coined, Boehm suggests an agenda to incorporate value considerations and creating a comprehensive framework for the existing SE principles [12]. He divides the agenda into seven key elements: *Benefit Realization analysis*, *Stakeholder Value Proposition Elicitation and Reconciliation*, *Business Case Analysis*, *Continuous Risk and Opportunity Management*, *Concurrent System and Software Engineering*, *Value-Based Monitoring and Control*, and *Change as Opportunity*.

The conclusion drawn in the paper is that using these value-based elements allows for new perspectives on what constitutes success in SE projects [12]. The elements

cohesively make up the framework for VBSE. It is recommended that small changes are made at first in a pilot-project to ensure delivery of increased value. With the specific goal of expanding knowledge and techniques to increase value creation in SE, a roadmap is provided for advancing towards VBSE at a large scale. Fortunately for software companies, multiple methods are available that enable companies to move towards VBSE which have been applied and proven valuable.

2.4 Customer Value

According to a paper by Khalifa, three categories of value are formalized; shareholder value, stakeholder value, and customer value [34]. This section will focus on the last of these categories. In the book The Value Model the customer value of a feature or product is defined as "the relationship between the perceived benefits the customer gains from a product, and the total expenditure in time, money and other efforts demanded by obtaining and using this product" [35]. The objective of a company is therefore to increase the perceived benefits while minimizing the resource cost of the customer.

In more requirements driven SE companies, customer value is typically based on internal assumptions about the customer as opposed to on data [7]. To define the customer value based on data the companies can employ many different methods, for instance as proposed by Drapp and Prabhala, a value equation can be used to attach a monetary value that informs the company of the customer interest and in extension the potential customer value [36]. These value equations can allow a company to find key value propositions and discernible monetary value of a feature from the customers point of view.

There are many examples of the mentioned models that can be used to quantify customer value. In an attempt to categorize these models Khalifa defined three groups that these models can be divided into; "value components models", "utilitarian or benefits/costs ratio models", and "means-ends models" [34]. The first category is based on the three key value elements of esteem, exchange and utility. Decisions are then based on these elements which make this type of models particularly well suited in the development phase. The downside with this category is that it does not model the interaction between customer and the company. In utilitarian or benefit-per-cost models value is defined as the difference between the customer benefits and detriment for acquiring the product or service. In this definition the benefits concern a multitude of attributes gained from the product or service while the detriments concern other factors such as time or effort to acquire the product and economic cost. The last categories' models are based on the supposition that the customer wants to receive some beneficial outcomes from the use of the product or service. An important distinction is that value proposition is based on the resulting customer experience and not by the value of the product. These categories overlap extensively and the usefulness of a model is limited if used in isolation.

The ability to provide great customer value is vital for a company since it is directly linked to the revenue of the company [34]. Khalifa found that increasing customer retention by only 5% increases the company revenue by between 25% and 100%. This should make all companies seek to provide as much customer value as possible but there is an obstacle in the way. It is difficult to understand what constitutes value for the customer because there is a contrast between what the customer conveys and what the data shows is desirable [37].

2.5 Modeling of Customer Value

When developing new systems and features there are some practices that are beneficial to follow in order to provide value to customers. One such important practice is to model the expected value of a feature or a product [4]. By doing this a company can more easily measure and validate value and work with value in a continuous way. This section will present two existing frameworks that works with modeling value.

2.5.1 Existing Modeling Frameworks

This section explores two different existing frameworks to model value. The first one is *Value modeling*, a framework used to quantifiably measure the value of features and products. The second is the *North-star metric*. This is used to evaluate features and products based on a pre-defined metric that represents the core value that a company offers.

Starting with value modeling, there is an increased attention towards utilizing data to maximize the value delivered to customers and in extension the revenue of the company [34]. This attention stems from the digitalization of companies and the increased adoption of data-driven and experiment-driven development practices. Value modeling is the process of quantifying the value of a feature or product according to some defined and prioritized key value factors using a value function [4]. This can help companies to reveal unknown beliefs [2]. Value function can vary in complexity, Bosch and Olsson divide the complexity of value functions into vague, comprehensive or simple [4]. While companies commonly employ simple or vague value functions, they seek to move towards more comprehensive functions to allow the company to more effectively optimize for customer value. Bosch and Olsson suggest a systematic approach to value modeling consisting of ten distinct steps [2]. These include; identification-, consensus-, normalization-, and prioritization of key value factors, design of an experiment (step 5 - 8), and performing the experiment (step 9-10).

In addition to dividing the value factors into complexity categories they can also be seen as representing three different levels in an organization, the business level, the product/system level, and the team/feature level [10][38]. In a presentation by Bosch he explains that value models can be either self contained or used in a hierarchy of value models [38]. For instance, a systems level value model can be based

on multiple subsystem level value models that in turn are based on multiple feature level value models.

Some key challenges have been identified when trying to introduce and adopt value models [2][10]. The first issue is the involvement of company functions where people at different levels of the organization might have varying amounts of engagement in the change taking place. Consensus of what metrics to use is another issue, the company needs to agree on, align, and connect high- and low-level metrics. Another study from the same authors found that disagreement within the teams caused many issues in progressing with defining value functions [2].

Bosch and Olsson found four challenges that companies face when trying to adopt value modeling; "Long feedback cycles", "Binary features", "Factors that seldom trigger" and "Incomplete set of value factors" [2]. The challenges relate to different steps in the systematic approach defined in [4]. The conclusion of these studies is that value modeling is an effective technique for improving effectiveness, increasing customer value and avoiding sub-optimization.

The second framework is the *North Star Metric* (NSM). This method evaluates features and products based on a single metric, the NSM, that represents the core value that the company offers to the customer [39]. The metric helps companies consolidate their efforts towards the most valuable aspect of the product or feature. Focusing on that one metric limits the practice of defining shallow goals towards growth and instead encourages long term delivery of value. The teams working at the company are the basis for the customer value delivery and the company's growth, therefore it is important that each team is aligned with the NSM [39]. If not, it might be challenging to focus different teams towards a shared objective. Aligning the teams allows them to define what variables are important and the impact they have on the NSM. It enables the team to recognize what relationship the metrics have to the growth of the company. It is also important to note that even if many different metrics seem to encapsulate the value delivery the NSM should still be made into one single metric. However, defining this metric is no easy task and it requires a large amount of prioritization, Chen and Fu suggests a five step modeling-based approach to find the NSM of a product [40]. These include; collecting data for the True North measure for success, identifying predictive signals for the measure, using machine learning to make a choice of signal, develop a couple of metrics based on the signals, and lastly to make the final choice of metric based on product intuition.

3
Method

In this chapter the method of the study is presented. Firstly, the chapter delves deeper into the three different phases of the study and the case study design. Next, the case companies that took part of this study is presented as well as the interviewees and their roles. The chapter also presents the data gathering process conducted as part of the literature review as well as the design of the interviews. The chapter proceeds to delve into qualitative data analysis followed by the workshop design. Lastly, the validity of the results are presented.

3.1 Study Design

The study was divided into three different phases. The first phase was the data gathering and problem identification phase. This phase included a literature review and interviews. The purpose of the literature review was to gain a better understanding of the field and the problems faced when adopting new ways to model value (RQ1). This was then used as the basis for the questions in the interviews. To complete the analysis on the collected data from the interviews the audio files were transcribed and coded. This allowed for patterns and generalizations of the data to be found. The literature review also highlighted some problems that other researchers have identified when conducting their own studies in this area (RQ1). Together with the answers from the interviews this formed the basis for the second phase. In this phase, the researchers defined a new framework based on the data collected from phase 1 and any key elements and criterion found therein (RQ2). The purpose of the last phase was to validate the new framework created in phase 2 (RQ3). The validation phase was conducted through a workshop where the framework could be tested by industry professionals. During the workshop the researchers could observe the participants and gather feedback on the framework (RQ3).

3.2 Case Study Research

This study was conducted using the methodology of a case study. Case studies generate a deeper understanding of the phenomena under study and are well suited for engineering research [41]. These phenomena are often hard to study in isolation and the flexibility of the case study methodology and the iterative workflow makes it easier. As case studies are different from controlled empirical studies as they have been criticized and said to be impossible to generalize from. However, it is important to remember that statistical significance is not the only important

factor. Furthermore, applying appropriate research methodology can help alleviate these concerns. A case study is expected to be based on research questions from the beginning of the study. This case study had three research questions and two hypotheses as a basis that guided the study. A case study is supposed to collect data in a planned and consistent manner. Case studies tend to focus on the qualitative data by means of ethnographic methods. In this study, planned interviews were conducted to collect data more consistently. Qualitative data offers a broader and richer perspective than quantitative data, although, it can be less precise. It is expected that inferences are made from the results of the collected data to answer the research questions, which is presented in chapter 4, empirical findings, and discussed later on. Next, a solution is expected to be produced and analyzed. In this study the solution is presented in chapter 5. Lastly, it is expected that the threats to validity are addressed in a systematic way. It is especially important in a case study to make analysis' of the extent to which the findings are relevant to other cases. The intention of case studies is to enable an analytical generalization where the results are extended to cases which have common characteristics.

3.3 Case Companies

The research reported in this thesis was done in collaboration with nine companies most of which are working in collaboration with Software Center [42]. All case companies except the ones marked with (*) are embedded systems companies that are developing software products and services. The (*) marked case companies are online companies are specialized in other industries. Although the companies represent different industry domains, they are all encountering the surge of data and must address the challenge of leveraging it effectively. For some of the participants this was not the first time they had partaken in a study in collaboration with Software Center, indicating prior engagement with the organization. The participants in question had taken part in workshops before and worked closely with some of the areas that the researchers in this study wanted to talk about during the interviews. A short description of the case companies involved in this study can be found in table 3.1.

Case company:	Description:
A	A company specializing in the design, manufacture, and supply of technology solutions for military, aviation, and security applications
B*	A financial technology company that provides a comprehensive suite of online payment solutions for e-commerce, retail, and digital transactions.
C	A company specializing in the design and manufacture of systems for renewable energy, marine, and power generation industries.
D	A company specializing in the design and production of pumps for various applications including water supply, heating, and wastewater management.
E	A company specializing in the design, production, and distribution of forklifts, warehouse equipment, and logistics solutions.
F	A company specializing in the development of autonomous driving technology and software solutions for the automotive industry.
G	A company specializing in the design and manufacturing of packaging equipment and materials for the food and beverage industry.
H*	A technology consulting company specializing in software development, product information, embedded systems, digital solutions, and IT infrastructure.
I*	The company is an insurance provider, offering a wide range of insurance products and services to individuals and businesses.

Table 3.1: The nine case companies involved in this study.

3.4 Literature Review

In the literature review two sources were used, academic literature and gray literature. The topics included digitalization, data-driven development, customer value, value modeling, A/B testing, DevOps, and many more. The initial academic papers were suggested to the researchers by the thesis supervisors who are experts in the research field. From these papers references could be followed and topics mentioned in the papers could be expanded upon using more recent papers. When following references some older articles were found that are central to the topic such as Boehms article from 2003 [12]. The researchers ensured that a subset of the papers were more recent to get a picture of how the field looks currently. The researchers focused on gathering insights and understanding from gray literature such as blogs, videos, and any other non academic research. These included blogs from professionals, academic researchers, and presentations at conferences. Notes were taken during the literature review to facilitate quick recaps later on in the analysis process. Taking notes allowed for a more effective study since the researchers could read in parallel and then look at the notes to gain a general understanding of the papers.

3.5 Interviews

In the course of gathering data and seeking insights for the thesis, a series of semi-structured interviews were conducted. The interviews were guided by a set of focus questions outlined in the interview design document which can be found in Appendix A (English) and B (Swedish). It is important to note that during the interviews the interviewers exercised flexibility rather than strict adherence to the focus questions. This was done to encourage more insightful conversations that could delve deeper into the subject matter. As such, this study utilizes semi-structured interviews, allowing for a better balance between structured questions and exploration of new themes.

To gain relevant insight of the pain-points companies face when adopting new practices for modeling value it is important to interview suitable candidates with the right knowledge and experience. The candidates selected for the interviews were all experts within their industry, working in companies at different stages of progress towards modeling value. A list of all interviewees and their roles can be found in table 3.2. This ensured that relevant insights could be gained through the discussions. The interviewees were recruited through a newsletter sent by Software Center, a strategic partnership between companies and universities, that the researchers are connected with. In the email newsletter the premise of the study was introduced and readers (employees at the companies associated with software center) were encouraged to reach out if they were interested in participating in the study. This had the consequence of recruiting only participants that were excited about the project and that wanted to share their knowledge and insights. A total of nine interviews were conducted with professionals from nine companies with varying services and products.

Case company:	Interviewee role:
A	Business Development at case company A
A	Manager at case company A
B*	Software Engineer at case company B
C	Global Project Manager at case company C
C	Team Leader and Product Manager at case company C
D	Data Engineer at case company D
E	Strategic Product Manager at case company E
F	Technical Expert at case company F
G	Manager at case company G

Table 3.2: The nine interviewees involved in this study.

To maximize the insights gained from conducting the interviews the interviewers divided up the responsibilities during the interviews. Interviewer A could focus on conducting the interview in a professional manner and keeping the discussion going by listening and asking follow-up questions as well as seeking clarification when needed. Meanwhile, interviewer B could be focused on listening to the answers given

by the interviewee and taking notes, this included seeking clarification if any answer was unclear. In addition to the notes, the interviews were also audio recorded. The recordings were the basis for the transcriptions that were used for analyzing the results of the study. These recordings were used to re-listen to the answers to clear up any misunderstandings later on in the analysis phase.

The interviews started with an introduction to familiarize the interviewee with the background and reason for doing the interview. The interviewee were then asked to briefly introduce themselves, the company and the role they play in the company. After this the interviewers asked questions regarding a high level overview of the structure of the company, the teams, the customers as well as development methods. Next the interview moves on to the main part. In the main section of the interview three topics were explored, the first topic was the company's digitalization efforts. The questions in this part of the interview were focused on the company's gathering and utilization of data. The second topic focused on gaining more insight to the company's work with data-driven development. Questions here were aimed towards DevOps, evaluating new features and using data to guide development. The last topic explored was the company's work with customer value. The focus was on understanding the company's own definition and application of customer value. The researchers inquired about any frameworks that might be used in companies with the purpose of improving their work with customer value as well as any hindrances to adopt such frameworks. In the closing section of the interview the interviewee is asked about the benefits they have seen through any work with customer value delivery. They are also asked to share any final thoughts and to ask any questions to the interviewers if any have come up.

3.6 Qualitative Data Analysis

The data gathered from the semi-structured interviews are qualitative in nature and the methods of analysis is therefore aligned with qualitative data and starts by preparing it. As mentioned in 3.5, the interviews are audibly recorded, these recordings are then transcribed using the OpenAI Whisper system [43]. Whisper is an automatic speech recognition system which allows the user to transcribe audio into text. This works with both English as well as a large set of other languages and each of the languages can be simultaneously transcribed and translated into English text. Whisper provides access to many different models with varying requirements and capabilities from *tiny* to *large-v3* [44]. For the transcription work done in this study the model "medium" was used for each of the audio files. When the audio is analyzed the system creates a number of files containing the text that was recorded in different formats which can then be further used for encoding.

The transcriptions were then coded using a program called NVivo 20, coding qualitative data is used to be able to find aspects or information that is relevant to the study in question [45]. These codes could then be used as a basis for the suggested framework discussed in 3.7.

3.7 Creation of New Framework

Getting started with the process of creating a new and novel framework was difficult. The aim of the framework was to solve some of the problems that were discovered during the literature review and the interviews. To start of this process the problems that were found were compiled into a list. The problems in the list could then be categorized into a few groups and these groups could then be prioritized based on the frequency of occurrence in interviews and importance from the literature. With the results compiled and categorized the process could proceed to the next step.

The researchers then created a timeline. In the timeline some of the different processes and framework steps were added to find where the framework could fit into the current landscape. These steps come from some of the frameworks that exist in the current academic literature that were read about in the literature review. The work of creating the timeline and the framework were done using a website called *Miro.com* which is a visualization tool for creative collaborative work [46]. There are templates for mind maps, flowcharts, and other common visual methods to get started.

The next step in the process was transitioning the list of problems into a mind map, seen in appendix D. In the mind map the information was more effectively structured and visualized. This process led to the generation of new ideas, culminating in the development of a new framework. This new potential framework could then be built upon, and steps could be created to guide the future user through each part of the framework. These steps could then be, similarly to the timeline, visualized to improve understanding. The visualization was created with simple and actionable steps to make sure that the process was easy to follow. A deeper, more detailed, explanation of each of the steps were written separately to ensure that the users could understand each step and how they can be applied in their context. Additionally, the creators explicitly expressed the focus, purpose, and benefits gained from using the framework. This could help the users understand the context, utilization, and value of the framework. The researchers gathered feedback from the supervisors of the thesis and iterated upon the framework to improve it, the final version of the framework was v4.2.

Once the previously mentioned steps were completed the framework was finished. It contains; a step by step actionable process that can be followed, explanations and deeper description of each step in the framework, and clear descriptions of the focus, purpose, and benefits of using the framework. The framework was now ready for feedback and iteration. The framework was, in the case of this study, sent to the supervisors of this thesis who are experts in the field of product management. The researchers then revised the framework based on the supervisors feedback. The framework outlined in 3.7 could then be reiterated upon to refine and improve the framework as much as needed before the workshop validation in the next section.

3.8 Workshop

The workshop was designed as a group exercise where the participants engaged with the framework. A workshop guide was created explaining the design of the workshop and the scenario produced for this purpose, the full guide can be found in appendix C. The workshop was divided into two different parts using the same scenario.

Part 1 included step 1, 2, 3 and 4 of the framework. In this part the participants were introduced to the scenario which included a description of a company working with embedded systems, a product overview and the roles the participants played during the workshop. The participants then went on to step 1 and got introduced to a set of epics and features that they could choose to work with. They then worked through step 2-4 in order. The participants then moved on to part 2 where they got introduced to a set of hypotheses, metrics, and experiment results that they were to discuss during step 6. The participants discussed two out of the three hypotheses before time ran out. In step 8 the participants made a decision regarding whether the hypotheses should be accepted or dismissed. Lastly the participants discussed three questions about the general usage of the framework to gather some feedback. Step 5 and 7 were not applicable to this workshop since they require real-world implementation and were therefore not included. Step 9 focuses on what the users are able to do after using the framework for a longer amount of time, while the workshop focused on trying the framework out, which is why step 9 was not included. The workshop material was all prepared in a Miro board with a designated work space to make it easier for the participants to collaborate.

The workshop was conducted online with three participants, outlined in table 3.3, comprising of individuals previously interviewed in the thesis as well as newly introduced individuals. At the start of the workshop the researchers introduced some aspects of the thesis and explained the workshop tasks. During the workshop all participants had access to the Miro board where they followed the design of the workshop step by step. The researchers listened to the discussions and answered questions if needed but mainly focused on taking notes. Lastly, the participants answered the three discussion questions and gave important feedback to the researchers.

Case company:	Participants role:
G	Manager at case company G
H*	Software Engineer at case company H
I*	SCRUM Master and Agile Coach at case company I

Table 3.3: The three participants involved in the workshop.

4
Empirical Findings

In this chapter the findings of the interviews and the workshops will be presented. The presentation of the empirical findings will include the companies' work in the areas of defining and validating customer value (RQ1) 4.1.1, specifically addressing consensus (H1) and utilizing data more efficiently (H2). The chapter will also include the important key elements and criteria needed when defining a comprehensive model of value (RQ2) as well as how effective the proposed solution was at mitigating the challenges of defining and validating customer value (RQ3).

4.1 Research Question 1

In order to answer research question one the researchers focused on finding out how stakeholders such as product managers, product owners, and other managerial professionals define and validate customer value. There was a special interest in how teams reach consensus about what constitutes value as well as any potential problems that exist with regards to effective data utilization. Since the last two aspects of the research questions have separate hypothesis' attached, the results for those topics will be discussed in the subsequent sections 4.2 and 4.3.

4.1.1 Definition of Customer Value

The study revealed that the **key value factors** companies use to base new features or products on was largely unknown by the interviewees. For instance one interviewee told the researchers that the key value factors were *"Not completely transparent right now"*. The majority of the interviewees did however mention some factors that they would follow and thought were the most important for the company. These factors were commonly decided through individual experience of the field. As an example, one interviewee said that *"I also tend to use my own experience as a customer to define some of my factors."*. There were also interviewees that had clear answers as to what the most important factors were for the company. Two examples of this are interviewees that told the researchers this: *"Performance, all the time. For us it is about that customers should produce as many packages as possible per day, that is what we have in our contracts."* and *"Safety is a binary thing. We can not not have it."*.

When it comes to the prioritization of key value factors the answers were more spread and differences appeared. Some interviewees expressed clear responsibility

for prioritization for example one interviewee told the researchers *"we have system engineers and system organizations that have [the prioritization of the most important measures] as its responsibility"*. Two other interviewees were less certain of how the prioritization practice was conducted and one of them told the interviewers *"I'm not sure how we would do it, but I'm sure that there is discussions"*. Additionally, the research revealed that there are some domain specific challenges present, one interviewee told the researchers that *"[Prioritization] is the challenge in our industry that is so heterogeneous, but we try to find the least common denominator."*. The study showed that prioritization of factors is dependent on experience, one interviewee in a developer position said that *"it's a mix. We get it from upstairs here that we know we need to do Q1 or Q2 this year."* but then that *"it's up to [developers] to decide what needs to be done and find out what needs to be done."*.

When bringing up the topic of modeling or calculating the **expected value** of a new feature or product, a majority of the interviewees said that their companies did not do any calculations nor modeling at all. One interviewee said that *"What I know is that we don't have anything like that. [...] So we can work with the ticket, we can solve it. There are no metrics or anything like that about what the value is. So you don't really know."*. Some other interviewees told the researchers about expected economic benefit that developing the feature could bring to the company, not as many spoke about the benefit that could be brought to the customer. Two examples of this economic perspective was two interviewees who said that *"I need to do some kind of business case."* and *"We try to find a market for [a feature] and then estimate the market on feedback we get from customers."*. Only two of the interviewees knew for certain that the value of new features or products were estimated.

4.1.2 Validation of Customer Value

Something that became apparent during the interviews was that the companies had problems validating customer value in general. The interviewees expressed that they were using either **manual validation or no validation** at all. These were the two recurrent answers from the interviews. Although there were different reasons why this was the case. One example showcasing no validation was *"with lack of data, we are a little bit in the blind at times. So I would say that our best metric is the sales volume."*. Another interviewee said that *"if a customer is not happy about something, you hear it"*. One interviewee stated that *"In that platform, all the data retrieval is manual."* referring to the fact that they are only able to do manual validation. Another method that was used to validate customer value was to conduct qualitative interviews, one interviewee went on trips throughout Europe to collect data to verify hypotheses.

When utilizing **automatic data gathering** to validate customer value the interviewees provided similar answers. They are not able to use automatic data gathering to that extent, if at all. Some examples that were given during the interviews were: *"We do not really have data gathering of the systems that we have out in the field.*

[...] That is something that we're looking into.", another example was *"I'm doing more self-engineering than data engineering sometimes because we're not really getting any data streams that are reliable."* and *"It does not mean that the customer uses the function they have paid for. [...] There is no automatic data gathering for that."*. Although there were instances of automatic data gathering used in some companies that data was more focused toward service, quality assurance or training data than finding customer values. One example mentioned during the interviews was *"we get data that we can record, system data that we store and record and use to train and optimize our algorithms"* Multiple interviewees did express that they understood the value of having automatic data gathering but the most common answer was that they were unable to do it and were looking into solutions to the problem.

4.2 Hypothesis 1

During the interviews the researchers found no empirical evidence that the interviewees were facing challenges due to not being able to reach consensus on what qualifies as customer value. When asked how the interviewees defines value, most of the interviewees did not have any set definition of value or method of defining it. When asked about key value factors most interviewees could mention some specific metrics mostly based on experience in the field. However, there were not many cases where those metrics were decided upon beforehand. It is apparent that the discussion of what constitutes value is missing and therefore there is no disagreements to be had regarding the topic.

4.3 Hypothesis 2

The interviews showed that companies had problems utilizing their data efficiently to be able to define customer values. Although the reasons were very different from company to company. Some examples showcasing different company struggles are the following: *"we're still always relying on the customer to give us the data first, which is a big issue"* another interviewee said that *"the corresponding data when the customers use our system [...] is always confidential so that we cannot take part in that data"*. Something else that became apparent is that some companies gather their data manually instead of using automatic methods. However, there are no empirical evidence that the problems with utilizing data is the reason for sub-optimized solutions that results in low-impact features.

4.4 Research Question 2

In this section the researchers present the findings connected to the second research question. The focus of this research question was to find out what stakeholders such as product managers, product owners, and other managerial professionals thought was key elements and criteria that should be considered while defining a new model of

value. While specifically addressing the definition of value. The results discovered in this study did not specifically answer what these professionals wanted from a framework. Instead, they highlighted the gaps preventing them from initiating the adoption process of said frameworks.

4.4.1 A Shared Definition of Value

The initial emphasis was on understanding the definition of value from the interviewees' perspective. The results were very clear, most interviewees did not have a clear definition of value throughout the company. All interviewees had some way of arguing around what value was to them. One example mentioned before that is applicable here was *"We have the standard money metrics. But I also tend to use my own experience as a customer to define some of my metrics"*. Another example is the use of a specific tool to help find and decide on value on a case to case basis called *Strategyzer* [47]. However, the main takeaway is that an explicit definition of value is missing.

4.4.2 Understanding What Constitutes Value

What constitutes value is something that is connected more to the company, a domain or a product as a whole rather than being connected to specific features. When the researchers asked the interviewees about any overarching values that they worked towards, the examples were similar to the answers mentioned above connected to the key value factors and metrics found under research question one 4.1.1. While the researchers sought internal discussions about customer value at a higher level, such discussions were limited. However, one interviewee did provide an example of their company's focus to move toward green energy *"We are still a market leader in terms of inspiration, moving in certain directions that people would traditionally not move. Mainly driven from a sustainability focus. [The company's] owner is very sustainability focused. So he actually doesn't mind losing a ton of money to make sure that that agenda is pursued."*.

4.4.3 Knowledge of Existing Frameworks

Another thing that became apparent was that most of the interviewees were not aware of any existing frameworks or methods from the academic world. When asked if they used any framework or had tried any methods to improve customer value delivery as a whole the answer was commonly "no". Something that kept coming back was the use of SAFe and other agile methods with varying results. However, the responses regarding agile methods did not align with the specific outcomes sought by the researchers during this part of the interview. The exception to this were one interviewee who was very well read on the academic research and gave some insights on the problem *"When you are so far ahead that there is frameworks and research results since 10 years back that companies still struggle to use in practice. [...] But in practice, you can't do it yet"*. Another aspect that was highlighted during the interviews were the domain specific circumstances that were stopping some companies from being able to adopt a framework. The prerequisites needed

to be able to start the adoption process of a framework was not possible to fulfill due to the domain. One example is the extra cost that would come with adding a cloud solution on a product *"Adding a Wi-Fi module is also not that cheap and even if you were to add like, let's say Bluetooth, and then you have an access point that can send data, that would still be two euros or so per [unit] and that is a big issue"*.

4.4.4 Using Opinion Instead of Data

Using experience instead of data was found to be a common occurrence in the case companies studied. When asking one interviewee about how they work with improving customer value delivery they said *"we use our experience and knowledge about how the system is used and we have many of our employees who have worked with operating the systems or being an end user of them so we have the insight and the competence into our business of what works and what does not"*. Another interviewee said that *"data is involved. But I think majority is [based] on experience and talking with the industry."* when asked if it is mainly experience or data that drives their development teams. This is discussed further in the first paragraph of section 4.1.1, where the study revealed that the most common way of determining what key value metrics to use, to measure the success of features and products, was through the subjective experience of the managers.

5
Framework

In this chapter the developed framework will be presented and explained. First, the 9 steps of the framework is presented together with a visualization of these steps. Second, the frameworks positioning compared to other concepts and frameworks in the field of SE is explained. Lastly, the purpose of the framework as well as a more in depth description of important concepts and methods employed is provided.

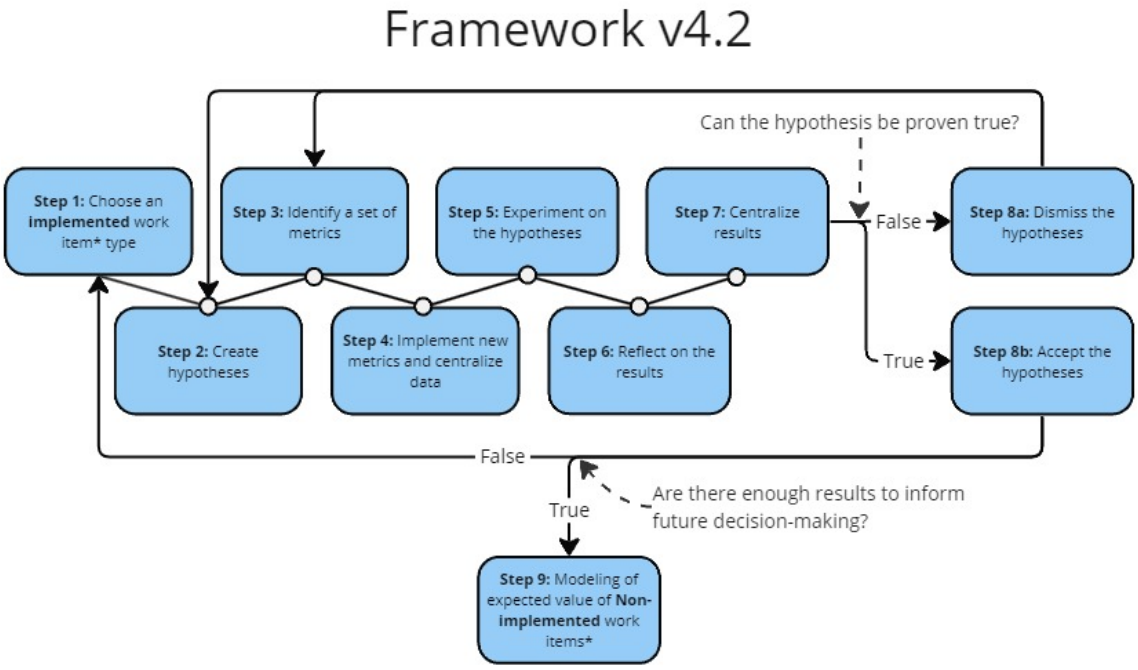

Figure 5.1: Version 4.2 of the framework with each of the 9 steps of the framework along with the paths that connect them.

5.1 Framework Steps

This section will explain all 9 steps of the framework presented in figure 5.1:

Step 1:
In step 1 the users choose an implemented and existing work item to focus on for

this iteration.

Step 2:
In step 2 the users create one or multiple hypotheses. The hypotheses describes what value the work item provides. The hypotheses, can and should, if possible, be based on data and experience of the users.

Step 3:
In step 3 the users identify a set of metrics connected to each hypothesis either by choosing already defined metrics from the system or by identifying new data points to base metrics on. When defining these metrics it is recommended that the user keep in mind the levels of measurement that are relevant to the metrics. It is important to be consistent in the measurement approach but be open for work items with specific characteristics that can be adapted to.

Step 4:
In step 4 the users implement new metrics and centralize data. It is recommended to set up a centralized space where gathered data and any relevant existing data can be stored together. If a data gathering system already exists then eventual new metrics can be incorporated into that system. Examples of useful data to collect is usage analytics, customer feedback, customer behavior or support tickets.

Step 5:
In step 5 the users test the hypotheses by creating experiments using data from the centralized space. Remember to use past experiment results to more effectively guide new experiments.

Step 6:
In step 6 the users reflect on the results of the experiments. This ensures that the results are valid and that the experiments test what was intended. In this step the users reflect on if the hypotheses has been proven or not.

Step 7:
In step 7 the users store all the experiment results in a centralized location. To explore and interpret the results the users can use data analysis and visualization tools. The results can and should be used to inform future decision-making.

Step 8a:
In step 8a the users have made the decision to dismiss the hypotheses. This means that the hypotheses has been proven false and the hypotheses, metrics and experiment need to be reevaluated and iterated upon. Learn from the mistakes and try to find the cause. Move back to step 2 and reiterate.

Step 8b:
In step 8b the users have made the decision to accept the hypotheses. This means that the hypotheses has been proven true and a better understanding of that work

items value has been reached. Before moving on to step 9 a decisions is necessary. If the results of the users accumulated knowledge of what constitutes value in the system can support the users future decision-making then the users should move on to step 9. If the user deems it necessary to gain more knowledge then a decision should be made to move back to step 1 and keep experimenting on what constitutes value in the system.

Step 9:
In step 9 the users are able to start working with new and non-implemented work items. With the users accumulated knowledge, centralized results, implemented metrics, and proven value they can model the expected value of new work items. It is important to use the experiment results from step 7 for this purpose since the accumulated knowledge can give new insight to help identify metrics to measure the expected value of new features.

5.2 Description of Framework

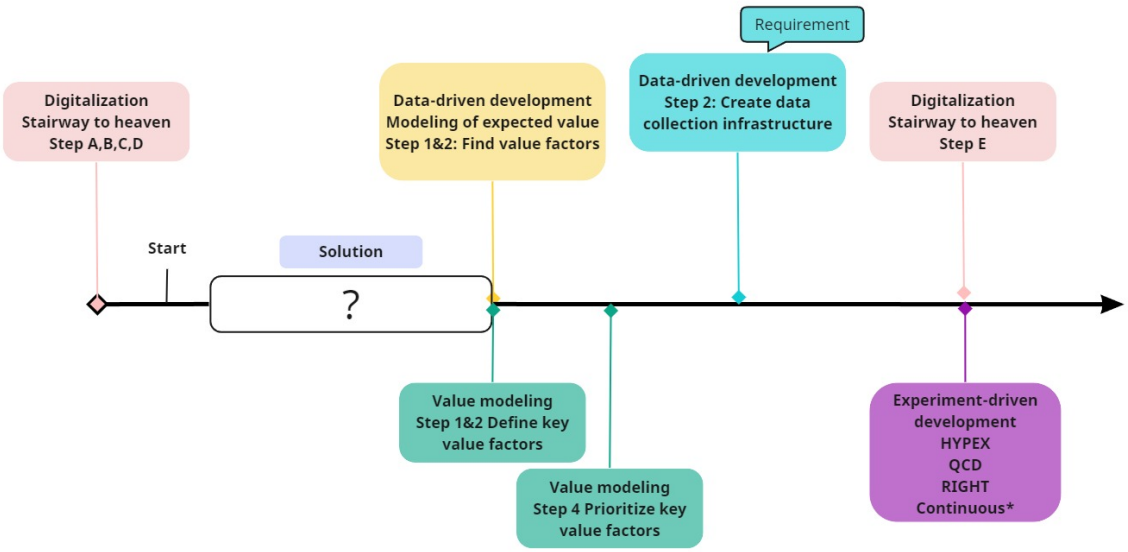

Figure 5.2: Timeline showing the frameworks positioning in comparison to concepts and other frameworks in the field of SE. The timeline itself represents the process of a company digitalizing itself and moving towards more advanced ways of modeling customer value delivery.

Before explaining the framework it is important to understand where in the field it is positioned. Figure 5.2 visualizes the frameworks location in comparison to other academic frameworks and concepts in the field of SE on a timeline. This timeline represents a company's journey towards adopting more advanced frameworks for modeling customer value. The timeline starts in digitalization and advances to

experiment-driven development such as the HYPEX model. As the timeline shows the framework is situated after the first steps of the Stairway to Heaven framework and the digitalization process 2.1. It is also the precursor to the first steps of Data-driven development 2.2 practices and step one and two of the Value Modeling framework 2.5.1. Step number nine in the framework is overlapping with the last mentioned frameworks and is a steppingstone into adapting these practices and frameworks. It is important to mention that this framework thrives on teamwork and collective effort. Leveraging diverse perspectives and experiences while engaging in discussions about hypotheses, metrics and results can significantly improve the outcomes.

Delving deeper into details of the framework, a decision was made to introduce work items with different levels of hierarchy into the framework. The use of the phrase *work item* is an analogy to agile methodologies where different work items are for example, *Epics* and *Features*. It is up to the users of the framework to choose which level of work item they want to understand the value of. This makes it possible to start at any hierarchical level of the system.

A new concept introduced in the framework that requires an explanation is levels of measurement [48]. Data can be divided into two main data types, categorical data reflecting qualitative characteristics and numerical data reflecting quantitative characteristics. Within these main data types there are two levels of measurement. *Categorical* data includes *nominal* and *ordinal*, whereas *numerical* data includes *interval* and *ratio*. The levels of measurement for any set of data will directly impact what kind of tests you can perform. Nominal data is based on qualitative characteristics or groups with no rank order, for example, gender and ethnicity. Ordinal data is based on qualitative characteristics that have a natural rank order, for example, levels of agreement (disagree, no opinion, agree). Interval data is based on quantitative characteristics with inherent ordering and equal spacing between points but an arbitrary zero, for example, temperature measured in Celsius (10-20 or 20-30 where the difference is the same) and where 0 degrees is arbitrary since it does not mean that heat is missing as opposed to Kelvin. Ratio data is based on quantitative characteristics with ordered data and an absolute zero, for example, weight or time where a value of zero means something. In the context of this framework the users are able to measure the metrics in different levels of measurement, although a baseline with a consistent measurement approach is recommended.

The focus of this framework is based on finding and understanding the value delivered by a feature, product, or system. The framework, unlike others in the field, does not focus on delivering new value to the customer but to allow product managers and other decision makers to understand the value of a feature, product, or system. This is done with the help of hypotheses, metrics and experimentation with data. These steps are iterated upon multiple times on work items at different hierarchical levels. This is also where the concept of accumulated knowledge comes into play. By building up a database with experiment results in a centralized space the users of the framework are developing their accumulated knowledge in a continuous

process. This results in a better understanding of their own systems and products value delivery. Their accumulated knowledge can then be leveraged to improve on the process while also facilitating progress toward the overarching goal of the framework: guiding users towards the adoption of other frameworks aimed at maximizing the amount of customer value delivery.

6
Validation Workshop

This chapter presents the outcome and results of the validation workshop. These results will first be presented in order to substantiate the answer to research question three. The results of both part one and two of the workshop will be presented and images of the workshop process will be showcased. Following this the answers to research question 3 as well as hypothesis 1 will be given. These results showcases how the framework undertake and mitigates the challenges found during the literature review and interviews.

6.1 Workshop Results

In part one of the workshop, which was concerned with steps one through four of the framework, the participants started by choosing the epic work item. However, when they continued to the next step they also included the two features associated with that epic work item. This meant that three different work items, that can be seen in figure 6.1, were included in part one of the workshop. At the beginning of the workshop the discussions revolved around what the two chosen features could be used for both generally and with specific features and what their potential value could be. This can be seen in figure 6.2. The participants then chose to move forward with "reduce cognitive load" as their potential value. By doing this they indirectly created a hypothesis that they moved on with. However, this early into the workshop the participants easily lost track of the goal of the step, discussing what value the feature gave rather than thinking about new potential features. This was realized by one of the participants who said *"We are focusing more on what we can do, rather than what value it gives"* which brought the discussion back to the topic of value.

Epic 1: Enhance User Experience with Voice Control

- **Feature 1**: Voice Recognition Technology (e.g., Amazon Alexa, Google Assistant) that allows users to control smart home devices via voice commands.
- **Feature 2**: Custom voice commands for common home automation tasks, such as adjusting lighting, setting thermostat temperature, or activating security systems.

Figure 6.1: The epic work item and the two connected features that was chosen during the workshop.

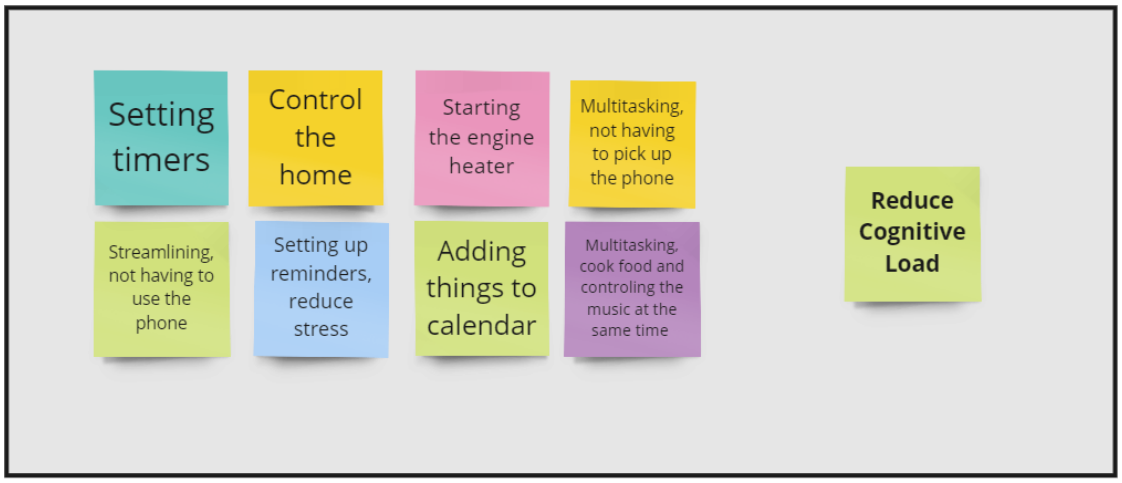

Figure 6.2: The chosen feature and its potential uses, as discussed by the participants, along with its potential value.

When beginning to identify metrics, the participants started off by thinking of subjective metrics that fall into one of the two categorical levels of measurement. To measure these subjective metrics one participant said that *"Surveys are used as a good way of measuring this"* and they started to discuss questions to be asked in these surveys, for example, if the users were feeling better, or if they were less stressed when using the feature in mind. However, the participants came to the conclusion that objective metrics were more relevant to use to actually prove the hypothesis, one participant said that *"we could measure the pulse of the user, that would be more towards direct data that can be measured and compared"*, to which the other participants agreed. Objective data was more valuable for their goals in that step.

Next the participants had a discussion of how they were going to implement ways to get data from these metrics. They were mostly discussing different tools that they could use to get access to this data. This meant using surveys to measure subjective data or smart watches and mobile applications to measure objective data. To

visualize this they used the metrics from before and drew arrows to visualize the connection between metrics and tools they could use to measure them. This can be seen in figure 6.3

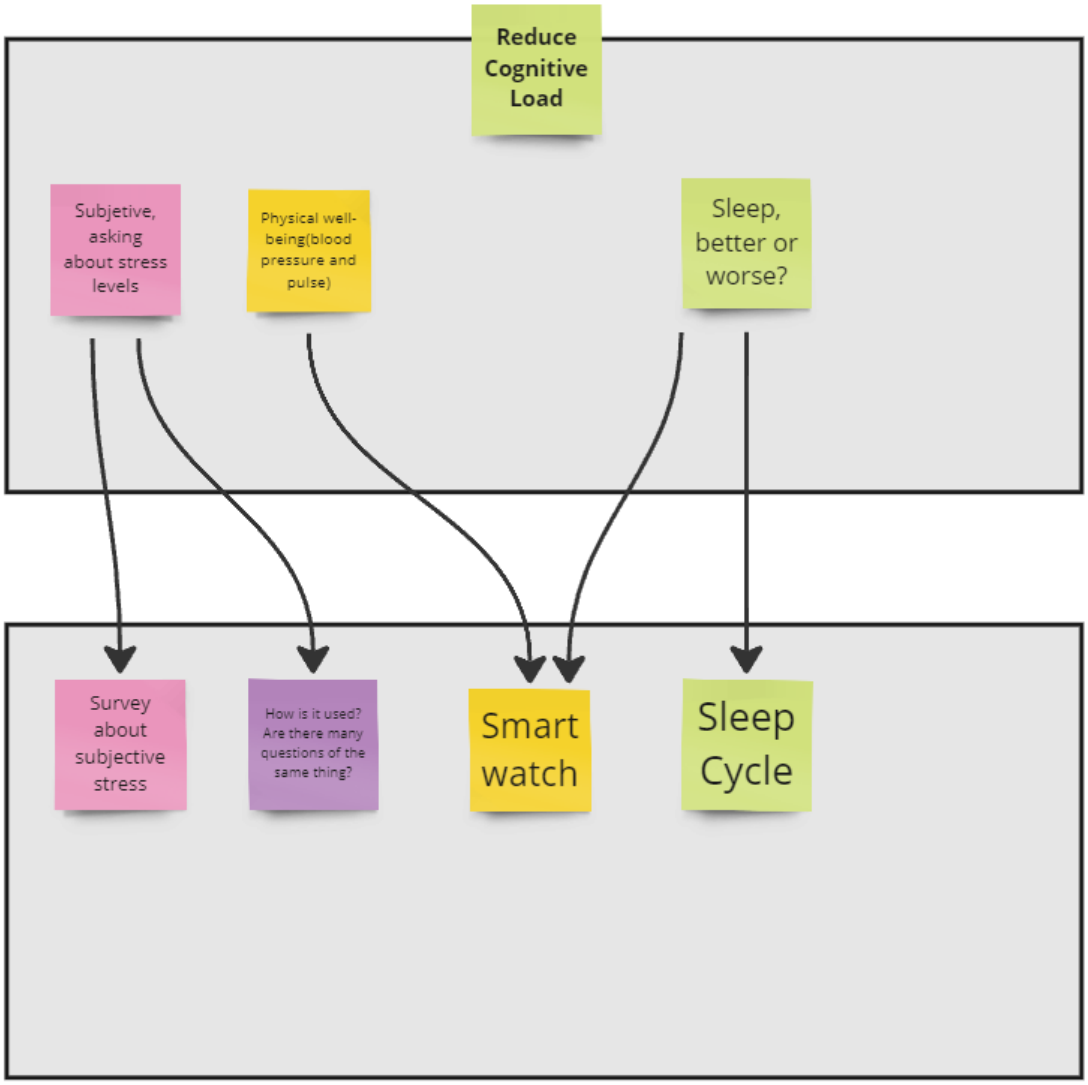

Figure 6.3: Description of potential uses for the chosen features and their associated value

During part two of the workshop the participants reflected on data connected to experiment results and discussed how well the data could validate the tested hypothesis. When discussing the first simulated hypothesis presented in figure 6.4, the participants noted that *"The first metric does not work on its own"* and then gave an example, *"if you ask the voice assistant a question multiple times but it can not understand what you are saying"*.

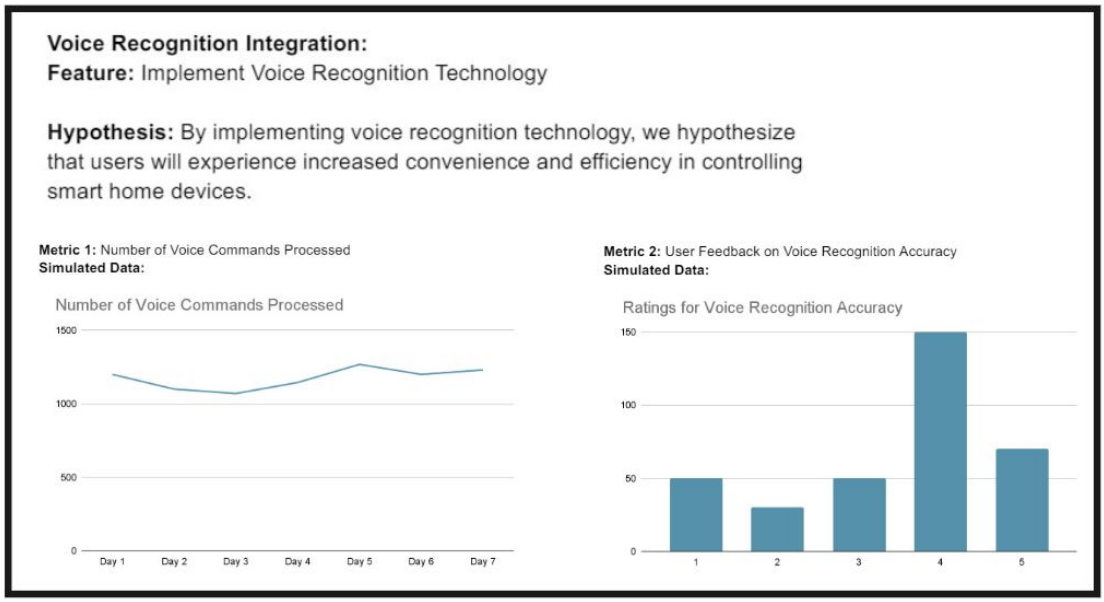

Figure 6.4: Data connected to the first hypothesis discussed during the workshop. Two different metrics are used to measure the hypothesis

The discussion in this part of the workshop mostly revolved around the quality of the data provided and what could have been done differently to improve the data. When discussing their first hypothesis, hypothesis one from the scenario, one participant made the point that one metric was of higher quality than another because *"the first one shows no trend"* and that *"It is mostly the trends that we are interested in"*. They also discussed the quantity of data and what that meant in this stage of the framework. For one of the metrics a participant said *"It is a [too] small sample to be used to answer the hypothesis, more data would give a better overview"* and another said that *"we think it is the right metric but we need more data"*. They also discussed what could be added or changed about the metrics to gain better insights that could validate the hypotheses. One participant said *"I would like to have reviews as well. For instance asking the person who selected 1, why?"* as a suggestion to generate improved insights by utilizing both objective and subjective data. Another example was one participant suggesting that *"You would like to see this over the course of a year"* to which another participants refuted, stating that *"When working in a hypothesis driven way you want to have short and fast experiments, otherwise you get a long time to market"*. On the same topic one of the participants said that *"I like that the experiment is short as it becomes easier for a product manager to reach conclusions"*. At the end of their discussion they decided that hypothesis one was accepted.

When discussing their second hypothesis, hypothesis number three in the scenario, they discussed that they were more hesitant to make a favorable decision. They reasoned that this was because of the implications of the hypothesis and its connected metrics, which can be seen in figure 6.5. The participants contemplated the decision to accept this hypothesis more seriously and carefully. The discussion also went on to mention the amount of metrics used. The participants argued that adding more metrics could improve the ability of the group to make good and dependable

decisions but the process could be more complicated. They also argued that its possible to remove old and irrelevant metrics from the collection of metrics as soon as they are no longer needed to lower the complexity of the system. At the end of this discussion the participants concluded that hypothesis three was dismissed.

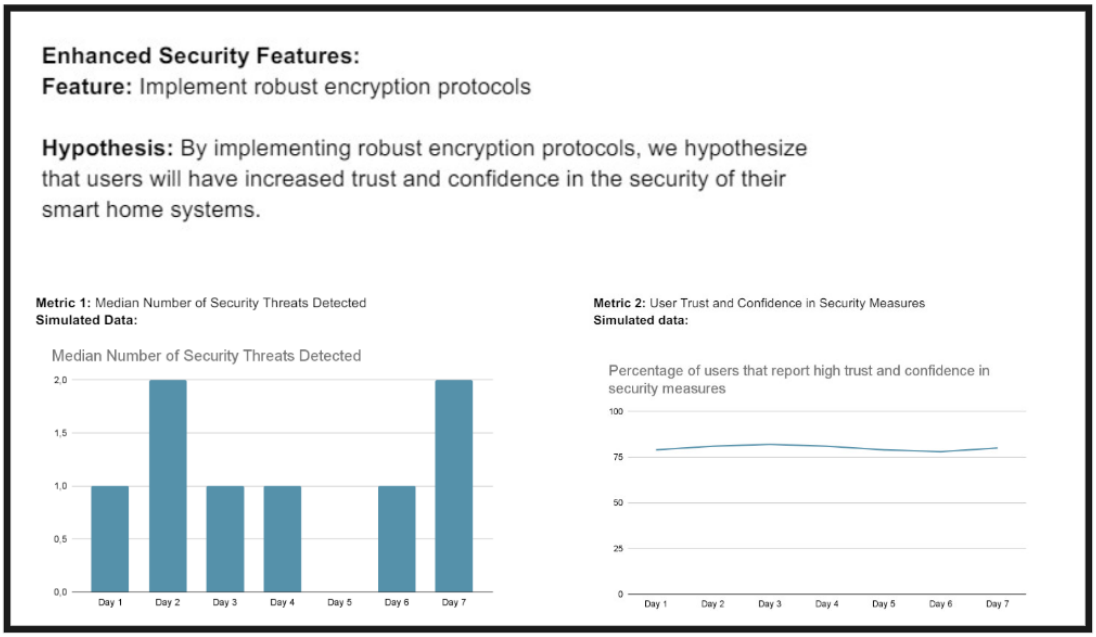

Figure 6.5: Data connected to the second hypothesis discussed during the workshop. Two different metrics are used to measure the hypothesis

In the last part of the workshop when asked about their thoughts about the process of creating experiments and using them to gain a better understanding of what constitutes value, the answers were overwhelmingly positive. One of the participants expressed that *"setting up hypotheses starts a discussions about what the customer value is because it is very hard to know what it is, but we can make good guesses"*. Additionally, they said that *"it is good to have these hypotheses in the backlog that can then be brought up again later on too, when more data and metrics have been created and measured"*. When asked about negative aspects of the experiment driven process the participants found one main potential issue which was the scaling of such a process. Two separate examples were brought up regarding this problem, the examples were that *"On a larger scale we will have to start thinking about cost, time, and resources"* and *"If you have a lead time of two years you will be able to come up with new hypotheses and metrics [during development] that can be added and you will have to be very structured when working with this"*.

When discussing the potential of the framework the participants were positive and thought that the framework was a helpful tool. However, they found it harder to give a definitive answer when asked about the use of accumulated knowledge and data for the purpose of calculating the expected value of new features. One of the conclusions that the participants came to was that calculating the expected value be-

comes easier with the amount of iterations that are done, since they add knowledge and data to the accumulated learning of the framework. Although, the participants expressed that you can never be sure of the value that a future feature can bring but that using this kind of approach can bring the users understanding closer to the truth. Additionally, they expressed that some uncertainty will always be present because *"There are so many factors that influence this"*.

In general, the participants found the framework useful and the feedback was exceedingly positive. The participants appreciated the iterative approach. Specifically that, following the framework steps, the hypotheses could be revised and improved if the outcome was not satisfactory. When giving feedback on the framework process, one participant suggested adding a path from step 8a to step 3 and rephrasing the question following step 8b to make it clearer. One participant ended the workshop with a quote about models stating that *"all models are wrong, but some are useful"* referring back to the sentiment that the framework will not always be right, but that it was useful to have.

6.2 Research Question 3

The goal of this research question is to evaluate how effectively the framework could mitigate the challenges found during the literature review and the interviews. During the study a choice was made to not work with all challenges but to focus on some of them. The most important one being *understanding what constitutes value*. As can be seen throughout the results of the workshop this is the main goal of the framework. There were many instances during the workshop where the participants discussed challenges they encountered, many of which were aligned with those identified during the thesis, as well as other important topics. The participants were able to progress smoothly to the next step of the framework, indicating that they encountered no significant problems where they got stuck. There are two main takeaway from the workshop when it comes to understanding value. First, the participants were able to discuss value and come up with ideas about potential value. This could be seen throughout the workshop where they freely discussed the work items, following the steps of the framework. Second, the participants were able to discuss the different metrics and draw conclusions from the provided data, some things that were mentioned during these discussions were *"I would not dare to make a decision based on this data"*, showing that they could understand the importance of reliable measurements. *"You could present or visualize the data differently to more easily be able to compare it"*, demonstrating their understanding of the importance of data visualization for analysis. *"The median can be a dangerous value to look at, the mean could be a better value"*, indicating their critical approach to analyzing the data for better insights. The fact that the participants are having these discussions conveys that the they are able to better understand what values they are trying to prove and that they in fact, do understand what constitutes value in the scenario by making use the framework.

Another challenge to mitigate was the challenge of *calculating the expected value*. This is specifically concerned with step 9 of the framework which was not testable during the workshop. However, the discussion questions at the end of the workshop provided some insight into this. One participant said that *"Possible [to calculate the expected value] yes, but it is a probability where you can start to predict things"*. Another participant said that *"Features targeting different customer groups are in a good position to base the tenth customer groups features based on the first nine"*, meaning that calculating the expected value on a new customer group is easier if the value for a know customer group already has been proven. Lastly, the conclusion that the participants came to when discussing the possibility of calculating the expected value in step 9 of the framework was that, *"Yes it is possible, but we can't say that we are 100% sure, but the probability is increased. We may move from 50%-90% sure but we may never reach a 100%"* The participants do in fact, think that the framework has a potential to mitigate this challenge.

The next challenge to mitigate was using *opinion instead of data*. This is a general challenge where experience is welcomed but should not replace data. As one participant said *"To have many people with diverse perspectives being part of the discussion would be very good, for example managers, developers or people in sales"*. So the challenge to mitigate is to avoid using only experience. In part 1 of the workshop where the participants tried the framework for the first they had to depend on experience. However, in part 2 they could fully base their decisions and conclusions they come to with data. In this part the participants demonstrated that combining their own experience with the provided data was crucial for reaching valuable conclusions and they did in fact, not rely solely on experience.

Lastly, there are more challenges that were found during the literature review and interviews that has not been mentioned in the results yet. These challenges have not been the focus of the framework and has therefore not been mitigated and still exists. This will be discussed somewhat in chapter 7, discussion.

6.3 Hypothesis 1

The workshop did not prove hypothesis one. There was no issues in reaching consensus on what constitutes value for the customer. There were different opinions on which potential values to continue with in the next step of the framework, although they never disagreed on what potential values were present. The participants recognized that there were many different but important values, and tried to gather diverse values from their perspectives rather than arguing about each value.

The challenge of reaching consensus is specifically noteworthy in the early stages of modeling value, where other research papers have identified it as a problematic area. Contrary to those findings, using the framework during the workshop did not introduce any of those problems during these initial stages of modeling value.

7
Discussion

In this chapter a discussion is had about many aspects of this thesis. First, we discuss the methods used for data gathering, creation of a new framework, and validation of said framework. Following that is a discussion about the empirical findings of the literature review and the interviews. Additionally, we discuss the newly created framework and the outcome of the workshop. Lastly, we discuss potential threats to the validity of the results, identified limitations of the thesis, ethical consideration, and future research aimed at improving the field of customer value and product management.

7.1 Discussion of Method

Numerous factors influence the outcomes of literature reviews, interviews, workshops, and the creation of frameworks. The effect of these factors may be positive or negative and should be taken into consideration when analyzing the result of a thesis. What follows is a discussion of the method that we utilized during the course of this thesis.

7.1.1 Literature Review

To gain an understanding of the existing frameworks and the problems that are present we first conducted a literature review. The literature review included both academic and gray literature to get a diverse mix of topics and mediums but most of the focus was put on the academic literature. We found the gray literature to be interesting and it sparked some interesting discussions. However, it might be beneficial to dedicate more effort into sourcing gray literature outside of academia to find new and insightful perspectives. The academic side of the literature review gave great insights into the problems that exist in the research area and how some of the currently available frameworks are structured and conceived. The method of finding both the academic and the gray literature was to start from five articles that were recommended to us by the thesis supervisors. We located all articles through *Google Scholar* or the *Chalmers Library*. In some cases, we followed references from these five main articles to discover additional relevant sources, resulting in a diverse collection. Although this approach was effective, it may have constrained the range of topics, potentially limiting a comprehensive understanding of the research area. Nevertheless, Google Scholar and Chalmers Library provided excellent supplementary sources for finding more recent and up-to-date articles. This adds the benefit

of understanding what the field currently looks like and what issues still exist today. Using these two methods of finding academic papers worked well for the literature review as the articles included a diverse set of papers from different authors, publishing dates, and topics. In contrast to the method used in this study, the papers could instead have been gathered based on their perceived value using the measure of citations. This would make the set of papers include a large amount of foundational papers which could show the most prominent problems and solutions that underline the research field but might miss out on some of the nuance that are present in papers discussing niche topics.

7.1.2 Participants

When finding interviewees for the data gathering phase of this study the thesis supervisors used their connection to Software Center [42]. This was a great opportunity as knowledgeable and study-relevant participants could be gathered much easier. However, this way of gathering participants introduces a few potential issues. Firstly, since all the case companies are connected to Software Center and therefore have a financial incentive to participate in the interviews to maximize the value of their membership, the results may be slightly skewed. The case companies are already interested in bettering their understanding of customer value in their organizations and therefore might have more knowledge and incentive to educate their employees in this area which can change the outcome of the interviews. However, the interviewees might be more knowledgeable and are able to give more accurate answers which is a positive aspect gained from collaborating with Software Center. The interviewees were well-versed in what particular problems their company faces when working with customer value. This deeper understanding enabled us to better craft a solution that effectively addresses the known problems. Additionally, a majority of the case companies where the participants were employed specialize in embedded systems. This means that the results might not be as general as if the participant pool was representative of the industry as a whole. It also means that the results gathered from the interviews might be specifically connected to the embedded systems domain and therefore the solution that is created based on the discovered problems may not work for all companies as desired. Alternatively, this can be seen as a benefit as the solution is created to be specialized for the embedded systems domain and may therefore work better for this subset of companies than a general solution would.

7.1.3 Interviews

When reaching out to potential interviewees the option of having the interview in either Swedish or English was offered to the participants to allow the discussions to flow more easily. This however turned out to be a mistake that increased the time spent in the transcription stage of the study. This is due to the automated transcription and translation tool. This tool uses a trained model to transcribe audio files with the option of translating from ninety nine different languages at varying capacities. Using this tool on interviews conducted in English worked almost flaw-

lessly and made the transcription highly efficient. However, when using the tool on interviews conducted in Swedish the results were not as great. The transcriptions included many errors which required us to conduct manual reviews of each of the transcriptions to edit mistakes made by the model. This added many hours of work in the transcription phase of the study that could have been avoided if all of the interviews were done in English. The use of the tool itself was a good way of increasing efficiency and to decrease the time spent on this part of the study, had the interviews all been conducted in English however, the effectiveness could have increased substantially. The next step was to code the transcriptions which was done using NVivo 20. The tool itself worked well for its purposes in this study but the results did not reveal anything that we had not understood through the interview process. However, even though the steps of transcribing, translating, and coding did not provide any new insights into the problem at hand, they did provide valuable empirical evidence which justifies the time investment.

To divide the responsibility during the interviews we took on the roles of main interviewer and secretary. Using these two roles worked well and kept the conversations going while allowing for deep understanding of the interviewees perspective and the creation of notes for later reference. As mentioned the interviews were held in the language that the interviewee preferred. By remaining flexible, the interviewees were able to express themselves more openly, using common industry specific terms and expressing themselves as they would with a colleague. While these advantages were valuable, was the study repeated, all interviews would likely be conducted in English due to the aforementioned transcription and translation considerations.

7.1.4 Framework Creation

Through studying the topics of customer value and product management a gap was revealed between the progress of academic research and industry adoption of that research. The aim of our framework is to fill this gap to allow companies to adopt new frameworks and measure the expected value of new features. For the creation of the framework we found great benefits in using a Miro board as it allowed us to create mind maps, flow charts, and timelines all in one collaborative space. Since Miro is a visual tool it allowed us to create the visualizations of the new framework at the same time as conceptualizing it. The tool allowed us to quickly start creating and changing the framework as the ideas evolved with new feedback. We received this feedback from the thesis supervisors who helped steer our framework in the direction of what was currently lacking in the field. This method worked well in our project as we could consistently check in to see if the framework had the right focus and what parts could be improved. When time started running out on the thesis the next step needed was to validate the framework.

7.1.5 Workshop Method

When designing the workshop we wanted to keep it as close to a real world application of the framework as possible. Through the use of the scenario the discussion

was continuous and the participants could engage with each other. The participants never got stuck and they noticed when it was time to move on to the next step in the process. The descriptions of each step were enough for the participants to understand what to do and for the most part they could keep to the specific task. This shows that the framework works as a good tool for guiding the users thought process. The participants often derailed the discussion, however by rereading the framework instruction they were able to bring the discussion back. Another thing that we noticed was that the participants easily started to discuss what value new features could bring to the system instead of staying on track and discussing existing features. This is something that we have encountered and we recognize how easy it is to do. Although it might be easier to discuss scenarios with measurements before and after implementation is done, this approach is not applicable when working in already implemented systems. Fortunately the participants noticed this themselves most of the time and we did not need to intervene that much in their discussions.

Using a Miro board for the workshop was a success. Since the workshop was held online, having a prepared workspace that the participants could collaborate on helped them communicate more effectively. The Miro board was also valuable to the participants since all necessary information could be kept in one place since.

The scenario used during the workshop was valuable for part 1 of the workshop since it allowed the participants to be at equal footings when working through the framework as none of them had specific or expert knowledge in the company or its products. It was also crucial for the purpose of testing and validating the later part of the framework, since the simulated data made it possible to test part 2. Using a scenario did not reveal any noticeable downsides.

The discussion questions at the end presented a good opportunity to receive feedback on the framework so far and the experience that the participants had during the workshop. It also provided us with an opportunity to understand what the participants had learned and what insights it gave.

7.2 Discussion of Empirical Findings

In the empirical findings, chapter 4, we unveil the most important challenges that hinder the industry´s adoption of new frameworks. What follows is a discussion of why these challenges are significant, why companies struggle with them, and the consequences they bring.

7.2.1 Why is the industry unaware of existing frameworks?

As mentioned in the empirical findings in chapter 4, most of the interviewees were not aware of existing frameworks that academia has produced. There are many explanations as to why this is the case. One important reason is that most embedded companies are going through other digitalization restructures and are still in that process, not looking ahead into new frameworks as of yet. During the interviews it

became clear that the use of Agile methodologies and SAFe were common, and these processes bring a lot of value. However, utilizing agile methodologies can be regarded as a prerequisite to acquire a shorter feedback loop. Working agile is one example of research results from years back that companies are still trying to adopt and perfect. Another important reason is the company culture. Some of the interviewees mentions that their management, although not opposed to change, are not yet ready to face such big undertakings. During the interviews it also became apparent that other company restructures happening can add to the difficult process of trying to adopt a framework. While companies are doing digitalization restructures, adopting agile methods and going through other company restructures or focusing on other goals, the research continues. The results are that companies have gotten stuck while research keeps going on, coming up with new ideas, trying to validate those ideas in the industry and keep failing to get the industry to adopt any new frameworks. The consequences of this gap between industry and research is that the developed frameworks that in theory should solve problems, instead are impossible to adopt since the industry does not fulfill the prerequisites to start. Furthermore, the pace of research represents a continuous challenge that keep broadening the gap and because of this the industry is not looking for new solutions since they are occupied with adopting previous ones.

7.2.2 Why do companies struggle with using data effectively?

Many of the common problems that we found during the interviews, presented in the empirical findings chapter 4, are connected to data usage. The basis of the problems lie in automatic data gathering which most embedded companies struggle with. There are different reasons for why this might be the case. One conclusion is that companies seem to be complacent with their way of doing manual data gathering. Companies perceive that they fulfill many of their needs by handling data manually. That may be true in the short run but to be able to continuously asses value over time another system is necessary. Another problem is domain specific circumstances that make it impossible to automatically gather data, one such example would be confidential information that stops the flow of data. Another example would be economic reasons of not being able to connect products to a cloud solution due to the extra costs. Although there were cases found during the interviews where automatic data gathering was implemented and actively used, it was used for analytics rather than to validate customer value.

The next problem is how to use existing data effectively. We found that even though some companies had the possibility to access data, they were unable to base their features or products on any data. One reason is that companies struggle with connecting those key value factors to features and products. We perceive that companies are missing a quantifiable way to prove how features affects value. Hence, they often struggle to grasp the value of a feature, contributing to the development of numerous unused features. One reason that companies are unable to prove feature value could be that they are lacking a way to define such metrics. Many of the key value

factors that the interviewees mentioned were based on experience in comparison to key value factors that have been proven successful by the use of data. Being able to use the quantifiably proven factors and understanding how these factors affect the customer is one key to developing new features or improving existing features to deliver continuous value. Another challenge of working with key value factors is how to prioritize them, which is a direct symptom of not being able to define those factors and not working with metrics in a quantifiable way.

From the interviews we know that companies struggle with defining key value factors. Therefore it becomes very difficult to calculate the expected value of new features. Those answers were somewhat expected since this step is connected to the early parts of some of the academic frameworks. This is especially prevalent in data-driven development and value modeling. This served as a confirmation of what companies were able to achieve using their data. During the interviews, discussions surrounding how to calculate the economic value of a feature or product were brought up. We recognize that this could serve as a metric for assessing the performance of a feature although this is not the customer-centric metric that we were looking for. What we have seen is that companies start falling into the trap of using experience when they are lacking ways to quantifiably prove customer value with data or metrics. Experience is very important but should not act as a substitute to data. Delivering continuous value to customers becomes very difficult to do if decisions are not backed up by data. Therefore collected data should be more valued than experience. Companies can become complacent with their expertise-based decision-making and reluctant to change their ways towards a more data driven method.

The last problem specifically connected to data gathering and usage of data is validation of customer value. Validation is an extremely important part of understanding customer value in general. Without doing any validation companies are unaware of how features or products affects customers. Automatic validation is the ideal and most effective way to perform validation. This can be achieved in different ways, for example, looking at customer behaviour, usage analytics, customer feedback, or support tickets. During the interviews we found that the kind of validation that is done in embedded companies is limited to manual validation or no validation at all. Manual validation is not a time efficient nor reliable way of doing validation and could even require a full-time manager, as one interviewee explained. One reason that manual validation is performed is because companies are lacking automated data gathering systems that are needed to perform automatic validation. With that said, the absence of validation is more problematic. If a company is unaware of what effect a feature has on a system they will not be able to continuously deliver value to customers in the long run. Therefore the goal should be to reach a stage where automatic validation is possible.

7.2.3 What are the consequences of companies struggling to understand what constitutes value?

Understanding what constitutes value is one of the biggest problems when it comes to working with value. When companies struggle with understanding what constitutes value, they also struggle to connect value to features or products in a system. This renders companies unable to improve the value of said system. To us, addressing this issue represents one of the initial steps towards effectively engaging with value.

Throughout this section we have discussed different ways data gathering and data usage impacts existing challenges seen in the industry. How it acts as the basis to many of the challenges that were found. Although we would like to solve them all we have decided to focus specifically on understanding what constitutes value. Additionally, we will focus on how to better understand, measure, and validate customer value through a series of stages presented in chapter 5, framework. Instead of trying to solve automatic data gathering and data usage, which is very problematic and depends on many more factors, we focus on providing a method to better understand and work with value. This is done by creating hypotheses and validating them using metrics, thereby associating certain values to features or products. In the next section we will further explain the choice to put our focus on understanding and working with value. Additionally, we explain how the framework can help improve the way companies work with customer value. We also discuss how it could assist in transferring their new knowledge of value and metrics into other frameworks, as well as improving their future decision-making.

7.3 Discussion of Our Framework

As is visualized in figure 5.2, our framework is positioned in an area of this field that is largely overlooked when creating frameworks. Our framework is made to help companies understand what value their features and products bring to the customers. We chose to make this the focus of our framework after conducting the interviews where many of the participants struggled with specifying what factors were the most important to them. As presented in section 4.4, many interviewees either did not know what their most important factors were or had their own definitions that were brought about from their own experience and beliefs. These findings proved to us that there is a fundamental problem with the understanding of value in industry. This made us realize that one of the first steps in some of the existing frameworks, to define key value factors and to calculate the expected value, is too difficult for many companies to complete. This hinders them from being able to gain the benefits of introducing these value based frameworks. The framework that we developed is therefore meant to bridge this gap and allow companies to move towards value based decision making.

There are a number of benefits that come with the adoption of our framework. Once a company has worked with our framework for a number of iterations and gained

a good understanding of the value their feature, product, or system provide they can start to see results. First, once the framework has been iterated through an understanding of what constitutes value has hopefully already been reached. This can be used when adopting one of the many frameworks that needs the user to define a number of key value factors, since our framework facilitate the understanding of factors like these. Additionally, there are already metrics in place to measure these key value factors that can be used in other frameworks. It is also possible to return to our framework at any point if there is a need to find or create new metrics.

As described in chapter 5.2 there are four levels of measurement, these should be considered when using our framework. In the case of our framework these have an order of importance and usefulness when trying to measure value creation. Most valuable is results found in the interval and ratio categories to gain specific and tangible numbers for the value of a feature, product, or system. This is a concept that is very hard to incorporate into the framework since many companies struggle with quantifying their data, this is discussed in section 7.8, future work, as well.

Our framework is highly flexible to the needs of the company as it can be applied to any level of the hierarchy of work items. For instance a team or product manager can start with an epic level work item and then work down to each feature level work item. In this case the first iteration would increase understanding of the epic level work item while the next iterations would give insight in how each of the smaller parts of it provides customer value. This process can be done in either direction, up or down the levels of work items as needed making the framework easier to adapt and use according to the specific needs of a company. Having the option of working in either direction of the hierarchy is better suited for application in real world scenarios. For example, if a small amount of employees wish to implement this framework in their context at a company they could start with work items at the level of which they have influence. They can then work towards moving the practice higher up in the company and use their iterations of the framework as a basis for future and higher level iterations. The data expands with each iteration and collects in the centralized location where it can be analyzed, visualized, and used to inform future decision-making.

There are still some disadvantages with this framework. Firstly, its very nature as a framework presents a challenge since there are numerous frameworks available in the field of product management that companies already struggle to adopt and this is an addition to that list. Although our framework is focused on a more niche part of the process the company still has to learn, understand, and implement the steps to see any benefit. The second disadvantage is that the real value of the framework comes from working through the framework multiple times. This makes it harder to see the benefits of the framework and may cause some companies or teams to give up on the process before realizing the benefits. The third disadvantage is that the time to iterate through systems can be exponential to the amount of levels in that system. For each level there is usually multiple children features that can be iterated through if a company wants a full overview of the whole system. This would take a

large amount of time since many iterations need to be worked through. However, it is still possible to get a comprehensive overview without iterating through all work items in a system. By reasoning about value using the accumulated understanding gained from many iterations companies can avoid the exponential work load.

Creating a large amount of hypotheses and metrics that are measurable when following the process outlined in our framework introduces the risk of human or measurement errors. There might be hypotheses that seem to be validated by flawed data that is then added into the collection of successfully hypotheses. This is a false positive outcome that could ruin the integrity of the results. We made sure to bring this concern up to our supervisors and then tried to mitigate the issue through dividing the step of validating the hypotheses into two new ones. The first of these is to validate the experiment that is done for hypothesis validation and the second one is to reflect and discuss the result of said experiment. This was done in the hopes of allowing the users to catch these false positives through discussion and reflection of their experiments. The opposite issue also has the potential to arise when working through the framework. Namely finding false negatives, dismissing a hypothesis that was true because the evidence did not prove convincingly enough. However, we did not find this problem as serious as the last since finding a false negative does not have any other negative effects on the accumulated understanding of value than missing one factor. Though the implemented solution to remedy the first issue may prove valuable to catch this exception as well.

When adopting and working through this framework the opportunities to adopt other value based frameworks become available. This allows companies to use our framework as a stepping stone towards established value-centric frameworks. This positioning was chosen because of the coverage of the current frameworks. We saw that there was a gap between the digitalization of a company and the adoption of data- and value driven frameworks, and the focus was therefore on bridging this gap. This allowed us to focus on a smaller niche and provide a more specialized solution. This means that our framework does not try to reinvent the wheel when it comes to value based development but instead that we provide tools to reach a point where it is possible to adopt data- and value-driven frameworks. The accumulated knowledge discussed in this section is also valuable when adopting other frameworks. This is exemplified in the article Make Up Your Mind, where one company with a large number of metrics and data could predict the value of all new features through models that use this data [4]. Although, in this example the company had a few advantages over the case companies in this report since they are not working with embedded systems, making their data gathering and analysis more streamlined.

In chapters 4 we presented the discovered challenges, while in chapter 5, we detailed those mitigated by the framework. However, some challenges were left unaddressed. We encountered difficulty in finding a single solution to resolve all problems due to their complexity and dependence on various factors. The challenges also include many domain specific problems that we are unable to "solve", such as confidentiality stopping the flow of data and economic factors hindering the possibility of connect-

ing components to cloud solutions. However, the framework is indirectly mitigating some of the challenges connected to the industry not knowing about existing frameworks. As mentioned before, step 9 of the framework has an overlap with other frameworks where users start calculating the expected value of new features. While our framework does not directly inform users about other frameworks, it does make the transition smoother.

7.4 Discussion of Workshop Results

Overall the workshop turned out to be a great way of validating our framework and each step fulfilled its purpose. The participants seemed to find the framework useful for understanding and working with customer value. The participants also realized the benefits of understanding the value that a product delivers to a customer. One of the participants commented, *"I absolutely think that this framework can help and I like that if we prove a hypothesis false we have the option of going back."*. Another said that *"This has been really great. I like that it's not a paper prototype, you can follow the actual steps and work with it."* expressing the appreciation for a tangible process to follow.

In part one of the workshop the discussion flowed freely and the personal experience of the participants worked well to brainstorm different potential values. It seems as if it was easier for the participants to rely more on their personal experience than to rely on data in the early iterations of the framework. When users have worked with the framework for a longer time and gone through multiple iterations, they have created a database of knowledge and the reliance on data is more feasible. During part one, the participants often returned to a discussion about new features that could be implemented. This is probably due to the scenario and the nature of not knowing about the product or feature beforehand, therefore the participants needed to discuss how these features could be further developed in the system to understand their potential applications. This was not what was originally intended with the framework but worked as a good way to start the discussion about value. Once they had figured out some potential applications for the features they could shift the discussion towards the value these features bring. Therefore, this still demonstrated how the framework can be utilized, although it was not used as originally intended since it needed adaption to fit the scenario.

In the first steps of the framework that regard the creation of hypotheses the outcome was slightly different from the expectation. When creating the framework we imagined specific hypotheses such as *"We believe that users with Alexa or Google Home will integrate their voice assistants with the home assistant SmartHub."*. Instead the participants created a more general verbal hypotheses. Even though this was not the original intention, it worked great during the workshop and it turned out to be an effective way of developing metrics in the subsequent step.

Additionally, the framework is not concerned with the specific method used to develop metrics. What matters is arriving at a set of metrics and hypotheses. It is

only beneficial to the framework that unexpected approaches to achieving the goal can arise, as it allows the users to adapt to the framework in a way that better suits their specific needs and unique demands. This highlights the framework's role as a guide rather than a rigid set of rules.

In part two of the workshop the participants discussed and decided on accepting or dismissing the hypotheses using data. One interesting discussion they had was when one of the participants reasoned that *"Dismissing a hypothesis is always 'safe' [as opposed to accepting it], you can always continue with new hypotheses or metrics"*. If the user is unwilling to accept a hypotheses for various reasons, it may in fact be appropriate to consider dismissing it. However, if the risk of accepting an hypotheses and being wrong is too high, a problem may arise where more hypotheses are dismissed then necessary. During the workshop the participants also discussed the difference between the two hypotheses they worked with and why they reached their conclusions, accepting the first one and dismissing the second. Except the difference in data quality, they discussed the fact that the second hypotheses included a threat level that was different from the first one. Which raised their awareness to the risk of accepting this hypotheses and the potential impact of getting it wrong. This suggests that different contexts surrounding hypotheses can unconsciously influence decisions. While being aware of this problem can help avoid it, it may still go unnoticed.

Another interesting discussion that the participants had was something that we had discussed as well, is if a hypotheses should have a success criteria or not. While discussing the data one participant said that *"Yes, the feature is popular, but do we really have increased convenience and effectivity? What are we aiming for? A 100% is what you would like to have but maybe 95% is enough"*, in some cases, a hypotheses may require a specific success criteria to be validated. It can be difficult to know what level of satisfaction is good enough and to interpret certain values, such as user feedback. The participants continued with this discussions and turned it around, saying *"50 times the assistant gives a really bad answer[compared to ca 300 good answers], is that really okay?"*. In this case it involves establishing a negative success criteria where the number of unfavorable outcomes does not exceed an acceptable threshold. Establishing a success criteria depends on the hypothesis and its objectives. However, it can be useful to have this as an additional tool when creating hypotheses.

During the discussion questions at the end of the workshop we got some feedback on how to improve the framework. Generally they thought that the framework was good and that they saw the advantages of working with it. However, they were concerned with step 8a. The argument was that *"It might be possible that the hypotheses is good but the metrics used were not enough"*. This means that instead of going from step 8a to step 2 where the user recreates the hypotheses they would instead go to step 3 and redo the metric identification and creation. We thought that this was a very welcome addition and a possibility that we had not thought of so we added that to the framework. One of the participants also realized during the

workshop that *"we are looking for metrics first and then trying to find a hypothesis to it, this is possibly the wrong way"*, although it is wrong when looking simply at the framework it is important to remember that the framework exists as a guide and to use the framework and to make exceptions when necessary is in no way "wrong". Therefore we did not change the framework in regard to this but it was a valuable insight to the usage of frameworks in general.

When it comes to hypotheses 1, we came to the conclusion that the participants of the workshop did not experience any challenges with reaching consensus on what qualifies as value when using the framework. In contrast to our results the literature study suggested that this should be a bigger problem. However, those findings suggested that stakeholders face these challenges while trying to calculate the expected value of new features rather than proving the existing value of already implemented features. The problem might still exist in step 9 which we have not been able test. However, experiment results and accumulated knowledge from using our framework has the potential to mitigate this problem since the expected value can be based on data and not only subjective ideas and experience.

7.5 Threats to Validity

There are a few factors that may impact the validity of the results of this thesis. First of all, as stated in the discussions about the interviews and the literature review in section 7.1 there is a potential for biased and skewed results. This could lead to our framework mitigating the wrong issues.

The next factor, and arguably the most important one is the fact that our framework accumulates knowledge over time. During a workshop it is not possible to validate that part of the framework since it requires real world application over an extended period of time. Another threat to the validity of our framework is the fact that all of the steps are not testable in a fictive scenario and therefore a complete overview of the framework can not be reached during a workshop. Additionally, the amount of participants during the workshop may result in insufficient validation results. Furthermore, conducting the workshop online has the potential to lead to a different outcome than an in-person workshop because of the digital, less natural, setting.

The quality of the framework is somewhat based on the amount of iterations of feedback that could be done. Feedback was received from our supervisors on each version and from the validation workshop. Since there was only time to conduct one workshop this might have impacted the final version of the framework which in turn impacts the end result of the thesis. Conducting more than one workshop could lead to a more polished and applicable framework but due to time constraints this was not possible.

7.6 Limitations

There are many parts of writing a masters' thesis that constrain the scope. The largest of which is the time constraint of 18 weeks. The scope was adapted to this limitation to ensure that the thesis was completed in time and a conclusion could be reached. With the time constraint came a limit to the amount of iterations of feedback we could do on the framework as well as the amount of validation workshops that could be conducted.

Conducting interviews and workshops with professionals in industry introduces some variability since the thesis topic needs to be interesting enough for professionals to want to participate and provide their time and expertise. The outcome of the thesis is also somewhat dependent on what the interviewees see as problems and what domain specific problems might be present. This introduces some difficulties in determining what is relevant for the solution which has the potential to be made more general or specific to a domain. Additionally, the workshop heavily depended on the participants who were willing to join. Different compositions of job positions, companies, and domains might result in vastly different feedback and outcomes.

During development our framework was limited to the knowledge and perspectives of our supervisors since their feedback was the main factor to improving the framework. The framework only had one instance of feedback from the industry, which was during the workshop. This means that there might be a certain degree of disconnection between the framework and its real-world application, despite the knowledge possessed by our supervisors.

The specifics of a given phase was highly dependent on the phases preceding it. Phase two for instance was dependent on the knowledge gained and problems revealed during the interviews and the literature review. The quality of the framework was dependent on the amount of iterations of feedback and validation that time allowed for. Phase three was dependent on the framework created in phase two since that was the focus of the validation workshops.

7.7 Ethical Considerations

The ethical considerations of this thesis are slight but important. The main concern is the confidentiality of the interviewees, workshop participants, and the data they provide. If the confidentiality of the answers are not explicitly expressed the participants will not be able to speak freely without self-censoring sensitive information or beliefs. Therefore the interviews all contained a clear explanation of how the data was to be used as well as who would have access to it. The data of the interviewees will remain anonymous in the report and will not be discussed with anyone except the thesis supervisors. In the report the companies were represented using general terms explaining their industry area and expertise without mentioning any company names. Additionally, each participant was only described using their

connection to their company as well as their general title and role in the company. No personal information was used and no particular answers can be traced back to the interviewees, keeping the promise of confidentiality.

7.8 Future Work

The findings of this study are not final and there is much to be done in the field of customer value and product management. As the literature review revealed, there are many problems in the field. While solutions have been developed to mitigate the issues, the interviews showed that many still remain. Even though there are a plethora of high quality and smart solutions out there, companies have a hard time adapting them into their own situations. This shows that more solutions to bridge the gaps and assist companies in adopting these frameworks are needed.

As mentioned in section 7.3, Discussion of our framework, one disadvantage of our framework is the exponential work that is required to iterate over a whole system, especially for large systems. Finding a solution to this challenge could be a great step towards getting more companies to adopt our framework. This could be done in a number of ways such as finding out the optimal amount of iterations and at what hierarchical level the framework should be applied to maximize benefit while minimizing time spent. This contribution may be feasible once the framework has undergone rigorous testing in real world scenarios.

Another important aspect to mention is the levels of measurement, particularly regarding the results. Our framework does not force the user to measure the results in any specific way, even though we mention that there is an order of importance and usefulness to it in section 7.3. If the results could be measured at the interval or ratio level the results would have a much clearer quantifiable value. It is currently fully possible to reach a more useful level of measurement with our framework and we recommended the users to do so if possible. However, we are not providing any guidance on how to do it since it is a big challenge that we did not have time to solve during this thesis. Therefore some further research could be done in this direction.

Lastly, it might be beneficial to try to merge our framework with other frameworks that starts with defining key value factors or calculating expected value. Doing a collaboration to merge our framework into the start of another may lower the barrier to entry for companies that want to adopt a more value-centric way of working. Adopting one framework that is longer could be easier than adopting two separate frameworks. Since our framework is a precursor to many other frameworks it could integrate as the first part of an existing and more established framework.

8

Conclusion

The aim of this thesis was to create a new framework to mitigate some of the challenges found in the field of customer value and product management. To identify challenges (RQ1 & RQ2) we performed a literature study and interviews with professionals in the industry. The framework was developed based on these findings. The goal of the framework was to better understand what constitutes value, focusing on existing, already implemented features, products, and systems. The users of the framework are able to identify and create hypotheses and metrics to conduct experiments upon to gather results about the value of work items. The accumulated knowledge of these results are then used to predict expected value of new work items. A workshop was then conducted to validate our framework (RQ3), testing the framework and gathering feedback from professionals in the industry. The key findings of the workshop was that the participants were able to better understand what constitutes value by using our framework. They were able to reflect on experiment results and draw conclusions about values, showing that by following the steps of the framework they were mitigating the challenge connected to understanding what constitutes value. The participants demonstrated that by integrating experience in the first half of the framework and combining it with data in the second half was what made it possible to quantifiably prove what constituted value. The participants also provided important insights on how the results of the workshop could be used to inform future-decision making and how it can mitigate the challenge of calculating the expected value of new work items. However, participants noted that this calculation is not a 100% accurate and should be an indication that the work item can potentially provide a certain value.

The result of the workshop was very positive and indicated that our framework was a useful guide for users to better work with value. More importantly, the results indicated that the framework successfully addressed many of the challenges it was designed to mitigate, which is our main contribution to the field. Furthermore, our framework not only operates independently but it also facilitates a smoother transition towards other frameworks, signifying another noteworthy contribution to the field. It is also important to highlight that the framework functions as a guide, rather than a rigid set of rules.

Although the results have been positive, it is important to acknowledge the limitations of this study, the main limit being the time constraint. Exploring the potential of iterative improvements and validating the framework through multiple workshops could have led to even more promising results. Moreover, the framework still faces

certain challenges such as utilizing levels of measurement, regarding the results. Future work should prioritize the development of methods to translate experimental results into numerical, quantifiable values at the interval or ratio level. Another possible area for future research is the development of methods that streamline automatic data gathering and validation. Despite it being one of the most significant challenge that we encountered, it was not the primary focus of our study and requires further exploration.

Throughout this study we have developed a new framework with a deliberate emphasis on ensuring that its initial complexity is approachable, setting it apart from many existing frameworks with rigorous prerequisites and challenging adoption processes. Therefore the framework has a potential practical application in industry. The next stage in the evolution of this framework would involve having a company adopt the framework and follow that company over an extended period of time to asses the long term results of the framework.

In summary, our framework offers a solution to key challenges found in the field. The validation workshop yielded positive outcomes and the participants recognized the potential benefits of implementing our framework. By introducing this framework to the field of customer value and product management, our framework streamlines companies' understanding of what constitutes value and enhances their ability to continuously deliver customer value.

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A

Appendix

Introduction:
We are currently doing our last year of masters studies in software engineering and technology at chalmers. We are writing the thesis in collaboration with Software Center together with our supervisors Jan Bosch and Helena Holmström Olsson. We have both been interested in the development process side of SE through our studies and we met each other in courses that taught those theories.

As we were taught by Jan and Helena about the problem with wasted resources in companies through unused features and R&D efforts that don't lead anywhere, specifically in the early stages of the planning and evaluation of new features where there seems to be difficulty defining value. This is what the thesis is aiming to mitigate through an improved method of defining customer value.

So far we have done part of our literature review on the topic to understand the academic view of the problem but we also want to understand the real-world application of the methodologies and to gain more perspectives by interviewing key persons with relevant roles in industry such as you.

The interview will be semi-structured which means that we have some questions prepared but we are happy to discuss things of interest when they come up and let the discussion flow more naturally. I am going to be the one running the interview and Lukas will be taking some notes and asking follow up questions.

The plan for the interview is that we will record audibly and the interview will then be transcribed and coded to gather the best qualitative data that we can get out of it. The recordings and transcriptions will only be accessible to the two of us but may be discussed with our supervisors Jan and Helena. In the report no names will be revealed. A general description of the company work may be used with relevant info such as if it is embedded, online, or on premise.

Interviewee introduces himself
With that said,

Could you tell us a little about yourself? Your role and responsibilities in the company, what you are working with at the moment, best thing about working at the company.

-

Could you tell us a little about the company? Key areas? Company structure? Biggest customers? Company culture?

-

Could you tell us a little about the team that you work with/in? Size? Roles? Tools? What customer?

-

What development methodologies do you use? Agile/waterfall? How do you prioritize features?

-

What is the companys'/team's relationship to the customers? How often do you meet?

-

Main interview:

Now we are planning on getting into more technical details of the work that you do. We would like to start with some discussion about the company's digitalization efforts and your use of data. I would like to specify that when we are talking about data what we are most interested about is user behavior or feature usage rather than user information.

Could you tell us a bit about automatic systems that the company or your team uses to collect data? How do you gather data? What data do you gather? (From whom do you gather data?)

-

Could you tell us more about how you work with your data? Are you able to efficiently use your data? What are some challenges with using your data? Is there an infrastructure in place to store the gathered data?

-

How do you use data for quality assurance and diagnostics?

-

How do you use data to help improve features, functionality and performance?

-

Okay, let us move on from digitalization efforts to some questions about your development

How does the company and your team work with DevOps? If not, why?

-

What benefits do you see from working with DevOps? What are some of the benefits you have seen in terms of customer value delivery? What are some challenges you have faced?

-

Can you tell us about how your team decides what new features to develop, are you using data to support your choices? What are some of the challenges with this way of development?

-

Do you calculate the expected value of features in any quantifiable way? Why/why not?

-

Are you using any methods to more efficiently use data to guide your development? Iterative development approaches? Dividing features into smaller slices? Shortening feedback loop?

-

Now that we understand your development strategies better we would like to know more about how you work with customer value delivery and validation.

Can you tell us about how you define customer value? Does it differ between company/team/individual levels?

-

How are you currently working towards improving customer value delivery?

-

Can you tell us about how you validate customer value? Are you using any specific methods such as A/B testing?

-

Have you defined any key values or most valuable metrics that you are working to improve? How do they differ between the team/system/company level? Are they based on data? How are these metrics measured in a quantifiable way?

-

How do you prioritize these metrics?/How do you prioritize features? Any systematic process? Are you using a Northstar metric? How are you working towards getting consensus within the team?

-

How does your way of working with value change over time? How are you working to understand how value evolves? How do your metrics change over time?

-

Is the company/your team actively working with any other framework that we have not talked about so far to maximize customer value delivery? Is there something that you do that works particularly well to deliver customer value? Maybe value modeling?

-

Yes:
In what context are you using this framework? In what step of the development process is this framework used? At what level of the organization? How does the framework relate to customer value?

-

Tell us more about your process of adopting this framework? How does the framework deal with defining customer value?

-

What can be improved in the process of adopting the framework?

-

What are some of the challenges that you have noticed when working with the framework?

-

→

Have you tried to adopt any frameworks to maximize customer value delivery that failed? Why did it fail?

-

Is there something in the company that is stopping you from adopting certain frameworks? Domain specific reasons? Politics? Difficulty defining key value factors?

-

Conclusion:

Now we are starting to reach the end of this interview but we would also like to know a bit more generally

What benefits have you seen through working with new ways of delivering customer value? Customer satisfaction? Revenue? Feature usage? Resource management? Saving time?

-

(for us) Any questions that we might not have gotten an answer to? Ask them now.

Is there anything that you think we missed that might be important to mention or anything that you wanted to ask us about?

-

Thank you so much for your time and participation!

B

Appendix

Introduktion:
Vi går nu sista året på vår master inom software engineering and technology på Chalmers. Vårt examensarbete skriver vi i samarbete med Software Center med hjälp av våra handledare Jan Bosch och Helena Holmström Olsson. Vi har båda varit intresserade av utvecklingsprocessen inom programvaruteknik genom våra studier och det var så vi träffade varandra.

Jan och Helena introducerade problemet om hur mycket resurser som kastas bort i företag genom att utveckla funktioner som går oanvända och forsknings- och utvecklingsinsatser som inte leder någonstans. Detta verkar vara ett särskilt problem i de tidiga stadierna av planeringen och utvärderingen av nya funktioner samt att det verkar finnas svårigheter med att definiera värde. Målet med vårt examensarbete är att försöka utveckla och förbättra metoder för att definiera, arbeta med, evaluera och validera kundvärde.

Hittills har vi genomfört en del av vår litteraturstudie om ämnet för att förstå det akademiska synsättet på problemet, men vi vill också förstå de verkliga tillämpningarna av metoderna och få fler perspektiv genom att intervjua nyckelpersoner med relevanta roller inom branschen, såsom dig

Intervjun kommer att vara semistrukturerad, vilket innebär att vi har förberett några frågor men vi diskuterar gärna ämnen av intresse när de dyker upp och låter diskussionen flöda mer naturligt. Jag kommer att hålla i intervjun och Lukas kommer att vara med och anteckna och ställa lite följdfrågor.

Planen för intervjun är att vi kommer att spela in intervjun för att sedan kunna transkribera den och samla in den bästa kvalitativa datan vi kan få ut. Inspelningarna och transkriptionerna kommer endast att vara tillgängliga för oss två, men kan komma att diskuteras med våra handledare Jan och Helena. I rapporten kommer inga namn att avslöjas. En allmän beskrivning av företagets arbete kan komma att användas.

intervjuperson introducerar hen själv
Med det sagt,

Kan du berätta lite om dig själv? Din roll och ansvarsområden i företaget, vad du arbetar med för tillfället, det bästa med att arbeta på företaget?

-

Kan du berätta lite om företaget? Nyckelområden? Företagsstruktur? Största kunder? Företagskultur?

-

Kan du berätta lite om det team du arbetar med/i? Storlek? Roller? Verktyg? Vilken kund?

-

Vilka utvecklingsmetoder använder ni? Agil/vattenfall? Hur prioriterar ni funktioner?

-

Vad är företagets/teamets relation till kunderna? Hur ofta möts ni?

-

Huvudintervju:

Okej, då tänkte vi gå in lite mer på de tekniska detaljerna kring arbetet du utför. Vi skulle vilja börja med en diskussion om företagets digitalisering insatser. Jag skulle vilja specificera att när vi pratar om data så är vi mest intresserade av användar beteende och funktionalitets användning snarare än information om användaren.

Kan du berätta lite om de automatiska system som företaget eller ditt team använder för att samla in data? Hur samlar ni in data? Vilken data samlar ni? (Från vem samlar ni in data?)

-

Kan du berätta mer om hur ni arbetar med er data? Lyckas ni med att effektivt använda er data? Vilka utmaningar finns det med att använda er data? Har ni infrastruktur på plats för att lagra data som ni samlar in?

-

Hur använder ni data för kvalitetssäkring och diagnostik?

-

Hur använder ni data för att förbättra funktioner, funktionalitet och prestanda?

-

Okej, låt oss gå vidare från digitaliseringsinsatserna till några frågor om er utveckling.

Hur arbetar företaget och ditt team med DevOps? Om inte, varför?

-

Vad ser du för fördelar med att arbeta med DevOps? Finns det några fördelar ni sett kopplat till kundvärde? Vilka utmaningar har ni stött på?

-

Kan du berätta för oss hur ditt team beslutar vilka nya funktioner som ska utvecklas? Använder ni data för att stödja era val? Vilka utmaningar finns det med er utvecklingsmetod?

-

Beräknar ni det förväntade värdet av funktioner på något mätbart sätt? Varför/varför inte?

-

Använder ni någon metod för att mer effektivt använda data för att leda beslut i utvecklingsprocessen? Iterativa utvecklingsmetoder? Dela upp funktioner i mindre delar? Förkorta feedback cykeln?

-

Okej, då skulle vi vilja gå vidare till ämnet kundvärde och prata lite om vad ni använder er av metoder för att definiera, arbeta med, evaluera och validera kundvärde.

Kan du berätta för oss hur ni definierar kundvärde? Skiljer det sig mellan företags-/team-/individnivå?

-

Hur arbetar ni för närvarande med att förbättra kundvärde?

-

Kan du berätta för oss om hur ni validerar kundvärde? Använder ni några specifika metoder, som till exempel A/B-testning?

-

Har ni definierat några nyckelvärden eller mest värdefulla mätetal som ni arbetar med att förbättra? Hur skiljer de sig mellan team/system/företagsnivå? Är de baserade på data? Hur mäts dessa mätetal på ett kvantifierbart sätt?

-

Hur prioriterar ni dessa mätetal?/Hur prioriterar ni funktioner? Finns det någon systematisk process? Använder ni er av en "Northstar"-mätetal? Arbetar ni med att få konsensus inom teamet? Hur?/Varför inte?

-

Hur förändras ert sätt att arbeta med värde över tid? Hur arbetar ni för att förstå hur värde utvecklas? Hur förändras era mätetal över tid?

-

Arbetar företaget/ditt team aktivt med några andra tekniska lösningar som vi inte har pratat om än för att maximera kundvärde? Finns det något specifikt ni gör som fungerar särskilt bra för att förbättra kundvärdet?

-

Ja:
I vilket sammanhang använder ni dessa tekniska lösningar? Vid vilket steg i utvecklingsprocessen används dessa tekniska lösningar? På vilken nivå i organisationen? Hur förhåller sig de tekniska lösningarna till kundvärde?

-

Berätta mer om er process för att anta detta tekniska lösningar? Hur hanterar de tekniska lösningarna definitionen av kundvärde?

-

Vad kan förbättras i processen för att anta dessa tekniska lösningar?

-

Vilka är några av utmaningarna som du har märkt när du arbetar med dessa tekniska lösningar?

-

→

Har ni försökt anta några tekniska lösningar för att maximera kundvärde som har misslyckats? Varför misslyckades det?

-

Finns det något i företaget som hindrar er från att anta vissa tekniska lösningar? Domänspecifika skäl? Politik? Svårigheter med att definiera nyckelvärdesfaktorer?

-

Sammanfattning:

Nu börjar vi närma oss slutet på intervjun så vi skulle vilja veta lite mer generellt om

Har du sett några fördelar på företaget och i teamet genom arbetet med nya sätt att leverera kundvärde? Kundnöjdhet? Intäkter? Mer användning av funktioner? Resurshantering? Tidsbesparing?

-

(För oss) Om det är något vi tycker att vi har missat så ta det nu

Är det något som du tycker att vi har missat som du tror skulle kunna vara viktigt att nämna? Har du några övriga frågor?

-

Tack så mycket för att du har tagit dig tid att vara med!

C

Appendix

Workshop Guide

The goal of this workshop is to understand how the framework works in practice and to find areas where we could improve it to make it easier to understand and use.

In part 1 you will collaborate and come up with your own hypotheses and metrics depending on what work item you choose. Since we cannot implement anything today you will also have a discussion of possible ways to measure this.

In part 2 you will get access to some hypotheses, metrics and experiment results and reflect on those and discuss if they prove or disprove the hypotheses

Scenario:

Part 1: Step 1-4 of the framework

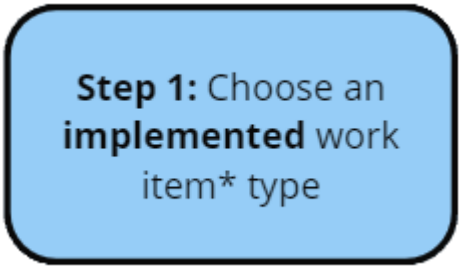
Welcome to the Product Management Workshop for Embedded Systems! Today, you are all taking on the role of product managers at TechGenius AB. Your task is to navigate through a simulated scenario using the provided framework as a guide. TechGenius AB works with embedded systems that specialize on their flagship product *GeniusHub*, a Home Assistant Smart Hub.

Product overview:
The GeniusHub is a central control unit designed to streamline smart home devices and services. It boasts advanced features such as voice recognition, AI-driven automation, and compatibility with a wide range of smart devices. From adjusting lighting and temperature to managing security systems and entertainment, the GeniusHub offers unparalleled convenience and efficiency for homeowners.

Current Situation:
Recently, TechGenius AB. has faced challenges in maintaining its competitive edge in the rapidly evolving smart home market. New players have entered the arena, offering similar products with innovative features and aggressive pricing strategies.

Step 1

The first step of the framework is to choose a work item that you want to work with for this iteration. Below is a list of already implemented epics and features. Choose one epic or feature, which hierarchy level you choose does not matter. Choose one that piques your interest and move to step 2.



Epic 1: Enhance User Experience with Voice Control

- **Feature 1**: Voice Recognition Technology (e.g., Amazon Alexa, Google Assistant) that allows users to control smart home devices via voice commands.
- **Feature 2**: Custom voice commands for common home automation tasks, such as adjusting lighting, setting thermostat temperature, or activating security systems.

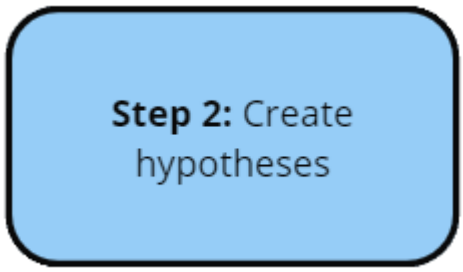
Epic 2: Automated routines

- **Feature 1**: Artificial Intelligence algorithms that learn user preferences and automate routine tasks based on behavior patterns.
- **Feature 2**: Allow users to create customizable automation routines through a user-friendly interface, allowing users to set schedules, triggers, and conditions for automated actions.

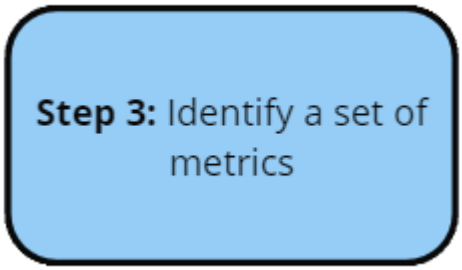
Epic 3: Remote control

- **Feature 1**: Allows users to remotely monitor and control smart home devices via the GeniusHub mobile app, allowing users to manage their home automation system from anywhere with an internet connection.
- **Feature 2**: Real-time notifications and alerts for important events (e.g., motion detected, door unlocked), ensuring users stay informed and can respond promptly to security or environmental changes.

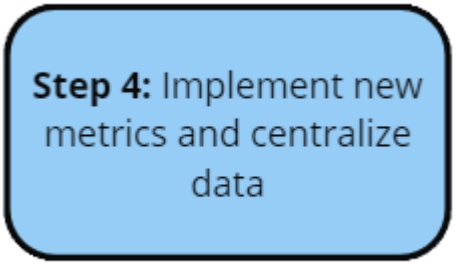
Step 2
Create hypotheses of what value the chosen work item provides to the customer. What benefits do customers receive from the work item? Discuss and formulate hypotheses. Remember that the work item is already implemented in the system.



Step 3
Choose at least one of your hypotheses (you can come back and choose another if there is time) and create a set of metrics that can measure this hypothesis. In a real-world system some metrics might already be defined. However, in this scenario we focus on creating new metrics.



Step 4
Discuss ways in which you can collect data on these metrics. In this scenario we are not able to implement any metrics or collect data but we would like for you to still discuss how it could be done.What kind of data could be useful to measure?



Examples of useful ways to collect data from our literature study and interviews:

Usage analytics:
Data collected on how users interact with the system/product for example, time spent on page, conversion rates, clicks etc.

Customer behavior:
Understand broader patterns of behavior, preferences, needs, and motivations that drive customer actions and decisions. For example, purchase history, browsing history and cart abandonment.

Customer feedback:
Direct feedback from customers, this can be gathered directly from the customers through for example, forms or surveys to gain insights on specific areas.

Support tickets:
Tickets sent by customers containing issues that they have encountered.

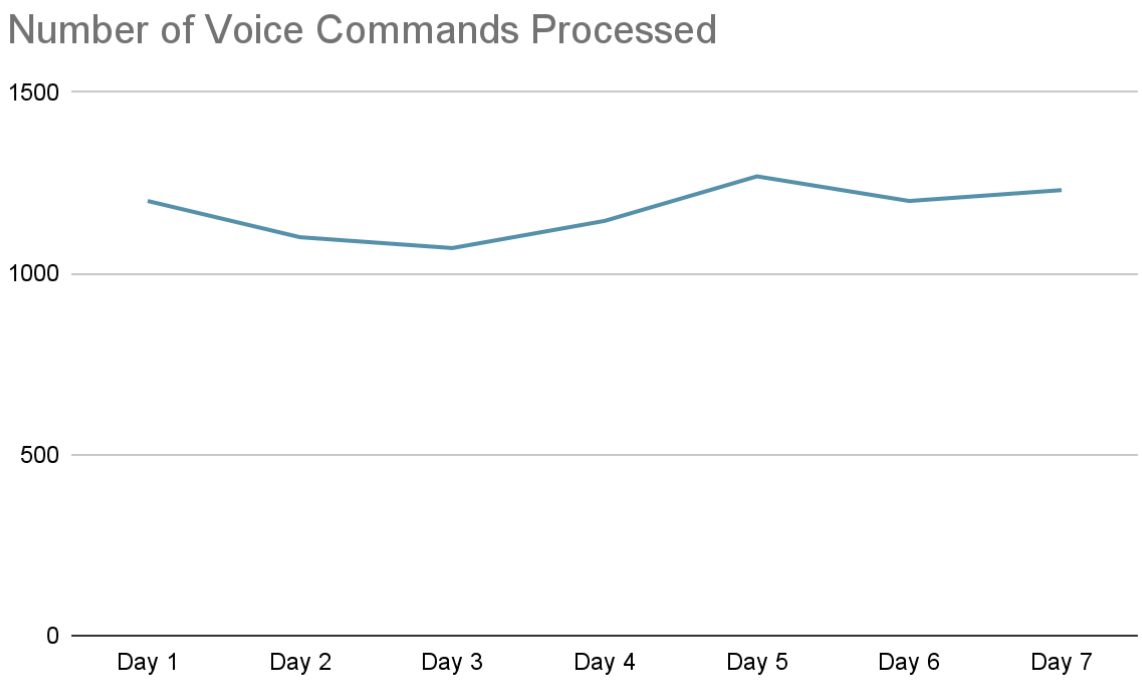
Part 2: Step 6 and 8 of the framework

In the second part you will discuss steps 6 and 8 with predetermined hypotheses, metrics, and data. Step 7 is not implementable in the workshop so this step will be skipped.

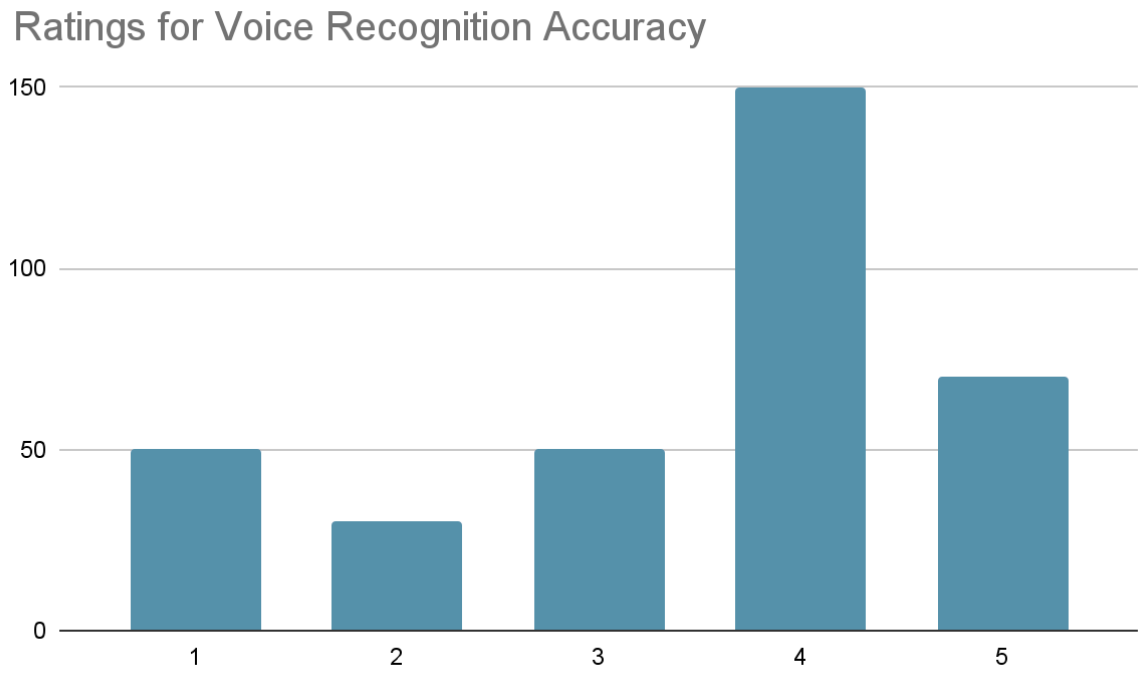
Voice Recognition Integration:
Feature: Implement Voice Recognition Technology

Hypothesis: By implementing voice recognition technology, we hypothesize that users will experience increased convenience and efficiency in controlling smart home devices.

Metric 1: Number of Voice Commands Processed
Simulated Data:



Metric 2: User Feedback on Voice Recognition Accuracy
Simulated Data:

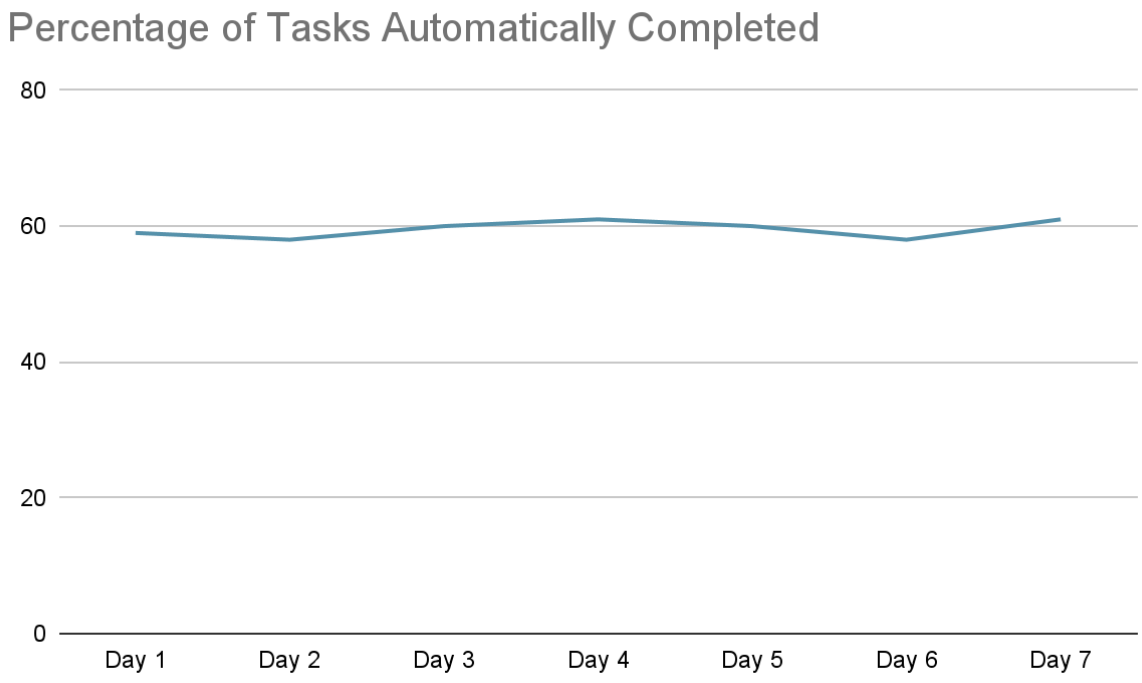


AI-Driven Automation:
Feature: Integrate Artificial Intelligence algorithms

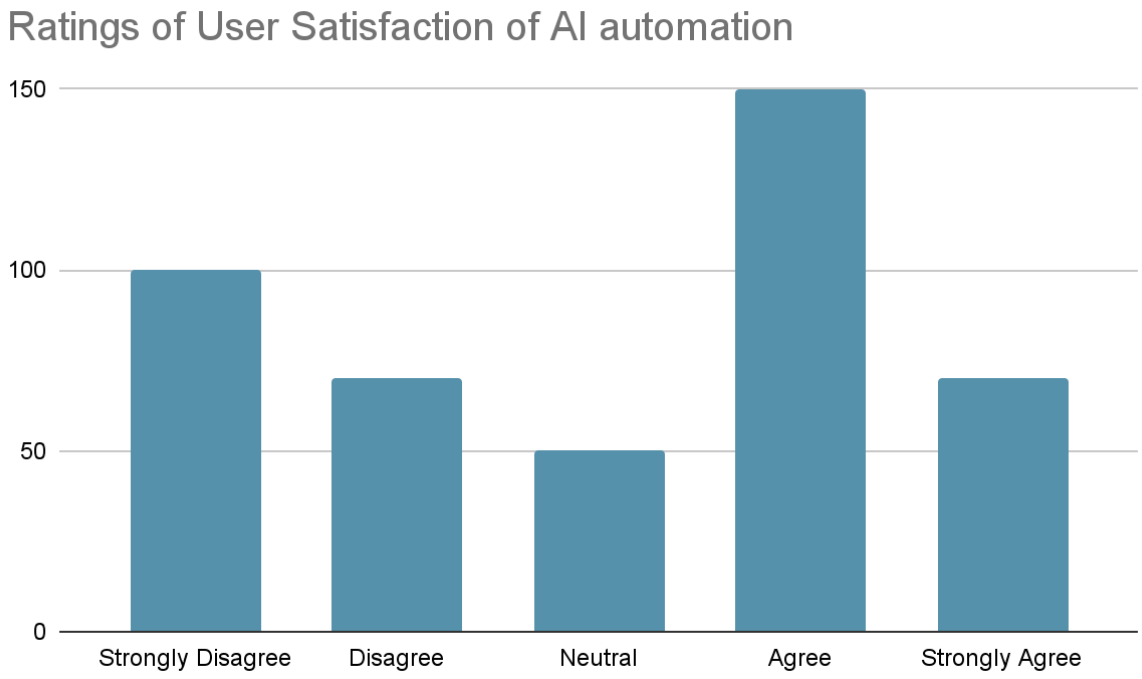
Hypothesis: By integrating AI-driven automation, we hypothesize that users will benefit from streamlined home management and reduced manual intervention, resulting in improved user experience and time savings.

Metric 1: Percentage of Tasks Automatically Completed

Simulated Data:



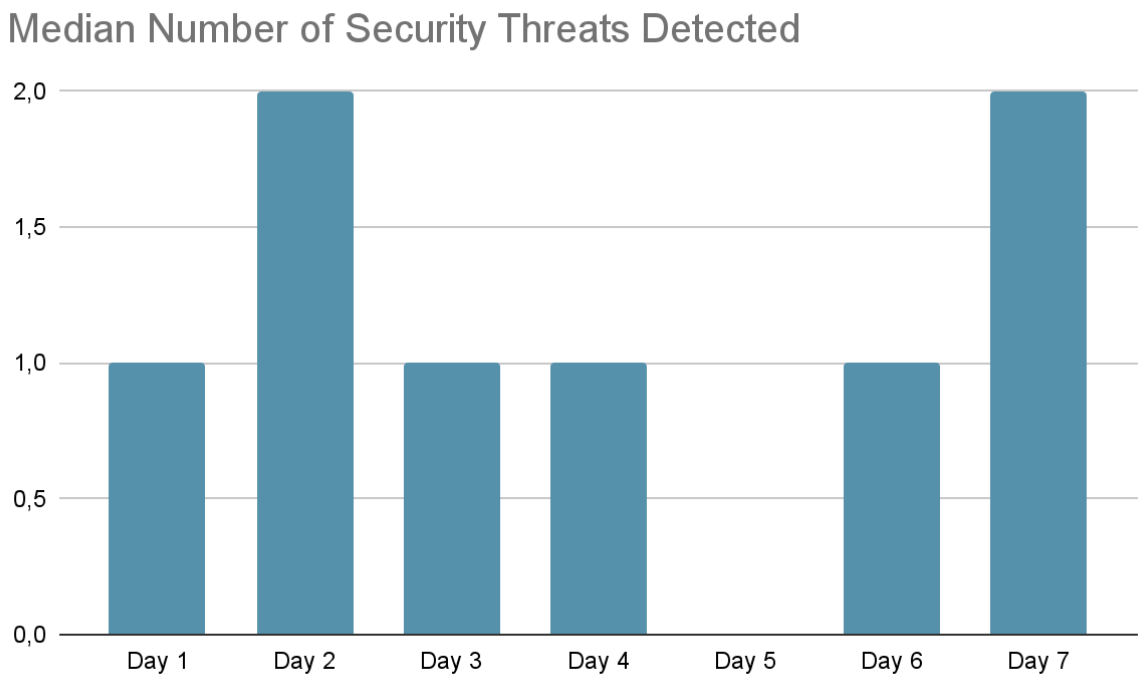
Metric 2: User Satisfaction with AI automation
Simulated data:



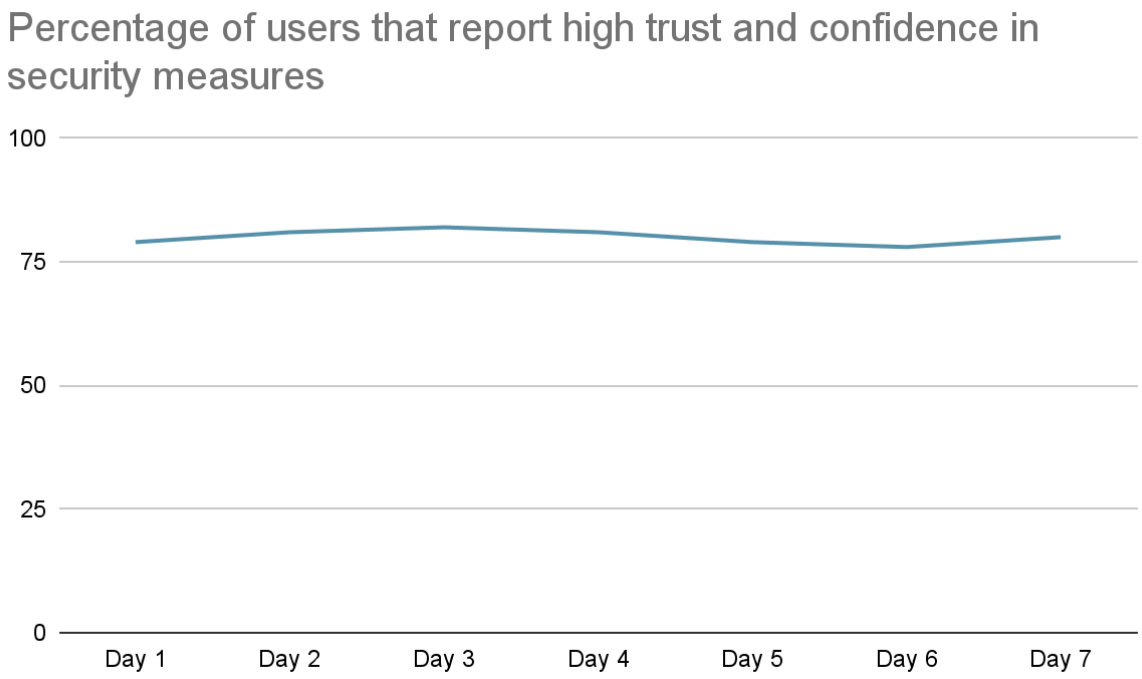
Enhanced Security Features:
Feature: Implement robust encryption protocols

Hypothesis: By implementing robust encryption protocols, we hypothesize that users will have increased trust and confidence in the security of their smart home systems.

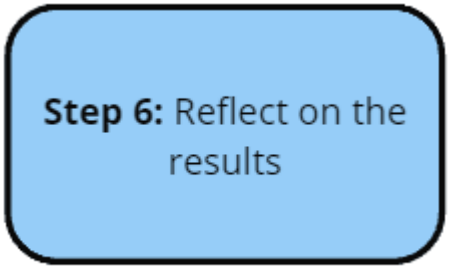
Metric 1: Median Number of Security Threats Detected
Simulated Data:



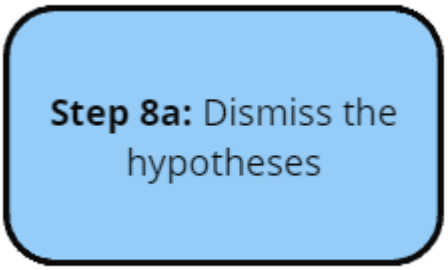
Metric 2: User Trust and Confidence in Security Measures
Simulated data:



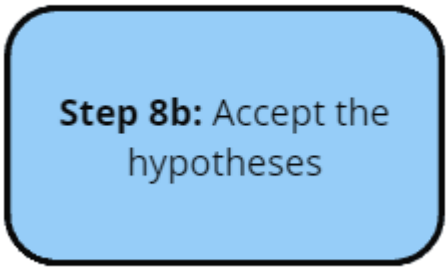
Step 6:
Reflect on the results and see what conclusions you can come to. Has the hypotheses been proved or disproved? Have the results measured what you wanted to?



Step 8:
Based on the outcome of the hypothesis and the discussion around the results decide if the hypothesis should be accepted or dismissed.



Dismiss hypothesis:
Discuss why and what might be improved for the next iteration. How could the hypothesis be changed to better represent what you wanted to measure and how can the metrics be changed to better suit the hypothesis?



Accept hypotheses:
Do you think that a better understanding of what constitutes value of that feature has been reached?

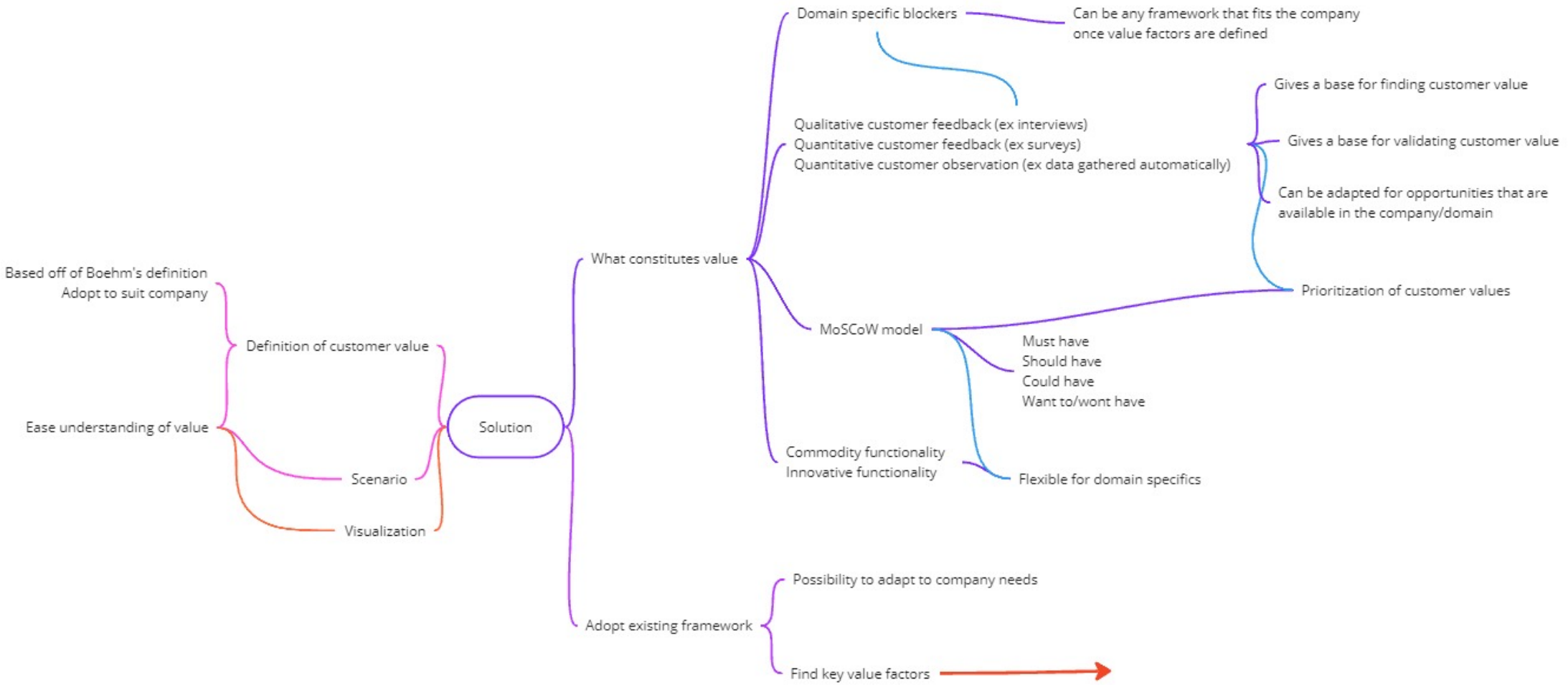
Discuss the following questions:
Do you think that experiment results like these, on a larger scale, can lead to a better understanding of what constitutes value in a system/product?

Do you think that, by using the accumulated knowledge of experiment results like these, it becomes possible to start using similar processes to calculate the expected value of new features?

Do you think that this framework seems approachable? Would it be possible to use this in your company? Why/Why not? Are there any domain specific circumstances that could be in the way?

D

Appendix


Solution
Definition of customer value
Based off of Boehm's definition
Adopt to suit company
Ease understanding of value
Scenario
Visualization
What constitutes value
Domain specific blockers
Can be any framework that fits the company once value factors are defined
Qualitative customer feedback (ex interviews)
Quantitative customer feedback (ex surveys)
Quantitative customer observation (ex data gathered automatically)
Gives a base for finding customer value
Gives a base for validating customer value
Can be adapted for opportunities that are available in the company/domain
Prioritization of customer values
MoSCoW model
Must have
Should have
Could have
Want to/wont have
Commodity functionality
Innovative functionality
Flexible for domain specifics
Adopt existing framework
Possibility to adapt to company needs
Find key value factors

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