Building a Shared Understanding of Customer Value in a Large-Scale Agile Organization
A Case Study

Master's thesis in Computer Science and Engineering

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Acknowledgements

Abstract

The trend of software development methods has transitioned from plan-driven approaches like waterfall method to value-driven approaches like agile methods, which has been widely reported as beneficial. Yet, there are challenges remaining within large-scale Agile organizations. One of the identified challenges that have been proven to be difficult is establishing a shared understanding of customer value. The purpose of this thesis is to investigate how a large-scale company currently shares their understanding of customer value, what success factors and barriers they encounter, as well as to what extent a shared understanding of customer value can be improved. A qualitative case study was conducted in a large telecom company. The data was collected through 12 semi-structured interviews, meeting observations and requirement handling documentation.

Five areas of barriers were identified, customer value enabling, long communication chain, just enough documentation, customer involvement and communication and documentation tools. The finding shows the urgent barriers are related to the creation of the customer value and customer involvement. If the customer value is not defined clearly and verified by the customers to ensure the accuracy, the knowledge sharing process becomes an amplifier of inaccurate information. Based on the findings, a model is created to mitigate the barriers identified. The model forms a structured foundation of shared understanding of customer value, create a shared understanding building process and finally recommendations for just enough documentation.

Keywords: Large-Scale Agile, Shared understanding of Customer Value, Requirement Engineering

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1 Introduction

In recent years, organisations have adopted Agile approaches in software development projects, and it has solved many challenges compared to the traditional Requirements Engineering (RE) approach, like communication issues, over scoping, requirement validation, requirement documentation and rare customer involvement (Inayat et al., 2015). One of the success factors of Agile is customer involvement (Schön et al., 2017). It gives the advantage of shortening the distance between developers and users, which means stakeholder and user involvement is no longer restricted in the initial phase of the project but throughout the development process. However, using Agile also creates new obstacles and challenges in RE especially in large-scale development teams, such as user value and system understanding; communication and knowledge management between the users and developers (Inayat et al., 2015, Kasauli et al., 2017b). One of the created obstacles we want to focus on in this thesis is the difficulties to build a shared understanding of customer value for each requirement.

In the study of Kasauli et al. (2017b) with the Software Center[1] in Gothenburg, building and maintaining shared understanding about customer value is presented as one of the challenges in large-scale Agile system developments. The study focuses on companies that develop both software and hardware products. It confirms that knowledge management of customer value is one of the challenges for companies when they try to adopt the Agile way of working. Within the "*A shared understanding of value*", the shared understanding of customer value within the team., the following challenges are identified, include difficulties to express customers value in user stories and long and complicated feedback cycles due to hardware development

1.1 Aim

In this study, we investigate how a large-scale organisation ensures that a shared understanding of customer values are built, how it is established in the requirements when a requirement is broken down in user stories and passed from team to team. To better understand the topic, we conduct a case study in a large-scale Agile organisation, with the aim to gain knowledge and understand of how the shared understanding of customer value and needs to be built through the chain of communication from customers to developers.

The scope of the thesis is the requirement handling process in the organisation, including different roles, communication channels and requirement tools, as well as internal and external verification of customer value. Thus, our study goal differs from Khurum et al. (2013) and Khurum et al. (2014) in that we are not considering decision making concerning a roadmap, but instead are examining activities that relate to establishing, sharing, and managing knowledge about customer value in large-scale Agile organisations.

The focus of the study is to identify success factors and form a model for a large-scale organisation which helps to build a shared understanding of customer values and improve knowledge management. The purpose of the model is to ensure that customer values are reflected in user stories and understood by team members, which can be confirmed by the customer. To illustrate the model, we observe sensibly the process of requirements handling, tools that a company uses, as well as the roles that involved in this process.

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[1] Software Center: https://www.software-center.se/

1.2 Research Questions

The primary objective of this study is to explore the understanding of customer value and to investigate how the organisation currently build a shared understanding of customer values in large-scale Agile environment. Based on the objective of the research, the following research questions have been defined:

- *RQ1: How is shared understanding of customer value built in a large-scale Agile environment?*
- *RQ2: What are good practices and barriers for building a shared understanding of customer value?*
- *RQ3: What are possible ways to mitigate existing challenges related to establishing, sharing, and managing knowledge about customer value?*

2 Related Work

In this chapter, we present the related work and background about existing challenges in large-scale Agile, Agile communication flow, knowledge management and shared understanding. The chapter closes with a structure of how the data will be analysed using the related work.

2.1 Existing Challenges

The Agile development method have gained popularity in software developing organisations by providing high-quality products in short time, with low cost and delivering customer value with better customer collaboration (Chow and Cao, 2008, Misra et al., 2009, Serrador and Pinto, 2015). The method has been adopted in many industries such as telecommunication and automotive, including small and large-scale organisations. Many studies stated that adopting the Agile practice improves the success rate of the software project (de Souza Bermejo et al., 2014, Dikert et al., 2016). In the Standish Group, Chaos Report 2014 (Clancy) stated that the three primary reasons for project success are user involvement (15.9%), executive management support (13.9%) and clear statement of requirements (13.0%). However, looking at the percentages, there are many barriers needed to be overcome by adopting an Agile method in a large-scale organisation. One of the main advantages of Agile compared to the traditional waterfall method is to involve user/customer more iteratively and reflect customer value with more proper development. However, when Agile is implemented in a large-scale organisation, customer involvement remains one of the challenges as many scholars stated from different dimensions below:

- The balance between customer value delivering and system architectures, the prioritisation based only on business value, the structure of the end product is lacking long-term planning, and with inappropriate architecture (Ramesh et al., 2010), it becomes costly to change, update or improve.
- Regarding the customer access and customer participation (Ramesh et al., 2010, Inayat et al., 2015, Kasauli et al., 2017b, Eklund et al., 2014), the Agile method relies on fast customer feedback. Without the feedback cycle, the short iteration becomes long iteration, and the cost and the time for changes become high. Often, the customers do not have a mutual understanding and the trust on the Agile RE, and therefore do not value the feedback loop, which adds to the already not optimistic situation.

In the context of large-scale companies, additional challenges are presented.

- According to the several studies (Kasauli et al., 2017a, Fabijan et al., 2016), a shared understanding of customer value is found as one of the challenges. The researchers stated that there is a considerable distance between the customer and the development team as well as between teams, how the customer value and feedback can be understood in the same way for all involved parts.
- High-level requirements management is mainly missing in Agile (Dikert et al., 2016).
- The gap between high-level requirements and user stories (Kasauli et al., 2017b, Dikert et al., 2016, Hsieh, 2006), after a long chain of requirement transition. The break-down user stories often do not reflect the customer value.
- With layers of project management structure and several stakeholder groups involved, the development team cannot reach the right person to help the team understand the requirements. (Kasauli et al., 2017b).

However, there is not enough information on how to eliminate existing obstacles, and to create a shared understanding of customer value. By using user stories, verbal communication, memory and acceptance tests, small development teams can form a shared understanding (referred to as shared conceptualisation) of a requirement, which is essential for function delivery. User stories serve as a

reminder of the feature. Knowledge transfer and storage are heavily weighted on verbal communication and memory (Abdullah et al., 2011). It is especially difficult and time-consuming to pass the right information to the right person within a large-scale organisation (Kasauli et al., 2017b), and often the requirement is passed on using documentation instead.

2.2 Customer value

Customer value is often described intuitively as changes of product, where the changes help the customer earn more income or to reduce operational cost (Kasauli et al., 2017a). Khurum et al. (2013) provide a systematic approach to categorise software values into a software value map which includes customer, financial, internal business, innovation and learning value, where each item is broken down into more sub-items (see appendix 1 for the customer value breakdown). With this approach, companies can map and evaluate the estimated internal and customer value, which are created for future functions to invest resources in the function with the highest value expected,

Customer value can also be seen as having different levels from high to low. It can be quantified by the process of transforming the customer value to customer needs and then systematically transforming into engineering characteristics (Zhang et al., 2013).

The approach contains three stages, (see Figure 2.1)

1) Identify and structure objectives: First, analyse customer statements then giving an objective structure to the collected requirements and establish a hierarchy of fundamental objectives. By asking "why" and "how" questions, the fundamental reason for the requirement as well as the possible means can be uncovered.
2) Specify attributes and construct value model: apply value model and multi-attribute utility theory to transfer the qualification data into quantification data. Value like customer number, customer preference should be applied in this step.
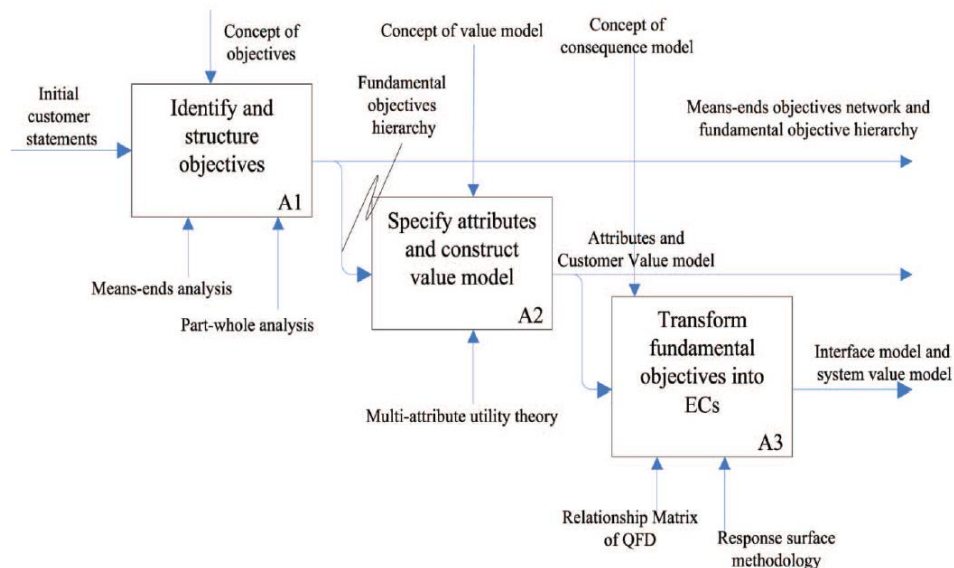3) Transform fundamental objectives into engineering characteristics.

Figure 2.1 A three-step procedure of the approach (Zhang et al., 2013, p333)

2.3 Agile Information flow

According to Abdullah et al., (2011), a requirement (user story) in the Agile method, generally have three elements, the documentation (often a post-it), the verbal communication and the confirmation. Within the large-scale Agile organisation, an additional element, the role, is added (Dikert et al., 2016). To support information flow in large-scale Agile organisation, tools are needed for distributed teams in two areas, verbal communication and documentation; for verbal communication, tools that can facilitate the most face-to-face-like communication (audio, video and interaction) will be most optimal (Yagüe et al., 2016). On documentation, it is the right combination of requirement management methods for the given context (Schön et al., 2017).

2.3.1 Documentation in Large-Scale Agile

The Agile trend has been minimising technical documentation, but when teams are distributed or in large-scale, there should be a greater focus on knowledge sharing through documentation (Yanzer Cabral et al., 2014). To successfully transfer knowledge from customers to developers via documentation, the refinement of the requirements is critical (Dikert et al., 2016) and one of the essential elements to include is the purpose of the requirement (Rubin and Rubin, 2011). Ideally, a requirement architect should be assigned to manage the gap between high-level requirements, to ensure that user stories are reflecting the high-level requirements but are still small enough for teams to handle (Dikert et al., 2016). It shows that a large firm should not roll back to traditional heavy documentation but work with concise and small enough requirement documentation to facilitate explicit knowledge and to trigger conversation for implicit knowledge sharing. After all, in Agile, documentation is served as an indicator to conduct a conversation, and in large-scale Agile, documentation should serve the same function (Glinz and Fricker, 2015, Abdullah et al., 2011).

There are a few more advantages documentation brings in Agile practice, 1) Time-saving for experts, who would not need to answer the same questions multiple times. 2) Preserves the "forgotten knowledge", the details of knowledge can be retrieved. 3) In a large organisation, a direct communication for knowledge transfer is hard. 4) Knowledge is lost when experienced workers leave the firm (Yanzer Cabral et al., 2014).

2.3.2 Verbal Communication

In large-scale organisations, many teams are in distributed locations; effective verbal communication could be facilitated by communication tools and communication channel.

Facilitate Face-to-face-like communication

In Agile, one of the leading communication channel is verbal communication (Abdullah et al., 2011). Though face-to-face communication should be prioritized (Yanzer Cabral et al., 2014), it is costly for a distributed team to meet. To facilitate face-to-face-like communication, aspects like audio, video and interaction should all be taken into consideration. With the combination of tools like Video-conferencing audio and video,) and smartboard (visual interaction of artefacts) help to eliminate the communication barriers between multiple locations (Yagüe et al., 2016).

Communication between different roles

The importance of communication between different roles was also stressed by Dikert et al. (2016). For example, product owners and their development teams, as well as clients and developers (Jebreen et al., 2016). From the researchers' best knowledge, no specific topic or information is pointed out to be communicated between roles. One way to view this is that some information has not been adequately transferred through the requirement chain, but it is not identified what the missing information is.

2.4 Shared understanding

Shared understanding can be categorised in many ways. Having the understanding of how knowledge or information can be categorised, methods and techniques can be implemented accordingly.

Definition of "Shared" Understanding

"Shared" understanding can be categorised into four categories (Cannon-Bowers and Salas, 2001),

1) Shared and overlapping, which refers to team members who share some common knowledge, for example, doctors and nurses who have overlapping knowledge on medical procedures, but doctors know more about diagnosis and nurses know more about medical care.
2) Similar/identical, which refers to team members who need to have if not identical but similar knowledge. It is often referred to as attitudes, beliefs, and therefore will draw the same interpretation.
3) Compatible, which refers to the ability to draw a similar conclusion from the same information input.
4) Distributed shared, which refers to members who have different skills and knowledge, while working together to achieve a goal, one may not have the specialised knowledge from another member, but as a collective, the knowledge is sufficient. The theory indicated how extensively a specific knowledge needs to be shared and how well each member should understand it.

Categorizing Shared understanding: Implicit and Explicit

Glinz and Fricker (2015) propose to characterise shared understanding along two axes: Implicit and explicit as well as correct and incorrect shared understanding (see Figure 2.2). Explicit shared understanding is mainly based on the requirements engineering process and its documentation. On the other hand, implicit knowledge has the characteristic of non-specific knowledge such as assumptions, opinions, and values which are not well studied (Glinz and Fricker, 2015). The theory gives a clear definition of the knowledge types, which helps to apply the correct approach and technique which are presented in the following sections.
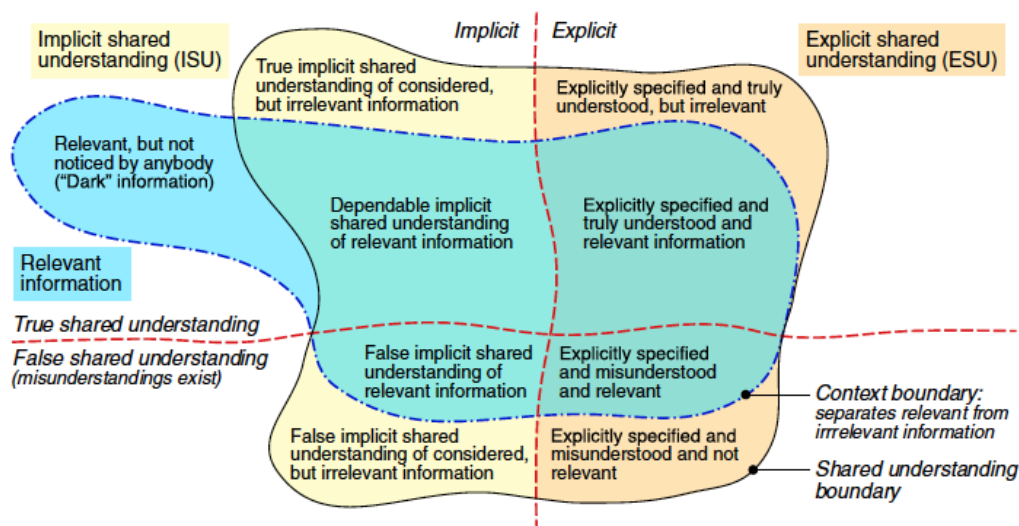
Figure 2.2 Forms and categories of shared understanding (Glinz and Fricker, 2015, p367)

2.4.1 Importance of shared understanding of customer value

Having a shared understanding has a direct impact on team effectiveness (Van den Bossche et al., 2011). With higher shared understanding, resources can be saved by transforming implicit knowledge to explicit. However, if it is an assumed shared understanding (misunderstanding) instead of a true shared understanding, the developed functions will likely not fulfil the stakeholder's needs, which can result in a project failure or significant re-work and unsatisfied customers (Glinz and Fricker, 2015).

2.5 Knowledge Sharing Cycle

Knowledge management has evolved from the first generation to the second generation, from specific technical issues with an information system to implicit social phenomenon with human systems and community practices (Yanzer Cabral et al. 2014).

Gasik (2011) developed a model (Figure 2.3) which illustrates the process of knowledge management. The process starts with selecting the required knowledge to solve tasks or problems (*identifying needed knowledge*). The source of the knowledge could be acquired from outside of the team (*knowledge acquisition*) or be created (*knowledge creation*). Next, the obtained knowledge can be applied to the tasks or problems (*knowledge application*) which may need adoptions to the applied situations. Once the knowledge has been verified or validated, it can be transferred and documented. *Knowledge transfer* involves communication of the knowledge between two or more parties, individuals or larger groups, which can be done by verbal communication or through documentation. *Identification and documentation of created knowledge* is the process where the knowledge created is acknowledged, defined and documented on external media. Now the knowledge has left its original process and externalised towards the organisational level. *Knowledge sharing* in this model refers to an organised version of the knowledge make available to a knowledge repository. Last, *external knowledge acquisition* refers to any knowledge available from outside the organisation.
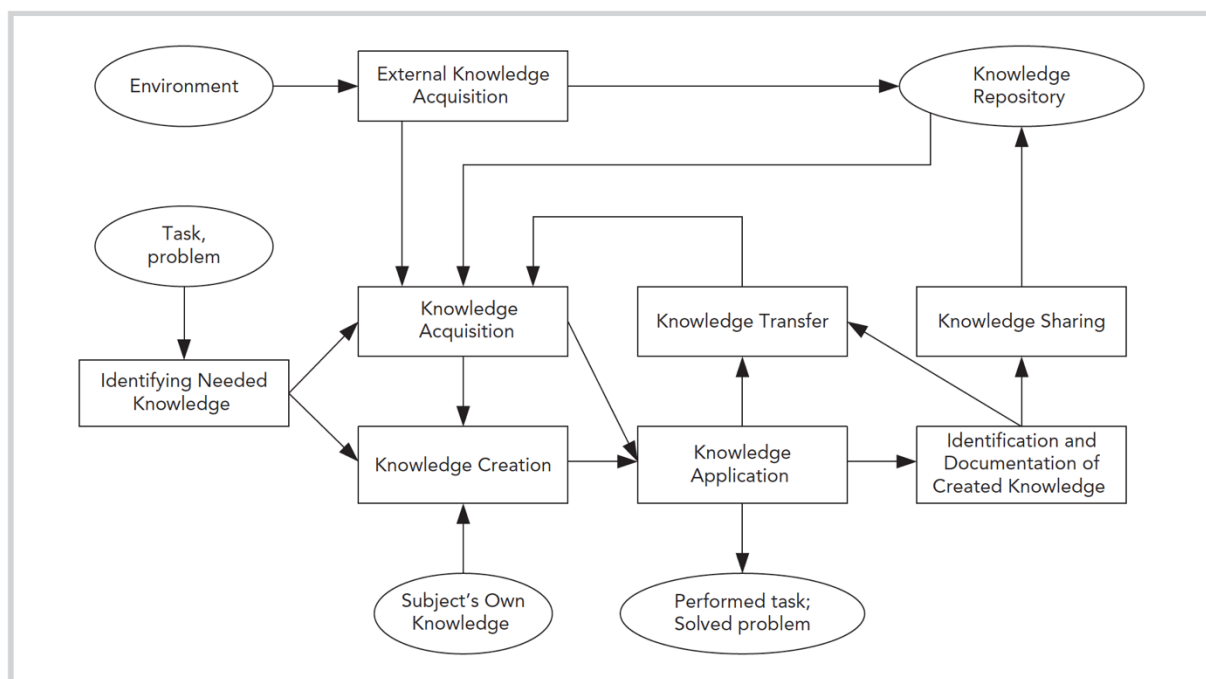
Figure 2.3 Process of Knowledge Management (Gasik, 2011, p29)

The knowledge management life cycle can further be positioned into three levels, organizational level, project level and individual level. In the Figure 2.4, the knowledge acquisition goes from external (global level) to internal (organizational and project level) sources. After the knowledge creation, the

knowledge sharing starts from individual level, it transfers through the project and organizational levels and finally reaches the global level.
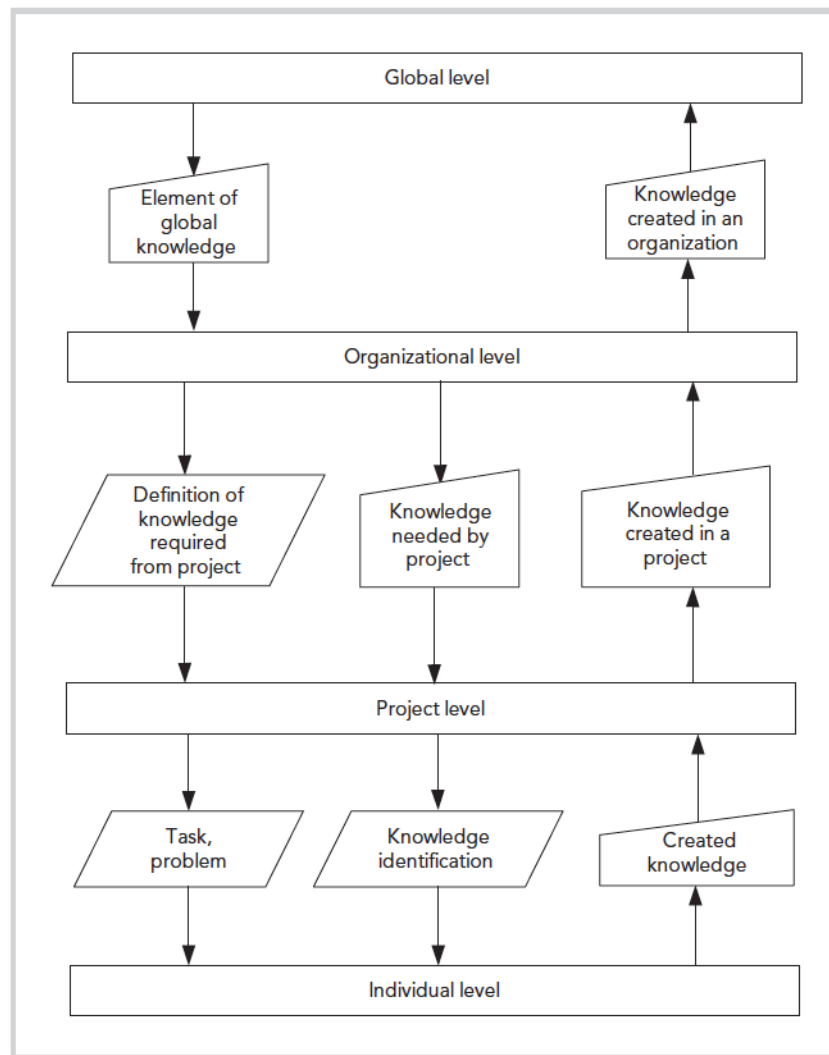
Figure 2.4 Vertical project knowledge flow (Gasik, 2011, p29).

2.6 Building a Shared Understanding

Glinz and Fricker (2015) categorized implicit and explicit knowledge (see section 2.4) in software engineering. They then further explain the approaches and techniques for sharing implicit knowledge.

2.6.1 Approaches

There are three approaches to improving the shared understanding of implicit knowledge (Glinz and Fricker, 2015):

- The first approach is to put in resources to make all knowledge as explicit as possible, which is a more traditional practice (Yanzer Cabral et al., 2014).
- The second approach is to expand the implicit knowledge as far as possible, which is an Agile mindset. Most knowledge is transferred during discussion and conversation, and the knowledge shared stays in people's memory (Abdullah et al., 2011).

- The third approach is to have a balance between explicit specification and implicit knowledge expanding, which is supported by Holz and Schafer (2003).

2.6.2 Techniques

Glinz and Fricker (2015) also collected practices (see Figure 2.5) to work with implicit shared understanding in three different categories, enabling, building and assessing.

Enabling, the aim is to form and lay the foundation of the knowledge, which is not enough for achieving or analysing share understanding. The techniques include:

- Knowledge gathering, the first steps of knowledge management, domain understanding and domain scoping help to achieve a general understanding of the domain concepts.
- Knowledge creation, with all information needed, putting the right stakeholder and team member in direct contact for discussion and feedback to ensure the scope of the domain and the shared understanding between senders and recipients of the information.
- Negotiation and prioritisation, with the knowledge formed, the importance of the knowledge needs to be ranked to be transferred with the proper emphasis.

Building, the goal is to ensure the formed knowledge can be transmitted within the team in the forms of explicit artefacts or building a body of implicit knowledge among the members.

- Transfer implicit knowledge to explicit form, by using artefacts like formal requirements or quantifying requirements. With the implicit knowledge now being transformed into explicit form, the knowledge can be shared in less time-consuming manner.

Assessing, it is to ensure all members have the same understanding. It can be achieved by using the following techniques:

- Assess understanding using explicit artefacts, for example, prototype, model and paraphrasing between authors.
- Increase implicit knowledge Assessment, such as having a smart ignoramus in the team to ask the obvious questions to confirm general assumptions.
- Increase assessment iterations, using short feedback cycles externally and internally to eliminate misunderstandings.

Enabling	Building	Assessment
Domain understanding	Formalizing requirement or architecture	Prototyping and Modeling checking
Domain Scoping	Quantifying requirements	Short feedback cycles
Stakeholder and project team member selection	Prototyping and modeling	Paraphrasing
Feedback	Handshaking	Having a smart ignoramus in the team
Negotiation and prioritisation		Measuring shared understanding or ambiguity

Figure 2.5 Categories of building a shared understanding techniques *(Glinz and Fricker, 2015, p.371)*

2.7 The lenses of shared understanding

To analyse how the shared understanding of customer value is built in the organisation, we analyse the data through the lenses (see Figure 2.6) of the knowledge sharing cycle (Gasik, 2011), share understanding technique category (Glinz and Fricker, 2015) and Requirement engineering (Damiler Chrysler, 1998).

The knowledge sharing cycle and categories of building shared understanding techniques were incorporated to locate activities in processes to analyse the causality between activities and challenges. Enabling is linked to knowledge acquisition and knowledge creation. Building is linked to knowledge documentation, knowledge transferring and knowledge sharing. Finally, Assessment, which is not included in the knowledge sharing cycle but is essential to create true share understanding.

The knowledge sharing cycle can also be loosely mirrored to the requirement engineering cycle, where knowledge acquisition maps to the elicitation stage and knowledge creation maps to the interpretation stage.
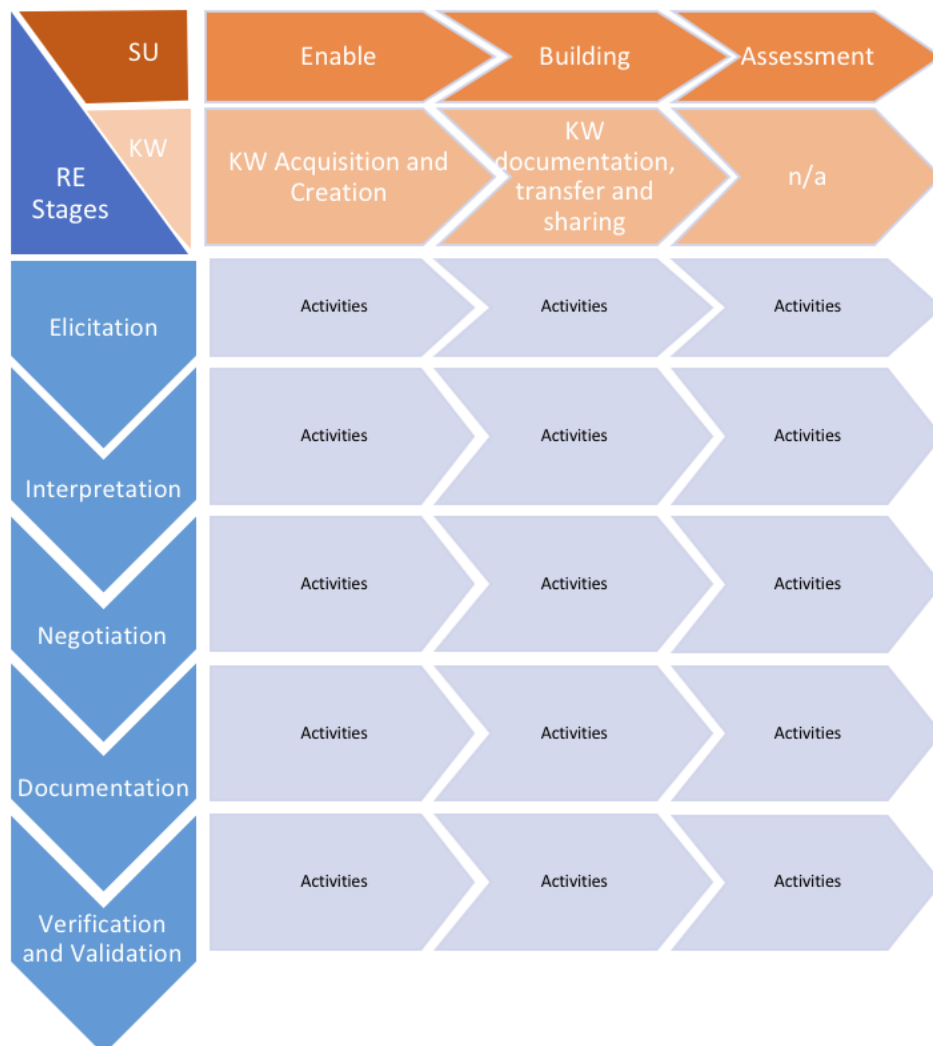
Figure 2.6 Lenses of Building Shared understanding in Requirement Engineering Process

3 Research Methodology

In this chapter, we illustrate the research strategy, and techniques used for data collection and analysis, and how these can help us answer our research questions. We also discuss threats to validity of this research and how to mitigate those threats.

3.1 Research Strategy

To answer the research questions, as well as to explore the objective of this study, a qualitative methodology is found be the most suitable approach. Qualitative research is intended to investigate real-life issues, social situation, human interaction and behaviour in an natural settings (Miller, 1992, Locke et al., 1987). Unlike a quantitative approach which requires existing theory base or background knowledge, the primary purpose of the qualitative approach is to explore unknown phenomena and to understand the underlying reasons through in-depth and detailed data (Creswell et al., 2007). It also allows the researcher to gather a data from multiple sources such interviews, documentation and observations. By using multiple data sources, the reliability of the data and the trustworthiness of the research outcome can increase (Breitmayer, 1991) The qualitative approach has recently been adopted in the software engineering field (Runeson and Höst, 2009) and it provides a wide range of methods and data collection techniques to carry out an enquiry (Creswell et al., 2007). For this study, we chose the qualitative case study method which is most suitable to answer our research questions.

A case study is a known methodology within qualitative research. It studies issues that are explored through one or more cases within a bounded system where its context might not be explicitly specified (Yin, 2014). A case study is usually conducted in a real-world context, which indicates that the study is within a less controlled setting (Runeson et al., 2012). The case study approach is commonly used in social, life, political sciences and psychology studies; however, it is also gaining popularity in the software engineering field (Runeson, 2006). This is because the rapid development of technology, the software engineering field to investigate and explore different factors and unknown phenomena related to project, product and process development. Therefore, the case study is an appropriate research strategy for software engineering enquiries since it investigates contemporary phenomena in its natural context (Runeson and Höst, 2009). The primary focus of the case study approach has an exploratory purpose; however, it is also commonly used as an improvement approach in the software engineering field where the researchers try to improve a particular aspect of the phenomena that have been studied previously. For those reasons, we chose the case study method to understand the current challenges of shared understanding of customer value in a large-scale Agile organisation, and how to improve the situation.

To obtain a research outcome for this study, it is vital to collect the right data and use appropriate data collection techniques to provide a valuable research outcome for this study. The case study provides different techniques to collect data from different sources such as interview, archival data, focus groups, and metrics. If the data are collected from multiple sources, this is known as the triangulation method. By using this technique, researchers can to increase the quality of the data. In a qualitative case study, data can be collected through open-ended exploratory interviews, observations, documentation and report analysis.

In this study, we decided to use a semi-structured interview as our primary data collection method. The semi-structured interview is categorised as first-degree data collection method, where the researchers can interact with the subject and collect data in real time. This allows the researchers to have more control over the data collection process, for instance, the type of the data, how it should be collected and what the context is. The semi-structured interview has open-ended questions, and it allows the interviewee to some extent to lead the conversation. The purpose of semi-structured interview is to let information or questions to arise, which may not have been considered in the first place (Creswell, 2013). This method allows the researchers to gather detailed data and obtain an in-depth understanding of the topic (Galletta, 2013). To complement our qualitative data, we followed

the case company's requirements handling process, which includes documentation and observations from meetings. Relying on several data sources enables triangulation to verify and confirm the results. In the following sections, the detailed process of data collection and data analysis are described.

3.2 Data Collection

Before we started the data collection process, it was critical to have background knowledge of the study objects. Therefore, the first phase of the study was to do a background investigation where related works were studied so that the researchers were able to identify the gap and eliminate duplication of the study or phenomena. Some vital related literatures were provided by academic supervisor for the starting point, and we further investigated relevant literatures based on the purpose and scope of the study. Once we had done sufficient background study, an interview guide was established to collect the relevant data for this study. The interview questions were formulated based on four main categories which helped us to gather the essential data that could potentially lead us to answer our research questions. For each group, we established questions to serve as checklists during the semi-structured interviews. The categories are presented below:

- Customer value (Common understanding)
- Customer value sharing process
- Communication tools and channels
- Documentation methods and tools

When conducting the interviews, the first step was to introduce the objective of the study to the interviewees, explain how the interview would proceed and how it would be used in the study (Runeson and Höst, 2009). Second, depending on the sensitivity of the questions, the interviewee's confidentiality should be informed. This is done by informing the interviewee that the given data will be stated anonymously in the report. This is to ensure that answers are more likely to be trustworthy rather than the interviewees feel reluctant to say anything that could potentially harm their current position. All interviews were recorded with permission to ensure that no data was lost.

To collect valuable and appropriate data, it is crucial to gain access to the right people (Yin, 2014) and to ask the right questions. To ensure those, we sampled the participants according to their roles. The participants were chosen from managerial to development roles, including product owners, strategic product managers, system an architect and cross-functional team members. By doing this, we were able to see the phenomena from different perspectives, and most importantly we believed that it would help us to see how customer value is shared in the different levels in the process. There were 12 participants in the study, 11 interviews were conducted and transcribed within one week after the interviews, and one participant provided written answers due to the availability. Three of eleven interviewees were located in Budapest, Hungary and the interviews were conducted and recorded through video meetings.

By complementing the data collected through the interviews, we decided to analyse relevant documentation such as feature reports. A feature report contains critical information regarding how requirements are generated and formed before delivered to the development team. We decided to follow the process of currently developing 1-2 features from an initialising period until pre-development period. This report allowed us to see the clear picture of how the company handle the requirements generating, and how the customer value is maintained throughout the process. Moreover, we also made observations by following the weekly meetings regarding the product and feature development in the company. This enabled us to have more reliable findings.

Once the data collection process is completed, we started analysing our findings and tried to answer our research questions. The general idea of data analysis is to navigate patterns in the data, which enables the researcher to discover and find meanings, draw a conclusion and build a theory (Hsieh and Shannon, 2005). There are different data analysing techniques for qualitative study; however, the most

suitable technique is chosen to be the coding and pattern matching in this study. This enabled us to have more reliable findings. By using this technique, it helped us to get a right result.

3.3 Data Analysis

To analyse our findings from different sources such as interviews and documentation, we used a common data analysis technique called a coding. Coding (Saldaña, 2009) is a process of organising and sorting the findings to create a chain of evidence and provide a coherent storyline to the reader. The technique is mostly used in qualitative data analysis. Coding is done by using a specific word or phrase that is given to a passage of text, and several blocks of texts can have the same code. It creates a pattern so that the research can analyse the data systematically.

We mainly used data analysing program, TAMS Analyser[2], for the coding. The program is an open source system that is used for identifying categories in texts. TAMS analyser is used to assign ethnographic codes to a block of text, and it allows researchers to extract, analyse and save the coded information. The program takes in different types of data sources, such as interview transcripts, documents, interview records and observation notes. Then we used coloured post-it and excel sheets for the data analysis.

After the data has been collected, the pre-set codes were created to categorise the data in TAMS analyser. The pre-set codes served as general categories and adding more codes for additional or new aspects into the general categories. We also used colour-coding to get a clearer view of the data. Each category was assigned different colours based on the categories of the codes which helped us create patterns and match the codes. The coding was done independently to avoid any bias. After the coding is completed, the program provided a list of categorised data based on the codes. Once the list was created, we proceeded to comparing the individually coded data to resolve any conflicts. The findings were also compared and contrasted with observation note and documentation, and the main findings of the study are extracted. When the findings were finalised, they were presented on different coloured posters. The colours of the post-it represent different categories, and they are further used in the study.

Lastly, based on the findings and related works, a model is developed to mitigate the challenges related to the enabling, sharing and assessing a shared understanding of customer values.

3.4 Validity Threats

Since there is no explicit definition of quality for the research study, the research quality vastly depends on the research design. To mitigate the validity threats and improve the trustworthiness of the research, the research should be aware of the possible validity threats such as misinterpretation, manipulated data and observation description. Lewis presented the five validity threats which are identified Maxwell, to strengthen the research quality(Maxwell, 1992, Lewis, 2009).

Descriptive validity: To avoid misunderstanding and presenting inaccurate data, it is essential to gather the data as it is. To increase the descriptive validity, we recorded the 11 interviews with consent from the participants. The participants were ensured that the data they were providing would be confidential and stated anonymously. The recording helped us gather more descriptive data, so we can make sure the answers are transcribed correctly and avoid omitting relevant data which proved beneficial during the data analysis.

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[2] http://tamsys.sourceforge.net/

Interpretation validity: One of the main validity threats for research is to misinterpret the data, especially during observations and interviews. Data should be interpreted from the participants' perspective, not from the researcher opinion. To accurately interpret the given data from the interviews, we interviewed the participants separately to avoid compromising the data interpretation.

Research bias: To avoid bias related to the researchers, for instance, changing the interview question to individuals or proclaiming own opinion by asking leading questions and rephrasing the interview responses, could affect our research findings. Thus, both researchers were present during the interviews to ensure each interview follow same setting and procedure, and we both double-checked that the recordings with transcripts to confirm the data.

Theory validity: when a researcher forces data to fit into their own perception or belief in particular theories. We as researchers tried to be neutral and observant, as well as restrain our personal opinions and judgments during the study. For this reason, we could mitigate bias that related to personal perception, and provide a result as truthful as possible.

Reactivity validity: Being present of a researcher could affect the setting of the research and the participants who are observed. There is a risk that people act and react differently to interview and observation due to researcher presence, not all people are comfortable with sharing their opinion. To mitigate this threat, we tried to avoid much communication with interviewees, instead following the interview questions and allowing the interviewees to elaborate on their answers.

3.5 Case Company

The study was conducted at Ericsson AB a global telecom company. The company is one of the leading providers of Information and Communication Technology to service providers with its headquarter located in Sweden. Ericsson market's areas divided into six geographical areas; South East Asia, Oceania and India, North East Asia, North America, Europe and Latin America and finally Middle East and Africa, where they provide services to their customers around the world.

The company has different units which take care of different parts of the organisational operation. This case study is carried out at the office in Gothenburg, Sweden. We collaborated closely with the Product Development Unit (PDU) and the Product Line. PDU is mainly responsible for the product development process. PDU consists of Cross-Functional Teams (XFT), Operational Product Owner (OPO) and Program Manager (PM) who develop products and ensure the quality. The XFTs and OPOs are located in different geographical areas, like Hungary, Sweden, and China. In the Product Line, area product owner and strategy managers work closely with sales and customer units to specify customer requirements and are responsible for budget and decision making on what features and products should be developed. The majority of APOs and strategy managers are located in Sweden. Customer units work closely with customers and the product line. Customer units are located in different countries depending on the market area.

Prior to the agile approach, the company has practised traditional software development approaches like a waterfall and V model since 1970. The agile method has been being practised by the company since 2012 and the agile way of working is adopted into their software development process. With the Agile approach, Ericsson now has quarterly release plan; Q1, Q2, Q3 and Q4. Table 3.1 shows the interview participants roles and their years of experience. The years of experience is scaled into 3 categories; very high (more than 20 years of experience), high (more than 10years) and medium (less than 5 years).

Table 3.1. The interview participants

Person number	Role	Experience level
P1	APO (Area Product Owner)	High
P2	APO	Very high
P3	APO	High
P4	OPO (Operative Product Owner)	High
P5	OPO	Medium
P6	OPO	High
P7	TSS (Technical Sales Support)	Very high
P8	XFT (Cross functional team) team lead	High
P9	XFT team lead	Medium
P10	XFT member	Medium
P11	SA (Software Architecture)	High
P12	PM (Program Manager)	Very high

4 Findings

The chapter is structured by the research questions. Section 4.1 is related to RQ1 where the company's software development process is presented. In section 4.2, good practices and barriers to building a shared understanding of customer value are presented in relation to RQ2. In section 4.3, the findings related to eliminating existing challenges in relation to RQ3 are presented.

4.1 (RQ 1) How is a shared understanding of customer value being built in a large-scale Agile environment?

In this section, the findings related to RQ1 are presented. The findings are structured into two sub-sections; the product development process and the activities that are related to building a shared understanding during the product development stages. Before introducing the main sections, the general perception of the agile transformation and understanding of the customer are presented in order to provide a fundamental for the following sections. Section 4.1.1 presents the overall product development process of the company in relation to the F stages as well as the roles and documentation tools that are involved in the process. Section 4.1.2 shows the activities that are conveyed to build the shared understanding.

Transforming from traditional to an Agile way of working

The Agile way of working is highly appreciated by the interviewees, for instance, one of the interviewees stated that "*I think that overall on the agile journey, we have improved many things and I would not like to go back.*" The interviewees also indicated that the Agile has its pros and cons. Since Agile has less documentation process, keeping the documentation up-to-date depends on individuals. An interviewee expressed that "Certain things should be still documented, and nothing is stopping you from writing good use cases, for example.". Due to the lower amount of documentation, the communication between teams, and collaboration with customers are seen as a critical aspect. One interviewee emphasised the importance of the customer collaboration as *"To understand what the customer wants and needs, we need to have that close collaboration with the customer. I think that is an aspect which is probably getting more and more important as things also move faster delivery."* Another interviewee stressed the importance of the communication as *"It is challenging to document everything. The tools and system are there to help, but the knowledge is shared through communication and experience, so the communication is critical."*

To bring customers and product development closer, the company has a customer unit department, which focuses primarily on the connection between the customer and the product development. It is also evident at Ericsson. The interviewees stated that the customer communication heavily relies on the customer unit, and the customer unit is seen as the bridge between the customer and the development units.

Understanding of Customer Value Definition

The interviewees expressed that the definition of customer value is abstract and covers many aspects. When we asked, "What does customer value mean to him/her?" in the interviews, most of the interviewees had to take time to think before providing a straightforward answer like generating income for the customer. Other interviewees expressed that when it comes to customer value, it is easily interpreted as business value or technical solution. However, some participants emphasised that they take time to discuss the "why" with their colleagues during the meetings. It indicates that the customer value is not discussed much in verbal communication or in documentation. It was evident that technical solution and business value tend to be the primary concern.

The general perception amongst the interviewees is that having a shared understanding of customer value is crucial. They stress that customer value is the fundamental purpose of why they are doing what they are doing. One of the interviewees stated that "*Everything started with customer value and everything should be translated into customer value. Otherwise, we will not have purpose and value on what we are doing*", and another stated that "*Customer value always should be at the bottom during decision making*". However, the interviewees also expressed that it is not possible to implement every request that comes from customers due to resources, technical limitation and business value to Ericsson. Thus, many interviewees expressed that it is critical to provide optimal service to the customers. "*In some cases, some of the products that we provide isn't necessarily beneficial for all customers, so we have to make sure to provide the optimal solution.*"

4.1.1 Product development process

To analyse how the shared understanding of customer value is built in the organisation, it is necessary to provide an overall picture of the product development process and the roles that are involved. In order to understand the development process, we provide the findings related to the roles and their responsibility. Furthermore, we explain the development process and the tools that they use during the process.

Roles and their responsibility
During the study, we interviewed different participants who have different roles and different responsibilities at the company. In this section, we explain the roles and their main responsibilities in the requirement handling process. Figure 4.1 represents the communication flow of requirements handling with regards to the roles involved.

- **Customer Unit (CU)**: The primary task of the CUs is to transfer the customer requests, called market requirement definitions (MRD) to Product Line which decides the requirement execution.
- **Area product owner (APO)**: The APOs belong to the Product Line and take care the customer requests that come from CUs and priorities them.
- **Operating product owner (OPO)**: The OPOs belong to the Product Development Unit (PDU) and are responsible for product development. The OPOs make sure that cross-functional teams (XFTs) develop a right product or feature according to the requirements. The primary responsibility of the OPOs is to ensure the quality of the product or feature, as well as support XFTs to perform efficiently.
- **System Architect (SA)**: The SA is a part of PDU, and their primary responsibility is to support teams in the technical area, as well as monitor team performance.
- **Program Manager (PM)**: The PMs is in PDU department and creates a release plan and are responsible for making sure the development process follows the release plan so that the feature or product can be released according to release plan.
- **Cross-functional team (XFTs)**: The XFTs' primary goal is to implement the requested requirement with high quality. Once the OPO defines backlogs of requirements, the XFT makes a plan together with OPO and executes the implementation according to the plan.

When we asked the interviewees, how the customer value is shared to them, and how they share it to others, all participants stated that the primary source of understanding and receiving the information is their closest direct contact with the customer. For instance, CUs is the direct contact of customers, for APOs it is the CUs, for OPO it is the APO and for XFTs it is the OPO. This indicates that each role in the chain has equally important job to share and receive the knowledge regarding customer value.
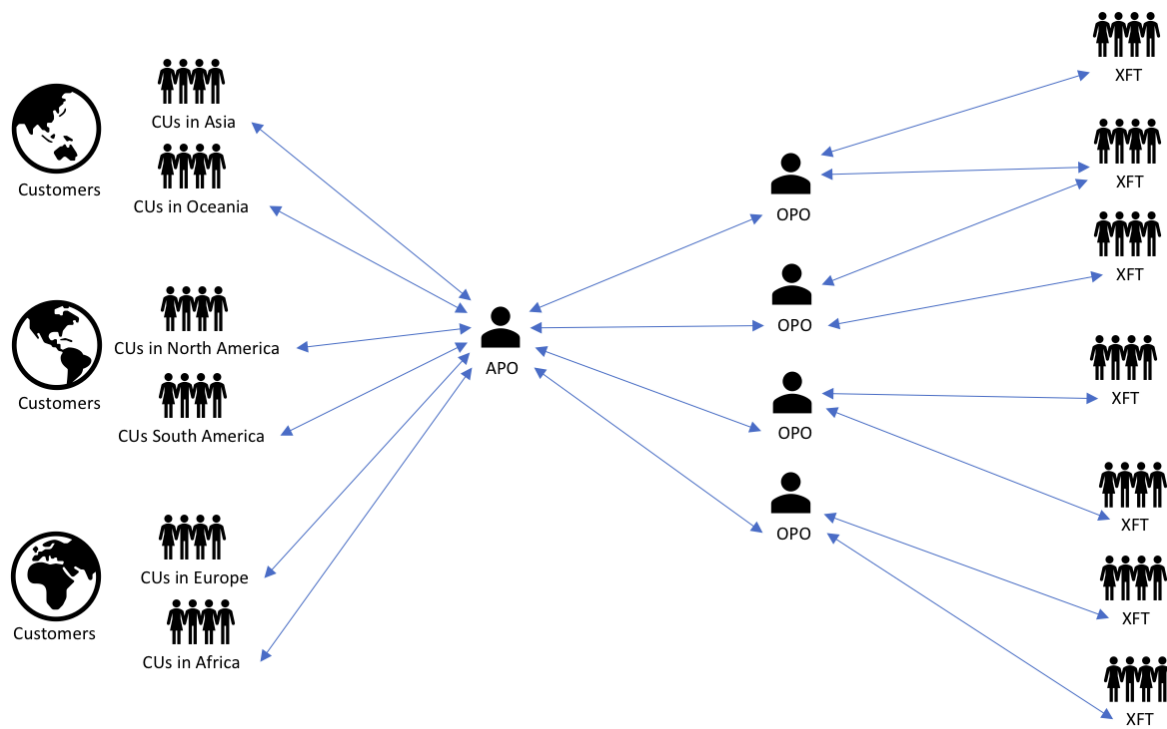
Figure 4.1 Communication Chain for requirements handling at Ericsson

Product development process

Here is the overall picture of the product development process of the company is presented. Figure 4.2 shows the product development Flow stages (F Stages) of the company.

Figure 4.2 F Stages, Product development process of the PDU

The product development process of the company is referred as F stages (see Figure 4.2). In each F stage, different activities are executed during the product development. In F0, the APO creates an opportunity analysis (OA) to define business value and market needs on new requests coming from several CUs. If a customer request has a high market demand and is technically feasible, the APO creates a requirement and prioritises it in the requirement handling system. In F1, the OPO is assigned to conduct a pre-study on the assigned requirement by defining brief information on technical aspects, business value and rough cost estimation of the implementation process. During F1, the OPO also creates user stories and backlog items, as well as appoints an XFT for requirement implementation. Once the requirement is specified and XFTs are assigned, the product/feature development is carried out during the F2 to F4 stages. When development is completed, the release is tested and verified internally at the end of the F4 and FA stages. In FG, the product trial is sent to the CU to be validated by a reference or chosen customer. The PDU has a specific department which handles the trial with the customer. Once FG is complete, the release is ready to be in the market.

Please note that in Ericsson, there is no F-stage name before F0, so we use the term Pre-F to represent the activities before F0. In Table 4.1, we illustrate the F stages and their procedures in relation to the responsible roles.

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Table 4.1 F stages activities

Process	Procedures	Final decision is made by	Documentation
Pre-F	Customer requests are accumulated from CUs.	CUs create customer requests.	Market requirements definition (MRD)
F0 Opportunity Analysis	Opportunity analysis on the upcoming customer requests is carried out.	APO decides to start opportunity analysis. APO implements a requirement and change status to F1.	Opportunity Analysis (OA)
F1 Pre-study	Business value, technical info, rough cost is estimated by OPO. Backlog prioritisation is decided. XFT(s) is assigned to the task.	OPO does pre-study with the help of the XFTs. APO and OPO agree on the prioritisation of requirements. OPO creates backlog prioritisation. OPO assigns XFT to do the specific backlog.	Pre-study Backlog
F2 Prepare Development	The scope of tasks and dependencies are finalised. A common understanding of scope is established. Release planning is done before development by PM. XFT stars development.	OPO starts development process. OPO and XFT agree on the requirement scope and development plan.	Release Road Map
F4 Complete implementation	The feature/product development is completed.	OPO agrees with PDU if the implementation is ready for testing and verification.	
FA Verification	The feature / product verified internally through different test.	OPO agrees with PDU if the implementation is ready for release.	
FG Validation	The developed product or feature sent to trial to be validated in a live network.	Customer validate the product/feature.	

Documentation and Tools used for requirements handling

During product development, two requirement handling tools, Focal Point and Hansoft, are used at Ericsson. The primary purpose of Focal Point is to store customer requests, and Hansoft is used to create backlogs for the requirements. Focal Point is mainly used by CUs in the Business Area and APO in the Product Line, and Hansoft is used in PDU by OPOs and XFTs. In Focal Point, a CU writes market request (MRD) which is gathered from customers and based on their requests during Pre-F, the APO creates a requirement in Focal Point and prioritises the requirements in F0. The OPO creates requirement backlogs in Hansoft for the assigned requirement, and it is used to track development activities (tasks) by XFTs in F1 and F2. Hansoft is seen as a primary tool requirements implementation. Figure 4.3 shows the relationship between the systems and documentation.
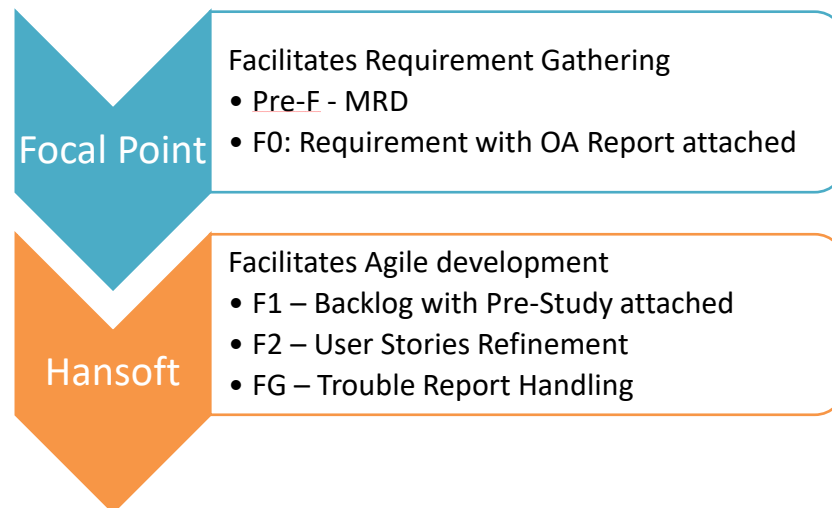
Figure 4.3 Systems and documentation

According to interviews and the observation, the two systems are not connected, and the requirements are manually synchronised by OPO. The tools are used in different part of the organisation, and the tools also have different access levels depending on the roles. For instance, the stored requirement is not feasible for the CU in Focal point, but some OPOs can have access to read the requirements. One APO states that*." In focal point, only OPOs and some system guys can have reading access. The APOs can write only in focal points."* but another APO express that *"Primarily Hansoft is the thing I use. I use Hansoft to put up the requirements and track prioritisation because the PDU works with the requirement implementation."* It indicates that the tools are used differently even by the same roles.

Communication tools

All interviewees agreed that both informal and formal communication is essential for understanding and sharing the customer value and needs. Both informal communication tools such as emails, electronic chat and formal communication tool like conference calls with presentations are vital to transfer information. Both tools are heavily used to facilitate communication between distributed members.

4.1.2 Information exchange Activities

Figure 4.4 represents the product development stages in relation to requirement engineering phases. The company follows flow unit (F) stages for their product development.

Figure 4.4 Relationship between F-stages and RE Stages

To analyse how the shared understanding of customer value is built in the organisation, we followed the three stages of shared understanding, enabling, building and assessment (Figure 2.6) (Glinz and Fricker, 2015) in relation to their activities. As we mention in the related work section, the enabling stage aims to form and lay the foundation of the knowledge to be shared. In the building stage, the goal is to ensure the formed knowledge can be transmitted within the team in the form of explicit artefacts or building a body of implicit knowledge among the members. In the assessing stage, it is to ensure all members have the same understanding.

4.1.2.1 Enabling a Shared Understanding

It is vital to form knowledge in advance in order to enable a shared understanding of the customer value. During the interviews and the observation of the case company, the shared understanding of the customer value is enabled between the F0 and F1 stages in relation to the requirement engineering phases such as elicitation, negotiation interpretation and verification.

Table 4.2 shows the activities that enable a shared understanding of the customer value in the organisation. The activities are presented in relation to the company's initial F states as well as requirement engineering stages.

Table 4.2 Activity table for enabling a shared understanding

RE stages	F stages	Activities for enabling a shared understanding	Roles involved.
Elicitation	Pre-F	(A1) Receiving the requests from customers	CU, Sales, Customer
	F0	(A2) Clarifying the new coming requirements.	90%: CU, Customer 10%: APO, Customer
		(A3) Clarify requirements with global clients in monthly or quarterly review meetings	Customer, APO, OPO
		(A4) Analysing the market requests by doing opportunity analysis.	APO, OPO
Interpretation	F0	(A5) Presenting the OA in the weekly PAB meetings.	APO, OPO, SPM, PM, Test APO
		(A6) Refine the requirement.	APO, OPO
Negotiation	F1	(A7) Perform the pre-study	OPO, (XFT)

		(A8) Creating user stories to define a scope of the requirement.	OPO, XFT
		(A9) Release planning in regular meeting	APO, OPO, PM
		(A10) Prioritizing requirements in regular meetings.	APO, OPO
Documentation	F1	(A11) The backlog is created in Hansoft.	OPO, XFT
		(A12) Ensure synchronisation between Focal Point and Hansoft monthly	APO, OPO
Verification	F2	(A13) Verifying the requirements during the daily Stand-up meetings or weekly meetings.	XFT, OPO

Elicitation: The requirement elicitation is executed during Pre-F and F0 states. In the Pre-F, the initial customer requests are received by CU and TSS (technical sales support). In this state, the customers only have direct contact with CU or TSS. Thus, the majority of the requirements clarification is done by CU, and APO and OPOs are involved only when there is a specific technical knowledge is required. The meeting (A3) happens monthly or quarterly depending on the customer. The APO with the help of OPO makes OA analyse the market requests to determine what requirement could be valuable for the customers, as well as for Ericsson to be developed.

Interpretation: The OA is presented in the PAB (A5) meetings where the APO, OPO, PM and SA are involved. The requirement is refined by APO and OPO, so it can be investigated further.

Negotiation: In order to prioritise a requirement, the requirement's scope and required resources need to be defined. This is done through the pre-study and user stories by OPO with the help of XFTs. The prioritisation is mainly done by APO; however, it is discussed in the regular meetings with OPO and Program Managers, so the PM can create release plans according to the prioritisation.

Documentation: Based on requirement specification and scope, OPO and XFT create backlogs of the requirement and divide into sprints in Hansoft. Since the requirements are synchronised manually between Focal Point and Hansoft, OPO makes sure whether the requirements are appropriately synced between the two systems and confirm the requirements order with APO.

Verification: The OPO and XFT verify the requirements during development in weekly meetings and stand-up meetings since it is possible that they change.

4.1.2.2 Building a Shared Understanding

In the building stage a shared understanding stage, the communication between OPOs and XFTs are emphasised. Building a shared understanding of customer value is often discussed during the prioritisation and development process during the F1 and F2 stages. Table 4.3 shows the activities of each role for building a shared understanding.

Table 4.3 Activity table for building a shared understanding

RE- stages	F-stages	Activities for building a shared understanding	Roles involved
Negotiation	F1	(A14) Understanding the customer value and needs in informal conversation.	OPO and XFT
Development	F2-F4	(A15) Customer value/goal is discussed by OPO and XFTs during weekly meetings and stand-up meetings.	OPO, XFT
		Expert help-out for the XFT	XFT, SA
In General,	In all stages	(A16) CU shares region news in the Bi-weekly meeting	CU, TSS, APO

Once a requirement is finalised and prioritised by the APO, the implementation phase starts in F2. The main actors during this process are the OPOs and XFTs. The development is divided into several sprints, and the team has a weekly, as well as stand-up meetings with their OPO. During the meetings, the OPO explains to the XFT teams why they need to implement the chosen requirement and discuss what value is provided to the customer. In some cases, the OPO discuss openly that a feature is a tick-box feature. Tick-box feature means, there is no apparent reason why a customer needs the specific feature, but it has to be implemented according to the agreement. The communication between OPOs and XFTs are both in formal and informal ways.

4.1.2.3 Assessing a Shared Understanding

The assessing stage ensures that the all members have the same understanding. To make sure, we used a verification and validation procedures to assess the shared understanding. The case company perform verification and validation internally as well as externally. Table 4.4 shows the activities that are used for verification and validation to assess shared understanding.

Table 4.4 Activity table for assessing a shared understanding

RE stages	F-stages	Activities for assessing a shared understanding	Roles Involved
Verification	F0	(A17) Requirement OA is verified in PAB meeting	APO, OPO, SA, PM
	F1	(A18) Final requirements are verified	CU, APO
	F2-F4	(A19) Backlog items are presented to OPO in each sprint demo	XFT, OPO
	F4	(A20) Complete developed user stories are verified by verification tests at the end of implementation	Test XFTs
Validation	FA	(A21) Trial testing in a live network.	PDU, CU and customer

| | FG | (A22) Customer testing with reference customer. | Reference customer, PDU, CU |
| | 1-2 times in a year. | (A23) Demo presentation to the customer. | Customer, XFT, OPO and APO |

Verification: Before development starts, requirements are verified in the meetings and through formal communication. Based on requests from CUs, the APO generates high-level requirements and present them as OA in the weekly PAB meeting, where the APO, OPO, PM and SA verify the OA of the requirement. Once the APO specifies the requirement, he decides with OPO on the feasibility of the requirements and sends them to the CU for verification. The requirement backlogs are divided into sprints; the team present a sprint demo to the OPO in end of each sprint to verify the backlogs. During the sprint demo, the present what has been developed so far and how it is functioning, so they can get feedback from the OPO. When the XFT completes the development, the feature is verified by a test XFT.

Validation: The validation procedure is at the end of the product development cycle where the customer holds a central role. The normal validation procedure is that the company send the trial to the reference customers before they release the product in the market. The reference customers test and try the features or products in their systems to validate them. Once they are validated, the company can release their product to the market. This process is done by the PDU together with CU and customer. The APO, OPO and specially XFT have a chance to meet customer during the customer demo presentation which is organised only 1-2 times in a year. During this event, the OPOs and teams can get feedback from the customer.

4.2 (RQ2) What are the good practices and barriers for building a shared understanding of customer value?

When we asked the interviewees if the current process supports the customer value sharing, they expressed that either it is not working well, or it could be improved. The interviewees also agreed that there should be a more direct interaction between stakeholders in order to understand the customer value clearly. "*I think we should have even more of interactions directly. Trying to get everyone in and having more of this informal way of handshaking is really needed.*"

Despite the barriers presented by the different participants, a communication blockage is identified as the most common obstacle. The communication blockage is referred as a bottleneck by an interviewee, who stated that "*It does not matter if people are sitting in different locations, a tool or a person can become a bottleneck unless there is more shortcut in the communication.*" Due to the organisational structure, the direct contact between CUs and OPOs is limited, and APOs are seen as the main contact person for CUs and OPOs. This increases the chance of the APO becoming a bottleneck in the communication chain. Some OPOs have direct contact with CUs in certain cases, but it depends on the previous work history or relation to that specific CU. In the following, findings of both good and ineffective practices that impact building a shared understanding are presented in relation to RQ2.

4.2.1 Enabling a shared understanding

In this section, we present the findings of good practices and barriers within the current process of enabling building a shared understanding of customer value. Table 4.5 summarised the barriers and good practices. Each item in the table will be further explained in the following sections.

Table 4.5 Barriers and good practices for enabling a shared understanding

RE stage	F-stage	Barriers	Short Description
Elicitation	Pre-F	(B1) Ability to gather requirements	The competence of the CU impacts understanding the customer needs and requirements gathering directly
	F0	(B2) Lack of communication with the customer	The APO and OPOs are not able to communicate with the customer directly due to bottleneck in the communication chain.
	F0	(B3) Who draws the picture of customer value?	Unclear which role is responsible for defining and transferring the customer value.
Interpretation	F0	(B4) Faulty assumption of customer values or goals	Customer value or goals can be overlooked by the expertise.
	F0	(B5) The difficulty of generalisation of a requirement	Challenging to fulfil all the customers' requests in one requirement
Negotiation	F1	(B6) Lacking high-level requirements	Technical details or solution are described rather than the customer value
Documentation	F1	(B7) Loss of customer value descriptions between the two systems	The customer value is presented vaguely or is not transfer through two systems
RE stage	F-stage	Good Practice	Short Description
Elicitation	Pre-F	(G1) Customers are verbal when expressing their needs.	Customers are willing to discuss their needs and what they want

4.2.1.1 Barriers

(B1) The ability to gather requirements – Elicitation/Pre-F: There have been concerns related to the competence of the CUs raised during the interviews. A participant stressed that *"The thing that sometimes does not work as good as it should, is communication with some of the customer units. It heavily depends on the competence of the customer unit people".* Furthermore, the recent loss of members of the CU impacted largely on the gathering the right requirements. One interviewee stated that *"You notice the gap in the process directly if someone leaves".* That the customer request and the requirements mainly gathered by the CUs, the person who has knowledge about the product, ability to understand the customer value and needs are withdrawn.

(B2) Lack of customer communication – Elicitation/F0: Having direct contact with customer during the requirement elicitation process is highly emphasised by APOs and OPOs. The interviewees highlighted that *"There should be as much as a shortcut as possible in order to understand what is*

critical, what they mean, and why they need it. "Sometimes the communication between the customer unit and the customer is not perfect. In reality, it could be better if we could talk to the customer directly". The interviewees indicated that the CU who owns the customer, refuses the APO and OPOs to have direct communication with the customer. An APO states that *"In some case, the customer unit misunderstands the customer, and some customer units do not want us to talk to the customer directly. If we could talk the customer directly, we could save time and money in some case."*

(B3) Who draws the picture of customer value? – Elicitation/F0: There are two different opinions on which role (APO or OPO) should be responsible for defining the customer value to be delivered in a requirement. Most interviewees expressed that the APO is the primary person responsible for transferring the customer value. Some interviewees stated that *"I strongly believe that it is the APO. This is really his/her main task"*. The other interviewees showed hesitancy to decide whether APO or OPO is the responsible role. One of the interviewees stated that *"From an Agile perspective, the POs (APO and OPO) should collect requirements. However, it could come from several participants, like system guy, and even the developer can help for defining the requirement."*

(B4) Faulty assumptions on customer values or needs – Interpretation/F0: The interviewees highlighted that in some cases, people tend to assume the customer value, so it ends up being based on their work experience, knowledge or personal opinions. It results in a risk of developing a faulty assumption. The interviewees stated that *"I think it could be better, sometimes we are so focused on what we believe, and we do not understand the customer value".*

(B5) The difficulty of generalisation of a requirement – Interpretation/F0: The company receives a large number of requests and business cases from customers globally. Often, several requests are merged into one requirement. Providing a requirement, based on all customer requests has proven to be challenging. One of the interviewees expressed that *"It always goes back to the prioritisation. Some customers are more valuable than others, and some features or products are highly requested in the market."*

(B6) Lacking high-level requirement – Negotiation/F1: In the interviews, when the participants were asked about what customer value the chosen requirements are providing, they tended to explain the technical solutions rather than defining the customer value. It indicates that the customer needs, and the technical details are specified explicitly, but the customer value is not. This is consistent with documentation, as in the field "rationale" in Focal Point, for some requirements, it states when the requirement is needed instead of for which business reason the requirement is needed.

(B7) Loss of customer value description between the two systems – Documentation/F2: There is a field called "rationale" in Focal Point where the CU and the APO can state customer value or the objective of the requirement. When the requirement is being rephrased into a user story, the customer value becomes vague or does not exist in Hansoft.

4.2.1.2 Good Practice

(G1) Customers are verbal expressing their needs – Elicitation/Pre-F: The interviews expressed that during the meetings with customers, they are willing to discuss their needs and what they want. The interviewees also emphasised that this kind of discussion usually with CUs or someone who has direct contact with the customer, thus it is difficult to say if this information is transferred through the whole chain.

4.2.2 Building a shared understanding

In this section, the activities related to building a shared understanding are presented. The activities are categorised into the barrier and good practice where the barriers hinder, and the good practices support building a shared understanding.

4.2.2.1 Barriers

Table 4.6 presents the activities that create barriers to building a shared understanding.

Table 4.6 Barriers to building a shared understanding

RE Stage	F-stage	Barriers	Short Description
In General	All Stages	(B8) Difficulty to create formalised event	Events organised by CUs to discuss customers and market
Negotiation	F2	(B9) Focusing on technical details	Technical details tend to be the primary concern
Documentation	F2	(B10) Unstable quality of user stories	The quality of the user stories highly depends on the competence and experience of OPO
	F2	(B11) The sweet spot of documenting just enough	Determining the right amount of documentation is crucial
Development	F2	(B12) The objective of requirements is unclear to XFT	XFTs are often unclear on the "why".

(B8) Difficult to create a formalised event – In general: There are different events organised at the company. The CUs take the initiative to organise events where they share insight to customers, and recently there have been several hackathons where people were working on real cases and discussing the customer value. However, participation in these events was reported as low. One interviewee pointed out that "*I mean we have so much to do. If it is mandatory, it means everyone must do it or maybe not everyone benefits and maybe you're not open if it is mandatory, you just do it*".

(B9) Focusing on technical details – Negotiation/F2: When a requirement is received, the conversation often tends to focus on the technical solution and implementation details, and the customer value is not discussed sufficiently. An interviewee mentioned that "*People tend to be quite technically oriented and to look for nice technical solutions, technical hinders and what is not working and those kinds of questions. But not always scrutinising as much on are we making the right feature regarding customer value.*"

(B10) Unstable quality of the user stories – Documentation/F2: The quality of user stories is dependent on the competence of the OPO. Sometimes, it is clear enough for XFTs to understand the customer needs or the details, but in some cases, XFTs have to conduct additional communication with the OPO to clarify the details. One interviewee expressed that "*It depends on how well the user stories are written. If it is written clearly, we understand directly, what is required and what is needed. Other times, we need to go to the bottom and see what is meant*".

(B11) The sweet spot of documenting just enough – Documentation/F2: In Agile, knowledge sharing relies on verbal communication rather than heavy documentation. Interviewees stressed that determining the right amount of documentation is seen challenging at the company. According to the interviewees, "*Documentation is good at a certain level, and after that level, it becomes a burden, so we try to find the sweet spot on the curve. Certain things should be still documented.*"

(B12) The objective of requirements is unclear to XFT – Development/F2: The developers are often given instructions on what to do and an order to do them without knowing the reason. XFTs are at the far-end of the requirement chain. Information on why a requirement is needed will often be lost on the way through the requirement chain.

4.2.2.2 Good Practices

Table 4.7 presents the activities that support building a shared understanding.

Table 4.7 Good Practices to building a shared understanding

RE Stage	F-stage	Good practices	Short Description
In General	All Stages	(G2) A distributed team is not seen as a challenge	The geographical differences do not hinder the communication and the collaboration.
Negotiation	F2	(G3) Internal communication.	The internal communication between product line and product development unit (PDU) is well established.
Documentation	F2	(G4) User stories are easy to understand when the quality is good	The well-documented user stories minimise the risk of misunderstanding.
Verification	F1	(G5) Having a clear picture of what and why.	The people are well aware of what they are doing and why they are doing in the organisation.
Development	F2	(G6) More verbal communication than documentation.	Verbal communication is preferable than documentation.

(G2) A distributed team is not seen as a challenge – In general: As a large-scale global organisation, the different units of the company are distributed around the world. For instance, the CUs and cross-functional teams are located in different geographical areas, and the headquarter is in Sweden. The interviewees expressed that the globalisation as a must, and there should be no communication barriers with their remote colleagues since the company operates globally.

(G3) Internal communication – Negotiation/F1: It was pointed out that the internal communication between different roles including APO to OPO and OPO to XFTs is well established. The interviewees expressed that whenever there is a question or a problem, it is easy to reach out to people. One of the interviewees stated that *"I always say yes if the OPO wants to set up a meeting. Even though some of the teams and OPOs do not sit together, I think we are quite good at communicating internally.".* If the requirement is a tick-box feature, the purpose is frankly shared as well. An interviewee mentioned that *"The OPOs are quite transparent about the tick-box features."*

(G4) User stories are easy to understand when the quality is good – Documentation/F2: As mentioned above in section 4.2.2.1, the quality of user stories varies. Well-documented user stories minimise the risk of misunderstanding and reduce additional meetings.

(G5) Having a clear picture of what & why – Verification/F1: The interviewees expressed that they have useful insights of the what they are doing and why they are doing it, and the teams are aware of the purpose of the assigned requirements. One interviewee stated that *"In most cases, we have a pretty good picture of what we are doing and why we are doing. Once in a while, we do have some misunderstanding, that is not often, but it happens."*

(G6) More verbal communication than documentation – Development/F2: Having verbal communication is preferable over heavy documentation. The interviewees stressed that the verbal communication is useful for sharing and building customer value knowledge and it is much appreciated. The interviewees mentioned that *"The customer value is usually shared through verbal communication and it is are very crucial to have this kind of communication, especially for the assigning."* It is believed that adopting the Agile principles allows Ericsson to develop faster and to be more adaptable to real-time changes.

4.2.3 Assessing a shared understanding

Table 4.8 presents assessment activity for building a shared understanding.

Table 4.8 Barriers and good practices for assessing a shared understanding

RE Stage	F-stage	Barriers	Short Description
Verification & Validation (V&V)	All Stages	(B13) Insufficient customer feedback	The different roles require the number of customer feedback

RE Stage	F-stage	Good Practices	Short Description
Verification	F2	(G7) Individuals' curiosity is encouraged	XFT members asking questions is encouraged by OPOs
V&V	All Stages	(G8) Direct customer feedback is helpful	Customer feedback is helpful for understanding the customer's perspective

4.2.3.1 Barriers

(B13) Insufficient customer feedback – V&V/F0-F1-PRA-FG: The feedback process is known to be insufficient. The interviewees highlighted that there should be more feedback processes in the organisation. The APOs would like to have a handshake with the customer are before requirements developed, the OPOs need more prototyping feedback on GUI, and XFTs want to know how the customer uses the requirements.

4.2.3.2 Good Practices

(G7) Individuals' curiosity is encouraged – Verification/F2: During the introduction of new requirements in meetings, the members are more and more keen to know the reason behind the requirements. People ask questions either to try to understand more or to challenge the value the requirement can bring. The trigger of conversation gives a chance for everyone in the room to align the shared understanding of requirements. This is very much appreciated by OPOs.

(G8) Direct customer feedback is helpful – V&V/F0-F1-PRA-FG: The interviewees emphasised that the customer feedback is very much appreciated. They expressed that this gives a chance to understand the customer's perspective on the functionality of a feature and gain insight on how the feature is used. "*During the customer demo presentation, you can get feedback, and it is very valuable.*

This speeds up the loop of learning on what the customers really need, what they used it for and how it works. So, you get broader understanding from this." It is also motivational for XFTs and helpful for future development. *"It does actually give positive reinforcement to the XFTs."*

4.2.4 Communication and Documentation Tools

According to interviewees, there are some pros and cons on using their tools for communication. This is summarised in Table 4.9.

Table 4.9 Barriers and good practices of communication tools

Tool types	Tools	Good Practices	Barriers
Documentation Tools	Focal Point	Provide a clear picture of the tasks	(B14) Non-transparent (B15) Bottleneck between two systems
	Hansoft	Having separate systems for different roles reduce the information overflow	
	Hansoft	Easy to monitor the progress of requirements	
	Focal Point	"Rational" field helps to formulate why	
Communication Tools	Emails Video/Audio Calls Chat Visualization	Audio meetings are fast and easy to set up	(B16) The video is complicated to set up
		Informal communication tools are effective in internal communication	(B17) Email is not optimal for requirement communication
		Visualization tools are used for communication	(B18) Audio calls are lacking an interactional tool

Documentation Tools

(G9) Good Practices: The interviewees highlighted that both systems provide a clear picture of tasks and their assigned people and they also make it easy to see the progress of the requirements. In Focal Point, if the requirement is rejected, or either the requirement is prioritised. Moreover, the field "Rationale" helps the APOs formalise the "why". On the other hand, the requirement development process is stated clearly in Hansoft. The interviewees also expressed that having separate systems for different roles reduces the information overflow.

Barriers: The interview participants stressed that having two systems for requirements handling creates non-transparency since there is no connection between the two systems. It is also time-consuming to synchronise the two systems, especially for APOs. The APO emphasised that "*It creates bottleneck*".

Communication Tools

(G10) Good Practices: An interviewee expressed that informal communication tools such as calls, email and chat are working well in the company's internal communication. The audio meeting is seen

as fast and less complicated if the two parties know each other previously. Visualization tools such as powerpoint or white boards are useful for getting the message across.

Barriers: The interviewees expressed that using video in the communication is effective if there are no issues. However, in most cases it is problematic and time consuming to set up. Also, when using audio calls, interviewees express that a tool like a whiteboard is missing. Many times, they will stop the call to draw an illustration offline and send it to the other party. Email is seen as an inconvenient tool for requirement communication. One interviewee expressed that "*Email is like a black hole*".

4.3 (RQ3) What are possible ways to mitigate existing challenges related to establishing, sharing, and managing knowledge about customer value?

This section includes the interviewees' opinions regarding changes required and how they could be conducted. By analysing the findings and the related works, we developed a model (chapter 6) which also answers to RQ3.

4.3.1 Enabling a shared understanding

In this chapter, suggestions from the interview participants that can improve enabling a shared understanding are presented. Table 4.10 presents the suggestion for enabling a shared understanding.

Table 4.10 Suggestions to enabling a shared understanding

RE Stage	F-stage	Suggestions	Short Description
Elicitation	F0	(S1) On-demand meetings clear the air	The right people or the right roles should be involved in the requirements elicitation process.
Elicitation	Pre-F	(S2) Rationale should be mandatory	The rationale should be mandatorily filled by specific roles, not depending on individuals.
Documentation	F2		
Verification	Pre-F to F2	(S3) Direct customer contact is helpful	Verification process should be carried out before the requirement is developed

(S1) On-demand meeting to clear the air – Elicitation/F0: It is emphasised that the right roles or people should be part of the requirement handling process with the customer instead of going through the long communication chain. An interviewee expressed that "The *right people to nail down a requirement should be put together in the meeting to have a requirement handshake*".

(S2) The rationale should be mandatory – Documentation/F2 and Elicitation/Pre-F: Currently, the existence of rationale depends on the person who created the requirement. However, it should be mandatory and should be passed on from tool to tool.

(S3) Direct customer contact for requirement verification – Verification/Pre-F to F2: Verification process should be carried out before the requirement is developed. The interviewees hold different opinions on which should be the final stage for verification. However, it is required in the requirement handling process to understand the customer value and the needs.

4.3.2 Building a shared understanding

In this section, the perception regarding the changes that could impact on building a shared understanding Table 4.11 shows suggestion the interviewees to build a shared understanding.

Table 4.11 Suggestions to building a shared understanding

RE Stage	F-stage	Suggestions	Short Description
In General	All Stages	(S4) Customer feedback needs to be shared by using maybe storytelling	By organizing events where people can interact, and meet might allow people share the knowledge of customer value and feedbacks.
Elicitation	F0	(S5) Ensure customer value (why) and goals (how) are well discussed	Rather than digging into the technical details, customer value should be discussed as well.
Negotiation	F1		
Documenta tion	F2	(S6) Just enough Documentation	The extensive documentation does not cover all the details; it is essential to document what is necessary.

(S4) Customer Feedback needs to be shared using maybe storytelling – In general: Customer insight is an abstract knowledge to be shared and would be difficult to write down. Therefore, events where the knowledge can be transferred verbally and where interactions are allowed could help with the purpose.

(S5) Ensure customer value (why) and needs (how) are well discussed – Elicitation/F0 and Negotiation/F1: This is a suggestion trying to mitigate the barrier "dive right into technical details". A duration of time has to be dedicated to for Customer Value discussion.

(S6) Just enough Documentation – Documentation/F2:   The interviewees emphasised that balancing the sufficient communication and documentation is crucial in Agile. One interviewee expressed that "*You do not want to spend half of your time documenting instead of doing things*". Another interviewee stated that "*if you do not have so much documentation or, or facts written down you need to be able to get it through tight collaboration and communication, but certain things have to be documented.*".

4.3.3 Assessing a shared understanding

The theme in this section is clear, more interaction with clients. The suggestions are as below:

(S7) Close collaboration with the customer – Verification/Pre-F to F2: Interviewees highlighted that being leading player in the market is not the case anymore and a close customer collaboration is essential to stay competitive. They also emphasised that the direct customer collaboration can help them to understand the real customer needs and values earlier and provide a product that meets them. This close and direct customer collaboration increase the chances of high customer satisfaction, as well as revenue for Ericsson.

"Recently, I think we have been in a situation where we were very big, and then we said OK, we would develop whatever we think the market want. We know what the market wants and everything that we develop was a market success, so to say. We have been there, where we had 35 percent of the market

share, you are the leader. Then you can develop, and customers will follow, so to say. However, we are not there these days."

"I think we should work closely with customers to know what they want and what they think works and try to work together with the customers and develop products based on their needs so that we can make a general product and sell more volume."

(S8) Verification on Prototype of GUI – Verification/Pre-F to F2: Interviewees expressed that it is essential to provide a prototype to the customer, especially for Graphic User Interfaces (GUIs), since they are the first thing the customers experience while using a feature, it is crucial to verify with the customer. The interviewees also emphasised that prototyping can help the customer understand what is being developed visually. At the same time, developers can develop a feature in the right way based on feedback they get from prototyping.

"Prototypes are a very good thing. According to me, we can prototype how the product works, where it connects and how it functions, etc. So, we can ask the customer what they think and if that is what they want. By doing that we make sure whether we are on the right track or not"

(S9) Frequently meeting clients for feedback – V&V/F2 to FG: Interviewees highlighted that they would like to are frequent feedback from customers. They also expressed that the XFTs and OPOs would like to be part of the feedback session so they can improve future development and stay motivated.

> *"I do have a chance to meet with customers during the demo session, and we receive great feedback from the meetings, sadly this kind of events are not so common. However, the feedback is valuable".*

5 Discussion

The challenges in a large-scale Agile organisation according to previous studies are mainly confirmed, for instance, missing high-level requirements, the scale of a large organisation hindering the understanding of the true customer needs and difficulty of gathering the right roles to have efficient communication. One of the challenges identified by the scholars is the balance between customer value delivery and system architecture (Ramesh et al., 2010). However, the case company is struggling less with the balance between these and more on the difficulty to identify the customer value to be delivered, which we believe is due to the low level of direct contact with customers during the requirement development process.

One unexpected challenge identified is the barrier to enabling customer value. In the case of Ericsson, the internal communication is functioning relatively well. From APO to XFT in the requirement chain, the members (including distributed team) feel little restriction of communication despite tool issues like lack of interaction tools and restricted system access. However, the requirement chain between customer and APO seems to be problematic. Issues include inefficient elicitation; the difficulty of direct customer contact due to jurisdiction and how to satisfy multiple stakeholders within a requirement.

In this chapter, RQ2 is answered with a discussion of barriers and good practices. The following sections discuss customer value enabling, long communication chains, just-enough documentation, customer involvement, and communication tools.

5.1 Customer Value Enabling

Three barriers emerged into the theme of customer value enabling; customer value elicitation, creation and understanding.

(D1) Understanding of customer value: To transfer customer value efficiently, the creation of common ground or a "shared conceptualisation" is crucial (Abdullah et al., 2011). Therefore, having a shared understanding of "what is customer value and how do we use it" will be one of the foundations to build a shared understanding of customer value. In the case study, we detected two types of unclearness; the definition of requirement levels and the definition of customer value

All interviewees have their understanding of customer value pointing in the general direction of generating income for customers. Though it is the primary goal of all requirements it is too general to have meaningful implications. We also discovered that the distinction between customer value and customer goals is ambiguous in the documentation; it shows that rationales are often describing requirement reasons (customer goals) instead of business reasons (customer value to be delivered).

This indicates that there is a lack of shared understanding of customer value definitions and structures in the case company, which leads to B6, lacking high-level requirement. The lack of a structured way of describing customer value increases the difficulty to define, transfer and understand the customer value to be delivered.

Despite the barriers, roles such as OPOs and APOs reinforce the individual to ask questions regarding the requirements and the decisions taken by OPO and APO to understand underlining reasons (G7). It enables the people in the chain to have a clear understanding of why they are doing what they do (G5) and to be more innovative and creative.

(D2) Customer Value elicitation: To have a high-quality requirement, it is essential to have the information of "why a requirement is needed and how the functionality will be used" in the elicitation stage (Lauesen, 2002). The concern of customer value elicitation is identified by combining activity A1, A2 and A3 - where the majority of the requirements come through CUs and B1 - requirement

elicitation competences of CU. Inaccurate or insufficient information poses a high risk of defining the wrong customer values, and it leads development in the wrong direction.

(D3) Customer Value Creation: In the case study, the company encounters several levels of barriers to customer value creation. The first, as mentioned above in D1, is a lack of structure to defining customer value. The second, in D2 – insufficient information of why and how. The third, in B3 and B5 – satisfying multiple stakeholders with one requirement; it is not clear which role has the responsibility to define customer value for a requirement. Lastly, all reasons above lead to B4 and B6, the customer value is defined faultily or is missing.

5.2 Long Communication Chain

Three problematic aspects of the communication chain were identified; each member of the chain, the bottleneck of the chain and implicit knowledge lost.

(D4) Each member of the requirement chain: Due to the structure of the organisation, direct communication between different roles are often limited. Although it reduces the required resources, it also increases the impact of each role in the chain. If a member at the beginning of the requirement chain makes a mistake or miss some information, it will be a challenge for the rest of the members in the chain to find the error or absence of information based on information received. In the study case, we see two instances, B1 – ability to gather requirements and B7 – loss of customer value between the systems.

One additional concern that could be implied from the data, each person in the chain has its own opinion and bias; this will hinder the information being passed on. The development team could receive a requirement with 10% information from the client and 90% information being added internally but assume the majority of the information is from the customer.

(D5) The bottleneck of the chain: In the communication chain, the APO is seen as the single link between the CUs and the OPOs (see Figure 4.1). It indicates that all requirements and information need to pass through the APO. If the APO misses a piece of information, then the information will not be passed on in either direction (requirements and feedback). One APO expressed the difficulty of having a deep understanding of each requirement due to time constraints, and he had to compromise on some "appear to be straightforward" requirements to have more time on important requirements.

(D6) Implicit knowledge lost: Implicit knowledge is often assumptions and slip away from meeting agendas. Information like reason for the requirement and the customer value often falls into this category. With the Agile method, there is a high risk of information lost when it is adapted by a large-scale organisation. If a person is not aware of some piece of information, the risk of losing information is even higher, and it is difficult to get it back. One solution would be transferring the knowledge by discussing the implicit knowledge or write down the implicit knowledge (Glinz and Fricker, 2015). In this study, we see at some activities (A2, A5, A6, Figure 4.3) are in place to facilitate the implicit knowledge transfer. However, the result is a lack of both B9 – focusing on technical details and B7 – customer value is often missing in the documentation. Moreover, with the environment of B8 – people are not so interested in knowing the customer value stories, it leads to B12 – customer value is often not shared to the end of the communication chain. However, it is evident from the study that well-refined explicit knowledge such as user stories can reduce the risk of misunderstanding and save time(G4).

The findings also revealed that in spite of not having joint communication and being geographically distributed, the internal communication between different roles and cross-functional teams are working effectively in the company (G2 and G3). However, it seems to be contradicting the findings (D4, D5 and D6) above, which indicates that the company might have a false shared understanding (Glinz and Fricker, 2015) regarding the efficiency of the communication.

5.3 Just enough Documentation

In a large-scale agile, documentation is one of the main methods to transfer knowledge. There are three challenges identified in documentation; the volume of documentation, implicit information in the documentation and the quality of the documentation.

(D7) Just enough documentation: As mentioned above, transferring implicit knowledge into explicit form (Glinz and Fricker, 2015) is one of the solution to prevent losing implicit knowledge lost. In Agile, documentation often serves as a trigger point for verbal knowledge transferring (Abdullah et al., 2011). However, in a large-scale organization, documentation serves an extra functionality, to transfer knowledge without time-consuming face-to-face communication between all members. Documentation has to be large enough for information transfer and small enough for documentation maintenance (Dikert et al., 2016). Ericsson agrees to the concept of reducing documentation (G6) but struggle with the sweet spot of "Just enough documentation(B11)".

(D8) Customer Value is missing in documentation: Implicit information like customer value, the "why" of the requirement is often overlooked (D6 – implicit knowledge lost) during verbal communication. Thus, leads to the absence or low quality of rationale in the focal point and the "why" in user stories. As part of high-level requirement, when documentation is missing, it is hard for low-level requirement to focus on what customer thinks is important and the focus would unconsciously drift to what the person working on the task thinks is important (Rubin and Rubin, 2011).

(D9) Quality of documentation: In large-scale Agile, the refinement of documentation is critical (Dikert et al., 2016). In B10 – Unstable quality of user stories and B6 – lack of high-level requirements, we understood that the quality of a written requirement heavily depends on the person who writes it. We discover lots of internal documentation regarding "how to write a good requirement". It is clear that Ericsson has made effort on having a standard, but the standard is not enforced.

5.4 Customer involvement (Verification and feedback)

One of the most evident benefits of Agile is customer involvement, however, it is also one of the most pronounced challenges for large-scale Agile (Ramesh et al., 2010, Inayat et al., 2015, Kasauli et al., 2017b, Eklund et al., 2014), which is confirmed by the case study as B2 – lack of customer communication. The following two points summarise the identified barriers:

(D10) Few Verification Processes with Customers: There are many activities for internal verification for requirements between APO and CU (A18), OPO and APO (A17), OPO and XFTs (A13, A19). However, there are few verification processes that directly involve customers from stage F0 to F2. The earliest customer involvement in the verification process is during the requirement elicitation (A1) with CU. After that, customers are involved in the validation process (A22), when the product development is completed. It indicates that there is a no customer involvement during the product development. This process is similar to the Waterfall approach. One APO expressed that in F0 stage, the difficulty of direct contact with customers often prolong the time needed.

(D11) Little Feedback: It is confirmed with this case study that customer involvement is difficult to achieve due to limited resources from both the customer and the organisation. Two managerial interviewees expressed doubt regarding the actual need for verification for each and every requirement. For them, the purpose of direct feedback for developers is to raise morale rather than to improve productivity. However, any form of customer feedback is highly appreciated by OPOs and XFTs.

One of the common challenges in Agile is the low interest from customers on the feedback (Kasauli et al., 2017b), however the finding of the case study shows that customers are willing to give feedback

(G1 and G8). When feedback occurs, it is very much appreciated by the interviewees. We think Ericsson could utilize the feedback process more to work closer to with their customers.

5.5 Communication Tools

In this section, the barriers related to documentation and verbal communication are discussed.

5.5.1 Documentation Tools

In general, the documentation tools are appreciated. They help to keep track of the requirement process on information of assigned member and the F stages. However, there are two major issues, the bottlenecks and data synchronization between the two systems.

(D12) Bottlenecks in the documentation systems: Documentation is an efficient way to transfer knowledge without much resources after the initial writing. It is clear that Ericsson has allocated their resources for documentation when a requirement is moved to the next F-stage (Figure4.3). However, due to unknown reasons to the interviewees, not all members have the access rights to see all the produced documentations (B14). One interviewee stated that people put less effort on documentation refinement when the documentation access is restricted. With the restriction of documentation, the effort of documentation seems to be less valuable.

(D13) Manual Data Synchronization between systems: The right combination of tools should be provided in order to facilitate the requirement process (Schön et al., 2017). It is common that RE tools are often separated from Agile development tool like in Ericsson's case. For instance, Focal Point is used by CU and APO to handle requirements and Hansoft is used by OPO and XFT to handle on-going development. The issue here is the lack of automation process (B15) to transfer data between the two systems. Hours of manual work is put on transferring data to ensure is stay synchronised. Not only create extra work, it also adds to the bottleneck of documentation information flow (D12).

5.5.2 Verbal communication Tools

Overall, the interviewees are pleased with the current internal tools that support verbal communication. The following are minor issues that interviewees stated.

Many interviewees express the importance of a whiteboard in meetings which is currently missing during communication with distributed teams. Instead, PPT or pre-prepared drawings are used to support the lack of interactive tools. During the observation, it is evident that the Ericsson office is equipped with interactive whiteboard, but the usage is little to none.

Though video conferencing is highly appreciated, the connection quality is proven to be problematic. Many interviewees settle on audio calls due to the hectic process of setting up video calls.

6 Model and Recommendations

In this chapter, a model that is developed based on the related works and the findings of the study is presented. The model presents a potential structured way to build a shared understanding of customer value in a large-scale organisation. In each section, recommendations specific to the case study will be presented along with topics, and lastly, section 6.4 includes recommendations for documentation tools.

The model is inspired by the realted work as well as the interviewws. The model aims to mitigate the 13 barriers (D1 to D13) identified in chapter 5 and at the same time provide a structured way to build a shared understanding of customer value in a large-scale organisation (see Table 6.1).

The design of the model is structured into three parts; creating a common language, knowledge flow of building a shared understanding and just enough documentation. Creating a common language lays the foundation of customer value and builds a way of working that all members understand. Knowledge flow of building a shared understanding presents the relationship between requirement engineering and knowledge building as well as the activities involved in each of the periods. Just enough documentation suggests how the implicit knowledge should be explicated into maintainable documentation.

Table 6.1 The relation of the model to the barriers identified in this study.

The model Steps	Barriers to be eliminated
Create a common language	D1, D3
Knowledge flow of building a shared understanding	D2, D4, D5, D10, D11
Just enough documentation	D6, D7, D8, D9
Documentation Tools	D12, D13

The focus of the model is to ensure the delivered final result satisfy the customer's business needs as well as user needs and technical needs. The model does not consider prioritisation between requirements nor release planning.

6.1 Creating a common language

To transfer customer value efficiently and accurately, common ground or a "shared conceptualisation" is crucial (Garbajosa et al., 2014, Abdullah et al., 2011). In order to eliminate D1 – understanding of customer value, three building foundations, the definition of customer value (Khurum et al., 2013), the definition of requirement levels (Zhang et al., 2013) and definition of shared understanding (Cannon-Bowers and Salas, 2001) need to be in place. With the structure of the definition in place, when a requirement is created, members have the mental map in mind already and only need to place the requirement on the map.

6.1.1 Definition of Customer Value

A pre-defined value map (Khurum et al., 2013) can provide an initial structured view (see appendix 1) and a common language to for all roles to transfer the customer value knowledge. However, the value map will need to be customised further to fit better into industry-specific customer values. For example, reliability is a crucial aspect of telecom, but in the software value map it is only presented as

reliability. For example, reliability can be broken down into sub-categories such as uptime, equipment durability, etc.

6.1.2 Definition of requirement levels

We mirror the three requirement levels (Zhang et al., 2013) to the abstraction levels in requirement engineering (Cockburn, 2000), where customer value links to summary goals, customer goals link to user goals and technical solutions link to sub-functions. The lower level requirement needs to be in line with the higher-level requirements. This is to ensure that when a high-level requirement is broken down into 300 technical solutions, all of the 300 technical solutions are still focusing on achieving the high-level requirement.

Customer Value is represented high-level requirements, which state business reasons and benefits of the customer value. Customer value might seem mundane sometimes, but it is indented. It is to restate the assumption or otherwise implicit information to ensure that all members, juniors to seniors, Customers to XFTs, have the same understanding. The separation of "customer value" and "customer needs" shows clearly the value to be delivered. This could help externally to ensure what the customers top priorities are and internally to clarify the primary purpose of the requirement.

Customer goals are the most common requirement level and show the role, the goal and the reason for the requirement. It is crucial that the reason for the customer goal level align with the customer value level.

Technical Solutions are the low-level requirements which are mainly technical solutions and their details needed to facilitate the goals above. This is the main information for cost estimation which is crucial to planning.

6.1.3 Definition of levels of shared understanding

With the level of requirements in place, next is to define how extensively each role should know about all levels. The definition of levels is based on Cannon-Bowers and Salas (2001)'s shared understanding. Each company has its unique condition based on organisational structure and industry-specific restrictions. The final usage of the theory should always be customised to fit the intended environment. Recommendations are shown below:

Customer Value – Identical shared understanding: All members involved should have an identical understanding of the main purpose of the requirement. It means the primary value that the requirement needs to deliver and why.

Customer Needs – Identical shared understanding: It is preferred that customer needs are identical shared understanding but depending on the size of a requirement, it could be an overlapping understanding. Overlapping means that all members should have a big picture on each part of the customer needs and the team developing the requirement should have a crystal-clear view on the customer needs and the reasons for of the requirement.

Technical Solutions – Distributed shared understanding: Many requirements require multi-disciplinal knowledge. It is clear that the technical detail will be the distributed shared understanding where for instance a software developer has a deep understanding of the code but shallow understanding of the hardware.

6.1.4 Which role defines which requirement level?

In the knowledge management lifecycle, knowledge first has to be acquired, then created and finally it can be transferred (Gasik, 2011). In the long chain of requirement comments, roles have to be assigned

as responsible for defining a requirement for the organisation throughout the iterative process. This will help to eliminate D3 – customer value creation.

Customer value, a role that has an overview of the product and clients will be most suitable. The role will define customer value for high-level requirement and draw the picture of customer value for internal communication.

Customer goals, a role that is close to the developers and clients will be most suitable. The role will need to consider customer value and refine customer needs into customer requirements, which are best expressed as customer goals, e.g. as user stories.

Technical details, a role that is an experienced developer will work the best.

For the case study company, the recommendation is shown in Figure 6.1. APO is a role that holds overall responsibility for a product as well as requirement prioritisation. In addition, they situate in the bottleneck of the requirement chain; he will have the best overview of all requirements. Therefore, we believe APO will be a good role to define the customer value for the company. For customer goals, we believe OPO will be a great fit; they are often responsible for the OA which includes user stories and use cases. Lastly the technical details could be OPO as a central role and XFTs as support. By responsible, we refer to have the final decision and being responsible for the decision.
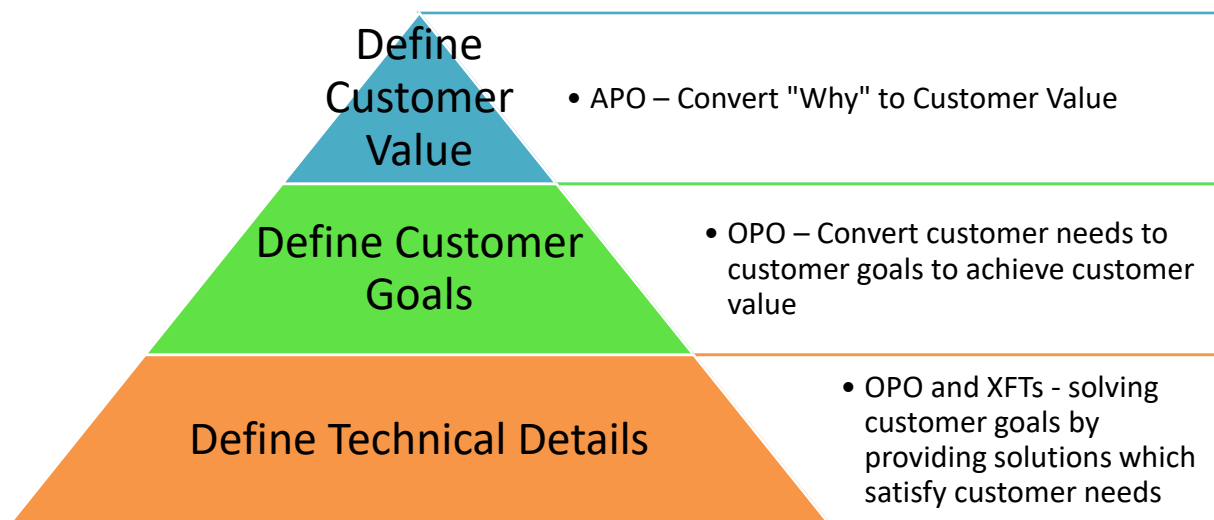

Figure 6.1 Role's responsibility of Requirement Levels

6.2 Knowledge flow of building Shared understanding

The model of knowledge flow for building shared understanding incorporates which requirement engineering states to show on the timeline (DamilerChrysler, 1998), the knowledge sharing lifecycle (Gasik, 2011) to show the organizational levels, and the shared understanding technique categories (Glinz and Fricker, 2015) to indicate the activities to be carried out in the period. As mentioned above in section 4.1, the Knowledge sharing life cycle and categories of shared understanding techniques were incorporated to locate the activities at the process in order to analyse relationship between the activities and barriers as well as the activities and techniques used.

The model below (Figure 6.2) shows the lifecycle of the timeline between the requirement management and shared understanding building periods. Ericsson's ways of working are adopted in the model to show the Shared understanding phases at each organisational level. The organisational levels and Shared understanding Lifecycle are explained in the following sections.
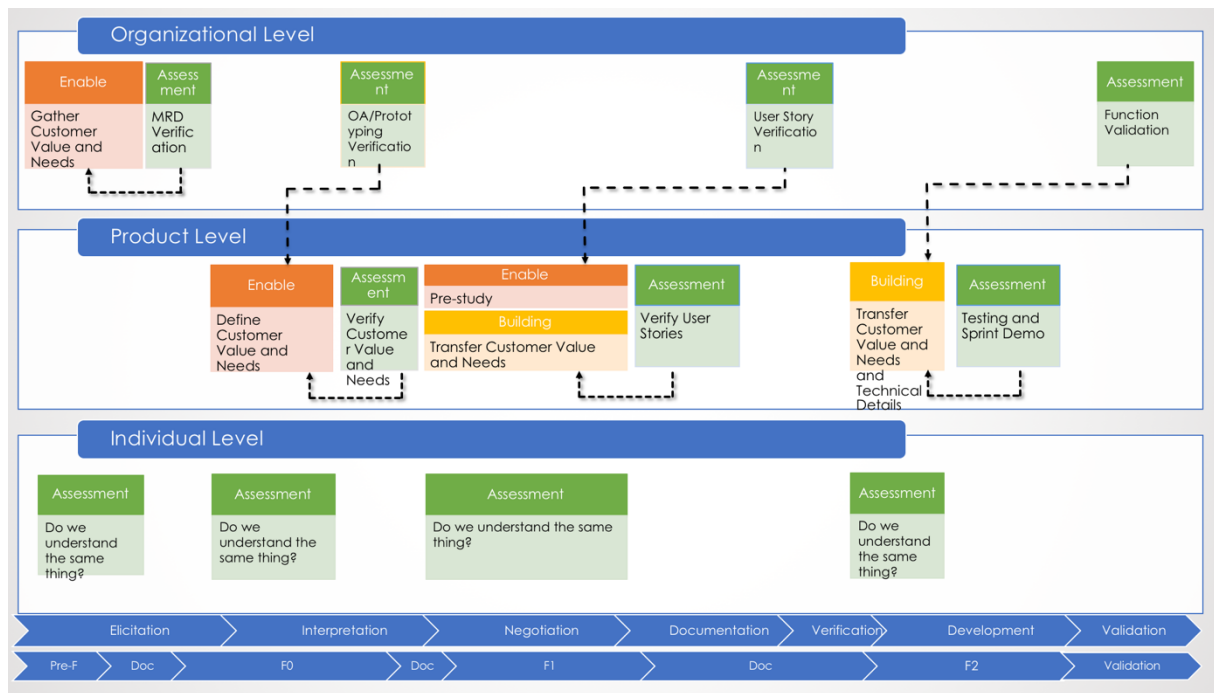
Figure 6.2 Shared Understanding Building Model

6.2.1 Organizational Level

The three levels of organization, product and individual are inspired by Gasik (2011)'s knowledge management model (organisation, project and individual).

- Organizational level shows activities with external units (outside of the organisation), such as customers.
- Product level shows internal communication activities between different roles. For the case company this stretches from CUs all the way to XFTs.
- Individual-level is on a personal level where the periods highlighted are most critical to ensure having a true shared understanding.

The organizational level starts with Enable where CUs actively gather the "why"s and customer needs, followed by documentation verifications with customers (MRD, OA, User story) at the end of each F-stage and finally the validation process after development. The iterations help to identify faulty assumption of requirements in the earliest possible stage. We believe the direct verification process (S9) with the customer will help to eliminate the barriers D10 – little verification and D11 – little feedback and increase customer involvement.

Product level, after APO receives MRD from CU, OPO will help to define the customer values and goals. In this stage, CU should support to retrieve more information about customer value if needed or APO should hold an on-demand meeting with all roles needed to shortcut the communication chain by having direct contact with the customer. This should help to eliminate D5 – the bottleneck of the requirement chain. Same as organisational level, for each document, a verification iteration should be conducted. The purpose of the internal validation is to ensure lower-level requirements align with higher-level requirement. In the negotiation phase (F1) and the beginning of the Development phase (F2), new members are involved in the requirement, hence the building phase of shared understanding.

Individual-level, as mentioned above, it is more a mindset or an attitude of not making an assumption and always reassure that the person whom one is interacting with has the same understanding.

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6.2.2 Shared understanding Lifecycle

In Figure 6.2, for each organisational level, there are activity items, enabling, building and assessing, indicating the cycle of knowledge sharing. The activity items are explained below:

6.2.2.1 Enable a Shared Understanding

In the enable phase, the main tasks are gathering information for requirements, and defining each requirement's level to enable the shared understanding. The case study points out the challenges in this stage being customer value acquisition and creation and documentation.

In the customer value elicitation process, CUs on occasion do not get to the bottom of requirements (D2) and when followed by a lack of verification after the F0 stage, this can lead to ambiguous MRDs and even faulty assumptions. It is recognised that CUs hold a crucial position in the requirement chain in the elicitation phase and cannot be replaced by other roles. Therefore, we believe a feedback process should be implemented. It could be from APO to CUs on documentation quality or trainings on requirement elicitation, to improve the skills of elicitation as well as documentation. The majority of requirements are elicited via CUs; accurate elicitation will improve time-to-market as well as saving operational cost. Also, when a request passes F0 and becomes a requirement, an on-demand meeting (S1) should be arranged directly with the customer (S3) and the CU for further requirement elicitation. This should ensure that the requirement fits the customer's needs and goals.

Customer value creation shows that often it is difficult to pinpoint the customer value (D3). First, with roles assigned as responsible at each requirement level, we ensure that each requirement level is carefully considered. Second, if a requirement comes from multiple customers, the opinions from the interviewees are to list out the customers and choose one of the most important customers on the list and use them as the main customer to serve for the requirement. This is a similar solution as proposed by Zhang et al. (2013) when defining customer value, variables like number of customers, customer preferences should be considered and weighted for decision making.

6.2.2.2 Building a Shared Understanding

In the building phase, the main task is to generate documentation and share the created knowledge to the members involved using verbal communication and documentation. The case study points out one of the challenges at this stage the long communication chain.

The organizational bottleneck shows that the APO is the single node from CUs to OPOs (D5), and the speed of the information flow depends heavily on the capacity of the APO. We recommend that after prioritisation, the most suitable people should be connected directly to continue the developing requirement. This setting might increase the risk of APO not having a full understanding of the customer needs. Therefore APO, the decision maker, should still be kept informed and involved.

To avoid losing implicit knowledge (D6), both documentation and verbal communication play a crucial role in a large-organisation. Implicit knowledge should be partially explicated to documentation and serve as a conversation trigger/reminder (see section 6.3). During verbal communication, an agenda should be set to discuss customer values and goals (S5) to ensure the building of shared understanding.

6.2.2.3 Assessing a Shared Understanding

In the assessment phase, the main task is to verify and validate requirements on the organizational and product levels and to ensure true shared understanding on a personal level.

Verification should be conducted after each document (MRD, OA, Pre-study and User Stories) or artefacts (prototype, model) are a generation. First, the internal verification where the roles responsible for each requirement level need to verify that their requirement levels are aligned with the higher-level requirement. This should eliminate D9 – the quality of documentation. Then the documents should be verified by the client either via CU or directly by APO or OPO (S7). The verification process should help to increase customer feedback (D10 and D11). In addition, both the interviewees and Glinz and Fricker (2015) suggest especially a GUI or any physical interface prototype verification, (S8), as they believe that this type of prototype serves excellent value during the development process.

The personal level, assessment is an attuited of working; individuals should not make assumptions and always be careful when transferring and receiving new requirements. This is especially crucial during the enable and building phases when new knowledge is created, or a new member is joining the discussion.

One of the techniques in the assessment (Glinz and Fricker, 2015) is paraphrasing; the purpose is to assess whether two authors have the same understanding. In Ericsson, the process is done by transferring MRD (written by CU) to requirements (written by APO), then to backlog (written by OPO). The issue here is CU does not have access to these requirements. Therefore they are not able to verify the next steps of documentation. We recommend to open access to all documents to all members involved; this will help to eliminate D12 - the bottleneck effect between the two systems (Focal Point and Hansoft) as well as for members to easily access the origin of the data, which might help to point out any misunderstandings.

6.3 Just enough Documentation

Glinz and Fricker (2015) point out that there are three ways to improve the shared understanding. We recommend a mix of the implicit and explicit solutions. It should be an optimal choice for resource planning at large-scale companies to help find the sweet spot of D7 – just enough documentation.

To achieve the balance between explicit and implicit knowledge transfer, a structured process has to be created. On that defines implicit knowledge that needs to become explicit knowledge and how it can be explicated.

Transfer Implicit Knowledge into Explicit Form

From the interviews, we see that customer value is often treated as implicit knowledge and with the structure of customer value in place, it can be more easily transferred to explicit knowledge. As mentioned before in section 5.1, by using a customer value map (Khurum et al., 2013) (see appendix 1), customer value to be delivered could be explicated as a category with a short description along with the high-level requirement and later broken down into customer goals and user stories. This should help to eliminate D6 - implicit knowledge lost and D8 – customer value missing in the documentation. The written text can serve as a trigger point for implicit knowledge transfer, aka conversation. Especially for distributed teams who do not have a chance of informal coffee machine chat, the explicated customer value serves as a trigger to start the verbal communication during meetings. To implement this, the field "Rationale" should be added to Hansoft and set as mandatory both there and in Focal Point (S2).

One confusion is how much of the customer value should be transferred; we believe it is essential for all team members to have an identical shared understanding of which category of customer value for example "reliability" will be delivered and why. As for the story of how APO and the customers will be a bonus but not necessary.

6.4 Documentation Tools

In section 5.5.1, two barriers were identified, D12 – documentation system bottleneck and D13 – manual data synchronisation.

The benefits of documentation in large-scale Agile is to save time for experts, preserve forgotten details and support knowledge transfer (Yanzer Cabral et al., 2014). D12 – system bottleneck has taken all the benefits away from the documentation. We recommend giving access rights to all related members, from CUs to XFTs. By increasing transparency, all documentation benefits can be reintroduced. Also, members can actively take the initiative to investigate further into documentation issues, instead of encountering the access right barrier and then stopping to pursue the root cause.

As mentioned in section 6.2.2.3, paraphrasing is one of the technique for assessing shared understanding. Rewriting requirements is important in the process of having a shared understanding of requirement engineering. However, D13 – manual data synchronisation refers to data that should be synchronised throughout the whole requirement engineering cycle such as requirement and release plan from Hansoft to Focal Point on both requirement and MRD.

7 Conclusion

By moving from a plan-driven approach to an Agile approach, customer involvement is getting more and more critical (Fabijan et al., 2016). It helps to accelerate the feedback cycle as well as developing the right requirements with the right emphasis on them. The difficulty of having frequent involvement in large-scale organizations identified as a challenge which is confirmed in this study. Furthermore, we would like to emphasise the importance of the customer's involvement at the beginning of a requirement's life cycle, where the customer value of a requirement has to be elicited and verified to ensure the deliverables are aligned with the customer's ultimate goals.

In this paper, we present our results from a single case study conducted in Ericsson, a large-scale Agile organisation. We believe the current process is functioning, but as the interviewees say, improvements can always be made. We identified two current main barriers in the process of building a shared understanding of customer value. The lack of a structured shared understanding of customer value definitions and inefficient requirement elicitation. Both barriers are in the enabling stage, which is the first step in building a shared understanding. There are barriers identified in building and assessing stages of building a shared understanding too, but we believe more will unfold after the enabling barriers are unblocked.

A model is presented as an effort to mitigate the currently identified barriers. The model includes three parts. 1) Creating a common language to ensure knowledge creation and efficiency of knowledge sharing and transfer, 2) Improving knowledge flow for building a shared understanding to ensure all members involved in a requirement have a true shared understanding of customer value, and 3) writing just-enough documentation to facilitate implicit knowledge being shared through documentation in a large-scale organization.

Plan-driven and Agile approaches are not a binary decision but a spectrum. Agile has been practised in Ericsson for a decade now; it is clear to us that the interviewees believe in the direction the company, and so are us. The challenge remains for Ericsson, as a large-scale organisation, to find the right balance of Agile in the spectrum, to find the sweet spot of customer involvement as well as documentation.

Future work

Due to time constraints, the model did not be evaluated in different parts of the organisation during the study. Therefore, the model should be evaluated in different parts of the company as well as in various industries as future research. The verification and validation of the model depends on the settings of industry or organization and whom is testing it. However, we think that using the model in workshops would be a good starting point. By practicing the model with method/process/tools responsible and see if it yields good insights in how to improve their value knowledge flows. Moreover, we disregarded elicitation and prioritisation since the study focused on building an internal shared understanding of customer value in the organisation in this study. However, during the interviews we noticed that the elicitation plays an important role in gathering the customer values and needs which is done by customer unit. Unfortunately, due to the time restrains and unavailability from the CU, we were not able to interview any person from CU. For this reason, the elicitation aspect is significant when investigating the shared understanding of customer value and we recommend future researchers to study the interaction between CUs and customers as well as how the elicitation process works.

Limitation

First, the study mainly focuses on building a shared understanding of customer value. Therefore this study does not cover the challenges stated in the Kasauli et al. (2017b) study regarding aspects of shared understanding of the system and the planning process. Second, on sources of requirements, the thesis only covers requirements that is elicited from the customers, the internally raised requirements

are excluded. Lastly, decision making of prioritisation is excluded as well. Dikert et al. (2016) states, for Agile to succeed, it needs to be customised to fit the specific organisation set up. This poses a limitation to the proposed model. Since the study is focusing on a single company, a generalisation of the study outcome is limited.

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Appendix

Appendix 1. Software value map (Khurum et al., 2013, p13)
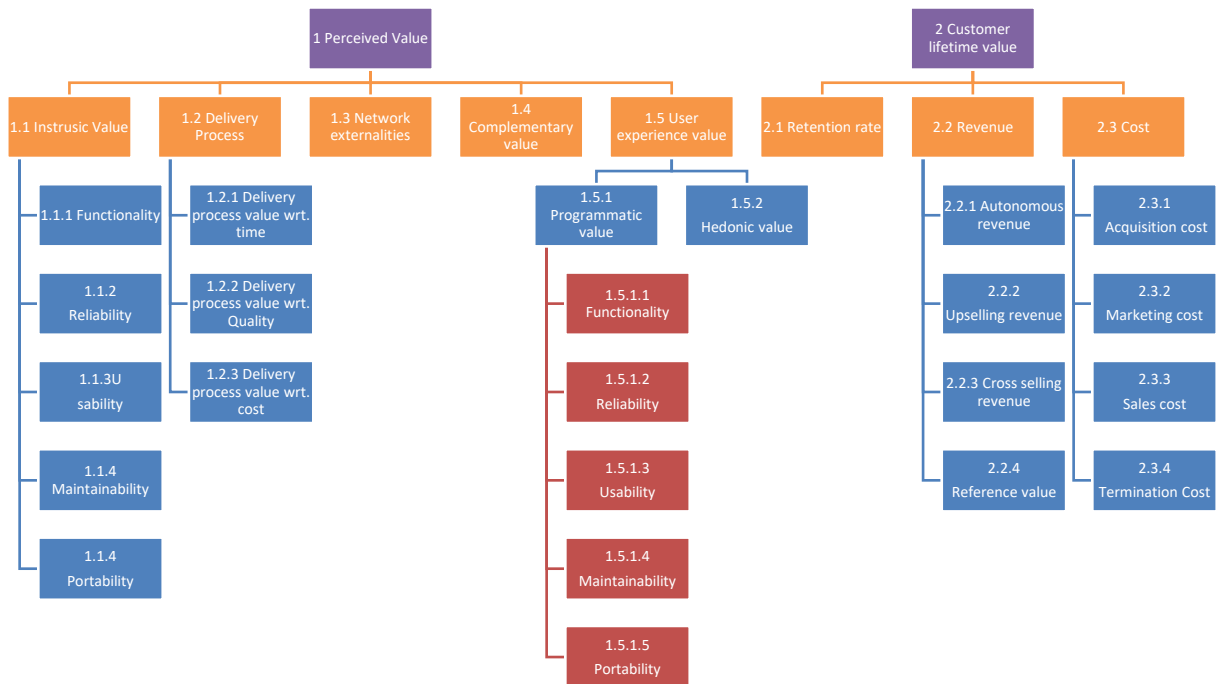
Appendix 2. Interview Questions

1. Can you tell us about yourself?
   - What is your job title/role?
   - What is your responsibility of your role?
   - How long have you been working for this company?
   - Which department are you working for now?
   - What is the size of the team?
   - Where do your team members located?
   - Which product do you work with?
2. From your point of view, what is customer value?
3. Looking at the below requirements, could you describe what is the main Customer value the requirements brings? (please choose requirements that you work with and skip the ones that are not familiar)

Split	All Outdoor
NPU	EQP
1588	1588
L3 VPN	ERP

4. Could you please describe **how the customer value was shared to you** for these requirement that you described in question 3? Is it any different from the general process?
   - From which role did you get the information?
   - Was any verbal communication or documentation involved?
   - Which tools were used?
5. Could you please describe **how you shared the customer value to others** (within the team or to other teams)? Is it any different from the general process?
   - From which role did you get the information?
   - Was any verbal communication or documentation involved?
   - Which tools were used?
6. From your point of view, which role should draw the picture of customer value for each requirement for the team to pass on?
7. Could you please describe **what do you in your role do to pass on the customer value knowledge to build long-lasting knowledge** (within the team or to other teams)?
   - Any tool involved?
8. Could you describe how did you **verify the customer value for the requirements** before the development process started? Is it any different from the general process?
   - Which roles did you verify the customer value with?
   - Was it verbal communication or documentation? Which tools were used?
   - Did you communicate with customer in any way? Is yes, what role on customer side do you have in contact?
9. Regarding the current process, do you find it working well or not well regarding the customer value understanding and **sharing for you/ to other members/ verify/ long-lasting**?
   - What do you think that works well?
   - What do you think can be changed? How would you change them?
10. From scale 1 to 10, how important do you think "having a shared understanding of customer value" is? Why?
11. Is there anything we should have asked but did not? Is there anything else you would like to mention/anything missing? How would you envision an ideal process of managing customer value?