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An Interactive Tool for Collaboration and Knowledge Sharing of Customer Needs in the Conceptual Phase

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Abstract. This paper aims to research how the use of an interactive tool can facilitate collaboration, knowledge sharing and enhance the understanding of customer needs in conceptual phase at a global shipbuilding company. An effective conceptual phase depends on collaboration and mutual understanding of customer needs to capture customer requirements and transform them into a base of design-document. Lack of early common understanding can result in increased project cost or in worst-case loss of contract. We used action research as an approach for our study and developed and implemented an interactive tool in a case at the company. In-depth interviews and root-cause analysis were used to determine the pain-points of the as-is situation. A feedback survey was used to evaluate the performance and result of the interactive tool. The results indicate that the interactive tool contributes to a better overview of ongoing projects, increased knowledge sharing, and enhanced common understanding.

Introduction

Company. Ulstein Group ASA is a Norwegian and family-owned company founded in 1917 and has about 600 employees. The company has a global presence with offices in five countries, with the headquarter located in Ulsteinvik, Norway. Ulstein Group ASA is the parent company of a group of maritime companies that focus and are specializing in ship design and maritime solutions, shipbuilding, power and control, and shipping (Ulstein Group, 2019).

Throughout the years, the company has gained solid expertise and experience with their design solutions. In the beginning, starting with repairs and construction of fishing vessels, followed by steel newbuilds including passenger ships, ferries, and offshore vessels (Ulstein Group, 2019). During the last years, Ulstein has entered a new market, the Exploration Cruise market, a market which is increasing rapidly.

Case. In this paper, we performed a case study on a project in the conceptual phase. The customer need is to get a medium-size vessel. The customer is international and new in the shipbuilding industry and has no earlier experience with the development process. Due to success in other industries, the customer wants to expand the brand and to see if there are possibilities in a new segment.

Problem. Ship design is a complex process that involves many disciplines, departments and people who need to work together to make the best solutions and design for the customer. Based on the vision of the customer, the ship designer has to develop the most cost-effective ship for a designated

task, where finding the best compromises regarding operational, technical and commercial aspects is crucial for success.

Ulstein have years of experience in ship design, where they have achieved great success through extensive competence, innovation and precise execution of developing vessels. However, by entering a new market, Ulstein need to understand and communicate with a new group of stakeholders in order to get awarded contracts. The contracts they are competing on winning are usually ‘’no-cure, no-pay’’ customer contracts, which means that they do not get paid if they do not get awarded the contract.

To focus on collecting, understanding and documenting the customer expectations and needs, and to communicate and share these both internally and to the customer, could be crucial in order to get the contract and to prevent enhanced cost later in the shipbuilding process. The evolution of cost and knowledge in a systems life cycle, Figure 1 adapted from Sols (2014), shows that committed cost enhance and easiness to change decreases throughout the life cycle.

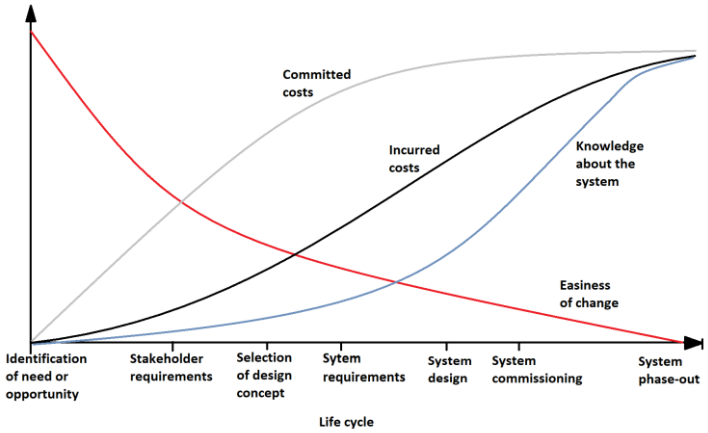

Figure 1 Evolution of cost and knowledge in a systems life cycle adapted from Sols (2014)

This paper aims to research which communication and knowledge sharing methods Ulstein use in the conceptual phase and how the use of an interactive tool can enhance the understanding of customer needs. Ulstein participates in an ongoing research project involving other industrial partners with the purpose of sharing knowledge on cross of partners and develop applicable methods and tools for early phase development. One of these tools is an interactive knowledge sharing tool called IKA, that indicate to be effective at one of the other industrial partners providing innovation-oriented consultancy (Røed Jensen, Muller, & Balfour, 2019). The IKA stands for Interactive Knowledge Architecture. In this research, we investigate how this tool will fit within Ulstein’s processes. The IKA may facilitate the collaboration between the departments, and we seek to investigate how this method can benefit the conceptual phase.

Research questions. In this paper we address the following research questions:

- Which communication and knowledge sharing methods does Ulstein currently apply in the conceptual phase, and what are the pain-points of the as-is situation?
- How can IKA enhance the understanding of customer needs?
- How can IKA facilitate collaboration and knowledge sharing in the conceptual phase?

State of the art

Requirement Engineering (RE). In our literature review, we want to include state of the art within requirement engineering because it highlights the importance of communication and having the right understanding of customer needs. Meeting the needs and requirements of the stakeholder is fundamental for project success (INCOSE, 2015). A study on software projects by The Standish

Group, reports that incomplete requirements and lack of user input are the main reasons why projects have challenges or failures (The Standish Group 1995, 2014). The importance of transforming the customer needs into getting the right requirements is well documented in the systems engineering literature, where the relative cost to fix a problem is based on where in the systems life cycle the problem occurs (Sage & Rouse, 2009) (Sols, 2014) (INCOSE, 2015). Requirement engineering is to develop requirements at both stakeholder and system level and includes the four tasks of eliciting, document, validate and verify, and manage the requirements in the lifecycle of a system (Sols, 2014) (Pohl & Rupp, 2011). The goal of the elicitation process is to make hidden knowledge about the problem or need explicit, and to ensure that people involved in the process is able to understand it (Pohl, 1997).

The System Engineering approach use Concept of Operation (ConOps) or Operational Concepts (OpsCon) early in the development process to facilitate a common understanding of the need of a system, without addressing the technical solution (INCOSE, 2015) (Sols, 2014). In a multidisciplinary business, the development of a good ConOps or OpsCon could benefit not only the customers but also enhance different departments' understanding of the system/stakeholder needs (Sols, 2014). On the other hand, writing a ConOps document could be a labor-intensive and time-consuming process (Peter Korfiatis, 2015). The findings from a review of 22 ConOps from government and private sector in the USA, was that the development process could take as long as 30 months. When the bare minimum of elements was selected, they finished the ConOps within three months (Ali Mostashari, 2011). To make the process agile, the research suggests improving three key areas: stakeholder involvement, shared mental models, and visualization (Ali Mostashari, 2011).

A study by Al-Rawas and Easterbrook characterize the communication activities as important in the requirement engineering phase, where the three major communication barriers are due to; *1) ineffectiveness of the current communication channels; 2) restriction on expressiveness imposed by notations; and 3) social and organizational barriers* (Al-Rawas & Easterbrook, 1996). Both technical and social skills are required in order to capture and elicit the requirements successfully. Where the ability to communicate to several stakeholders involved in the process and establish a mutual understanding and agreement is key (Pohl, 1997).

Knowledge Management (KM). Knowledge management is a broad concept, addressed in several disciplines such as business management, engineering, IT, economics and psychology (Lloria, 2008). To understand the concept and value of knowledge is the first step in defining KM. According to Noruzi et al. the knowledge is considered to be the most valuable and strategic resource of a company. Efficient knowledge flow in a company, increase the learning capability and enables business growth (Noruzi, Stenholm, Sjögren, & Bergsjö, 2018). The knowledge hierarchy is a way of explaining the relationship between data, information, knowledge, and wisdom. Data is facts and figures and is considered to be the raw material for the creation of information (Sols, 2014). Information is data with context, and knowledge is information in action and is the ability to give it meaning. Wisdom is knowledge with insight (Nazim & Mukherjee, 2016). In relation to Information Management (IM), KM focus on human intervention, knowledge and tacit knowledge, while IM provides necessary tools for KM (Lloria, 2008). The definition of knowledge management in system engineering literature is the process of creating, sharing, using, protecting and discarding knowledge throughout the lifecycle a system (Sols, 2014).

Challenges in managing knowledge in a company are that the creation and storage of it are at an individual level, in the employees' head. In order to successfully manage the knowledge in a company, both the explicit (recorded) and tacit (personal) knowledge needs to be captured and utilized (Nazim & Mukherjee, 2016). The INCOSE System Engineering Handbook identify the motivating factors for implementing KM in company as; sharing information across the organization; reducing redundant work due to not having the right information at the right time; opportunity to use the existing knowledge and not making the same thing twice; focus on best practice; and capture the

tacit knowledge and transform it to organizational knowledge (INCOSE, 2015). Nazim & Mukherjee describes principles of knowledge management success depends on three basic pillars, people, technology, and process (Nazim & Mukherjee, 2016). People address the mindset, technology enables the people to get as much as possible out of the KM, and process facilitates and guides how to capture and use knowledge (Nazim & Mukherjee, 2016).

Soft skills in complex projects. When developing a system, like Ulsteins development of Exploration Cruise vessel, the technology in its self is complex and challenging, where the company needs to stay on top of the evolving and new technology in order to be competitive in the market and to meet the needs of the customer. Adding people in the process, with different knowledge, experience, location, language, culture, personal needs, and value are some of the factors that bring added complexity to the projects (Crowder & Shelli, 2013). Research about project complexity in the aerospace sector by Azim et al. discovers that people have the highest impact on project complexity by almost 75%, compared to process (21%) and product (9%) (Azim et al., 2010). The research concludes that soft skills, including organizational, teamwork, communication, and other people-based skills, are important in complex projects (Azim et al., 2010).

Architecture Overview A3 Architectural Overviews (also called A3AO) is a visual tool used for communication and knowledge sharing and is based on simplifying the information by limiting the amount into two A3 pages. The goal is to have an effective and easy tool to use in daily work, which supports architectural reasoning (Brussel & Bonnema, 2015). In order to support complex systems with multidisciplinary teams, the information and content of the A3 Architectural Overview have to capture the required knowledge needed for the different disciplines and stakeholders (Borches, 2010). Borches states that sharing knowledge through architecture has been identified as one of the key success factors in software engineering (Borches, 2010).

Interactive Knowledge Architecture. IKA is an interactive knowledge tool developed by a project group in Semcon Norway AS and is used in the early phases of system development. The tool is used as a platform for project documentation, where the purpose is to build mutual understanding for both the project team and customer (Røed Jensen, Muller, & Balfour, 2019). The tool is based on Human-Centered Design principles described in ISO 9231 :a) the design is based upon an explicit understanding of users, task and environment b) users are involved throughout design and development c) the design is driven and refined by user-centered evaluation d) the process is iterative e) the design address the whole user experience f) the design team includes multidisciplinary skills and perspectives (ISO-9241, 2010). The IKA is a tool for navigating through and visualize project documentation, what kind of information the platform will contain, is up to the user of the platform.

Research Methodology

The type of research design chosen for this study is action research (Figure 2) (Riel, 2019). Action research in an iterative process, where the research takes form while it is being produced. For each cylindrical process, we analyze and reflect on the result, before adapting, plan and performing the next cylindrical research process. Action research is a process of continual learning (Riel, 2019). We use in-depth interviews to gather data and to understand the as-is situation at Ulstein. We use the data into a root cause analysis to find the cause and effect of problems in the current situation at Ulstein (Andersen & Fagerhaug, 2006). By observing as participants, we observed the activities and communication during the project meetings. Focus groups were used to gain a rich understanding of selected topics, such as root cause analysis results, and the development of the method used in the case (Morgan, 1998). We collected a survey in the final phases of the project to verify the IKA performance. A set of questions regarding the experienced use of the IKA, where the questions had to be answered on a numeric scale, were used.

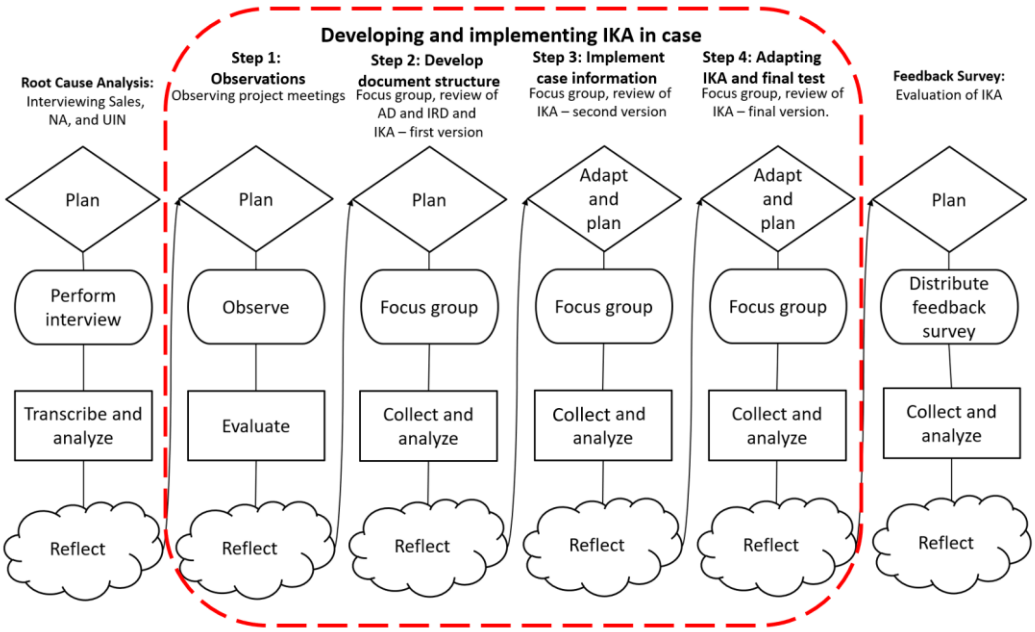

Figure 2 Action research process, illustration based on (Riel, 2019)

Interviews. We applied semi-structured in-depth interviews, where the interview consisted of several key questions. The purpose of the interviews was to gather information and gain knowledge about Ulsteins' work process, communication and knowledge sharing methods, and the pain-points in the conceptual phase. With a semi-structured interview, it also gives the freedom to discover and talk about other topics that may emerge along the way (Saunders, Lewis, & Thornhill, 2009). We transcribed interviews and applied root cause analysis, consisting of an Affinity and Interrelationship diagram, to find the root causes of the pain-points in the conceptual phase. To validate the data, we presented the result in a focus group to get feedback. Table 1 describes the population of the participants, where the selection of participants was based on the involvement in the conceptual phase. All the participants were informed of the purpose of the research and consented to the interview. All information gathered in the interviews is anonymous and not to be linked to any of the participants.

Role	Experience in Ulstein
Naval Architect	20-25 years
Naval Architect	10-15 years
System Architecture Manager	25 + years
Sales Manager	5-10 years
PLM Manager	1-5 years
Business Analysist UIN	5-10 years
Business Analysist UIN	5-10 years

Table 1 Interview participants

Observation. We observed project meetings and had the role of observer as participant. With this role of observing, the participants know the researcher's identity and goal (Saunders, Lewis, & Thornhill, 2009). The researcher is not engaging in the activities but can discuss with the participants. The purpose of this method was to observe how they communicate with each other, what kind of information they use, how they present the information, and how they collect the new information gained in the meeting. Notes of the observations were taken during the meeting and evaluated afterwards.

Focus group. We used a focus group, a qualitative research method where the goal is to generate a rich understanding of participants' points of view through group discussion about a pre-defined topic

(Morgan, 1998). We had a total of three focus groups, where we presented the participants with different topics. In the first focus group, the goal was to verify and discuss the results from the interviews and root cause analysis and the first version of the method used in the case. In the second focus group, the goal was to review the second version of the method used in case. We presented and reviewed the final version of the method in the third focus group. Notes taken during the discussion in the focus group were analyzed and used when adapting the method. The participants are described in Table 2 and are selected based on their involvement in Ulsteins conceptual phase.

Participant in focus group nr.	Role	Experience in Ulstein
1, 2 and 3	Naval Architect	20-25 years
1,2 and 3	Naval Architect	10-15 years
1 and 2	System Architecture Manager	25 + years
1 and 3	Ulstein International	5-10 years
1	Ulstein International	5-10 years
2	Ulstein Design and Solutions Manager	1-5 years
3	Sales Manager	1-5 years
3	Naval Architect	25+ years
3	Naval Architect	25 + years

Table 2 Focus group participants

Survey. We created a survey to collect statistical data about how representatives involved in the conceptual phase evaluate the performance of the method used in the case. Each respondent was asked to answer the same set of questions, which provides an efficient way to collect responses prior to qualitative analysis (Saunders, Lewis, & Thornhill, 2009). We based the design of the questionnaire on how the method performed regarding enhancing understanding of customer needs, facilitating collaboration and knowledge sharing and relating to the discovered causes in the root cause analysis. The survey consists of 28 questions, where 23 of them were created using a Likert scale ranging from ‘’strongly disagree’’ to ‘’strongly agree’’. The five last questions were open-ended and are designed to gather the respondent’s thoughts and meanings and allow them to explain their answers.

We used Net Promoter Score (NPS) to analyze the data gathered by the use of the Likert scale questionnaire. When using NPS, it reduces the impact of the varied perception the respondents may have about the Likert scale and distinguish the respondents between promoters and non-promoters. When the NPS score is below zero, the respondents will probably complain about the method, when it is over zero, they will most likely promote. (Muller, 2013). Table 3 describes the population of survey respondents.

Role	Experience in Ulstein
Naval Architect	25 + years
Naval Architect	25 + years
Naval Architect	20-25 years
Naval Architect	10-15 years
Ulstein International	5-10 years
Ulstein International	5-10 years
Ulstein Design and Solutions Manager	1-5 years
Sales Manager	1-5 years

Table 3 Feedback survey respondents

Current way of working in Ulstein

This paper focuses on the conceptual phase before the customer signs the contract. The process steps and descriptions are based on in-depth interviews, observations and company reports. Figure 3 is a

description of the conceptual phase using the system engineering framework (Sols, 2014). The process flow can vary, depending on the customer.

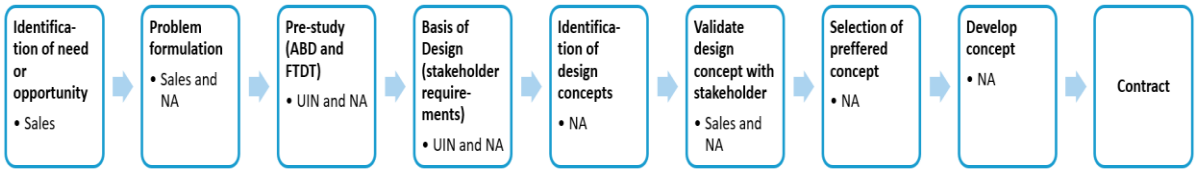

Figure 3 - Conceptual phase at Ulstein

As the figure above is showing, the conceptual phase depends on the Sales, Ulstein International (UIN) and Naval Architect (NA)-departments collaboration. The figure above shows the different steps in the process, and which department has the primary responsibility for the actual process step.

The first contact with the customer is initiated by the customer contacting Ulstein, or that Ulstein reaches out to the customer. Some of the projects are internal project, where Ulstein is their own customer. The initiation of communication is through email, phone calls, exhibitions, visitations or a shipbroker, where the sales department usually have the first contact with the customer. The degree of specification in the customer request can vary from a very specified and detailed tender list to a more open point of view, where the customer wants to see the possibilities and have a set of wishes. When the customer is less specific about their needs, the room for innovation grows, and the need for Ulsteins' pre-study tools increases.

During the first meetings with the customer, sales and NA focus is to define the problem formulation and to gain knowledge in three areas: Operational, technical and commercial aspects. After the initial meetings, the UIN department uses the information gathered to perform a pre-study, to ensure that the business case of the customer is feasible. Analysis of the market, including competitors, potential customers and market, is used to gain a better overview of the problem domain, and to increase the quality of the communication with the customer.

An early mutual understanding of customer need is essential in order to capture the stakeholder requirements and transform them into the base-of-design document (BoD). The document is the NA's interpretation of the information gathered in the earlier process steps and is used as a reference throughout the shipbuilding process.

Alternative design concepts are developed based on the output from the pre-study and the BoD document. The early design concept usually consists of 3D renderings of the design, main design parameters and general arrangement of the vessel. To get a fast response and validation, the design concept is shared with the customer as early as possible. The conceptual phase is an iterative process, where feedback of the early design concept could lead to changes not only in the design of the concept but also in the problem formulation and BoD. The process of communication back and forth with the customer eventually leads to the selection of the preferred concept and developing the concept. The final vessel design is captured in a ~250-page building specification, which is the final delivery to the customer before the contract is signed. Depending on the customer, the conceptual phase can vary in length, some projects can use only a few weeks, and others use several months or years.

Root Cause Analysis of communication and knowledge sharing pain-points

Every problem has a cause. To solve a problem, the root cause must be identified in order to get it eliminated (Doggett, 2005). According to Andersen and Fagerhaug (2006), can causes be classified

as; a) Symptoms - could be mistaken as a problem, but is just a sign of the actual problem. b) First-level causes – causes that directly lead to a problem. c) Higher-level causes – causes that are linked to the first level causes, but do not directly cause the problem. The highest level of cause is defined as the root cause of a problem (Andersen & Fagerhaug, 2006).

The purpose of the analysis is to investigate if there are any pain-points in the communication and knowledge sharing process at Ulstein, and the root cause of the problem. In order to conduct the root cause analysis, we use the data gathered from the in-depth interviews. We use a two-step process, where we at first use affinity diagram to categorize the statements, and in the second step is to use the interrelationship diagram to create a relationship between the causes and effects. The interviewed participants are a representative selection of the three departments (Sales, NA and UIN) in the conceptual phase.

Interrelationship Diagram. The interrelationship diagram, also called relations diagram, was developed as a part of a toolset known as seven new quality control tools (Doggett, 2005). The purpose of the diagram is to identify, analyze and clarify the relationships in complex problems. Figure 4 shows the relationship between the causes and effects discovered in the interviews. Each statement has in and outgoing arrows that represent the relationship between the two. The statements with the most outgoing arrows are the root cause of the problem, and the statement with the most ingoing arrows is the effect of the root cause. Due to confidentiality issues the text in the white boxes in the interrelationship diagram is blurred.

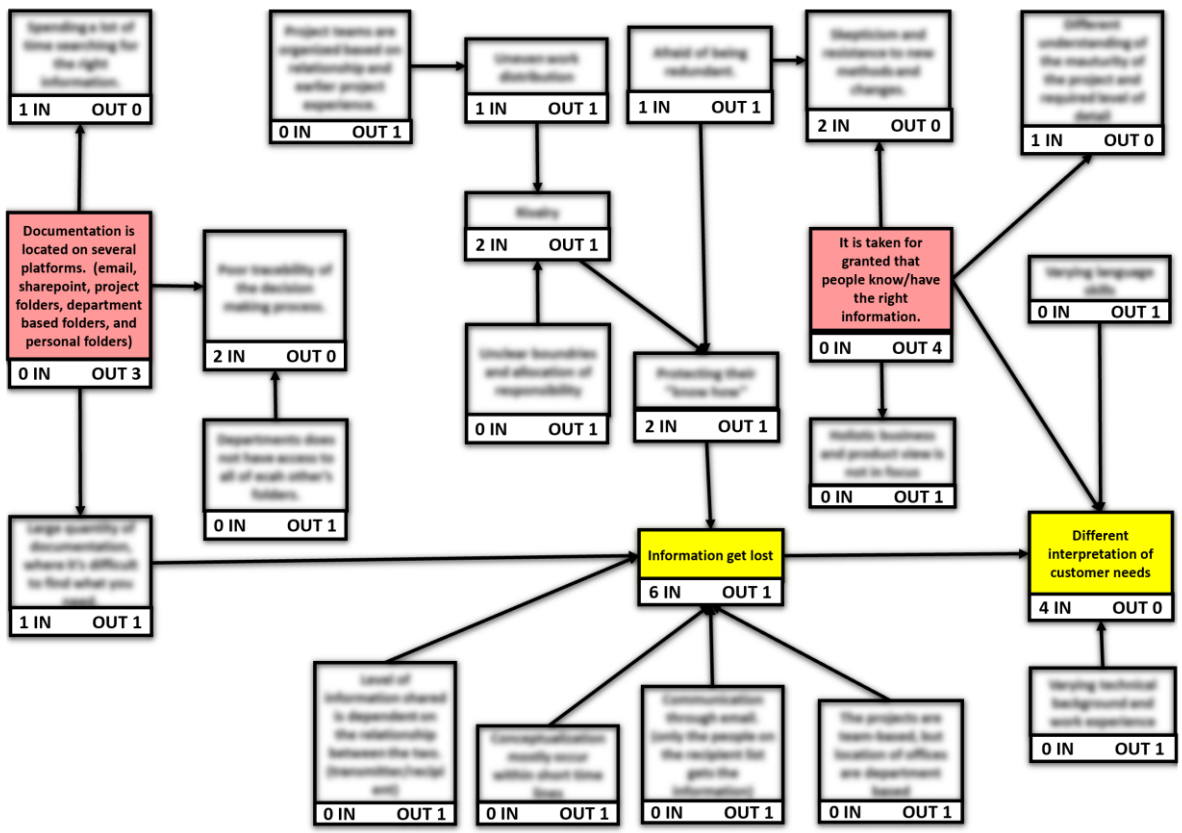

Figure 4 Interrelationship diagram - root cause analysis

The main findings from the root cause analysis and interrelationship diagram (Figure 4) show that the two main causes (highlighted in red) for pain points in the communication and knowledge sharing at Ulstein in the conceptual phase development are; 1) It's taken for granted that people know/have the right information; 2) Documentation is located on several platforms. The main effects

(highlighted in yellow) of these causes are; 1) Different interpretation of customer needs; 2) Information get lost.

The statements we use in the interrelationship diagram are gathered through in-depth interviews and are the researcher's perception of the interviewed participants' meanings. In order to reduce the impact of the researcher's perception and understanding may have on the result, we present the result in a focus group where the participants' comment and discussed the result. Based on the findings in the focus group, we adapt the interrelationship diagram.

Developing and implementing interactive knowledge sharing tool

Interactive Knowledge Architecture. In an earlier research project done by Røed, Balfour and Muller (2019), they used the IKA as a platform for project documentation, where the purpose was to build mutual understanding for both the project team and customer. Based on the result of the root cause analysis and the initial research questions, we decided to implement IKA in a case at Ulstein. The use of IKA has been at the start of a new development project, where project information is documented in pre-designed templates and shared through the platform. The architecture of the IKA is formed hierarchal manner, where the top level consists of a "home page'', shown in Figure 5, where it is possible to access different categories of project documentation. Hyperlinks are used to link content together and to form a structure of the documentation. Navigation buttons are placed on the bottom of each page.

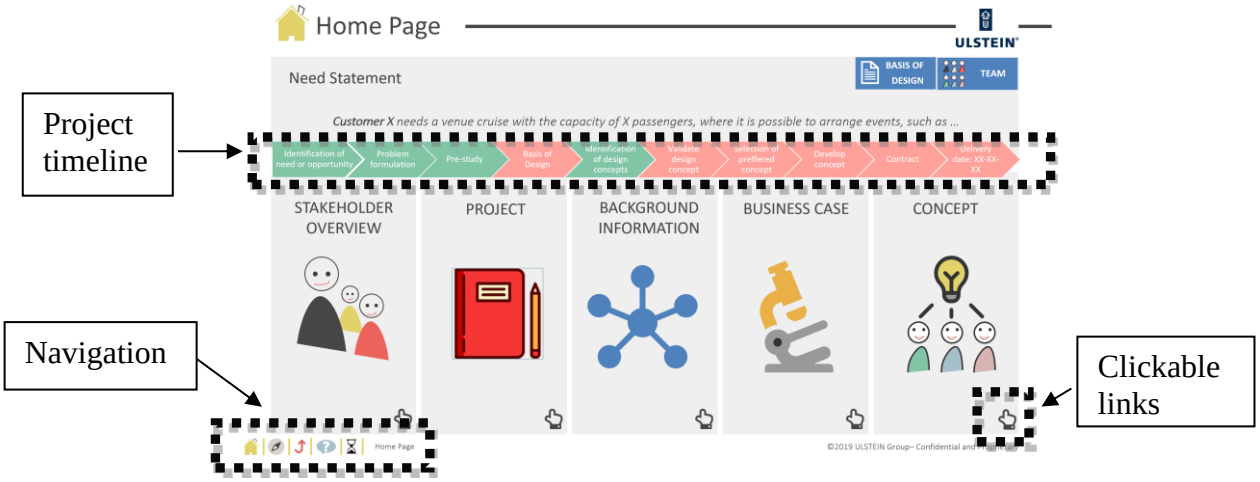

Figure 5 IKA Home page – Ulstein case

The program used to develop the tool is Microsoft PowerPoint, which is a known and common program among companies. It has high accessibility and the possible threshold companies would have to use the tool is much lower. The companies do not have to invest in program licenses or use a lot of resources in learning the program (Røed Jensen, Muller, & Balfour, 2019). The hierarchy of the document, shown in Figure 6, is a breakdown structure where the level of detail increases from the one above.

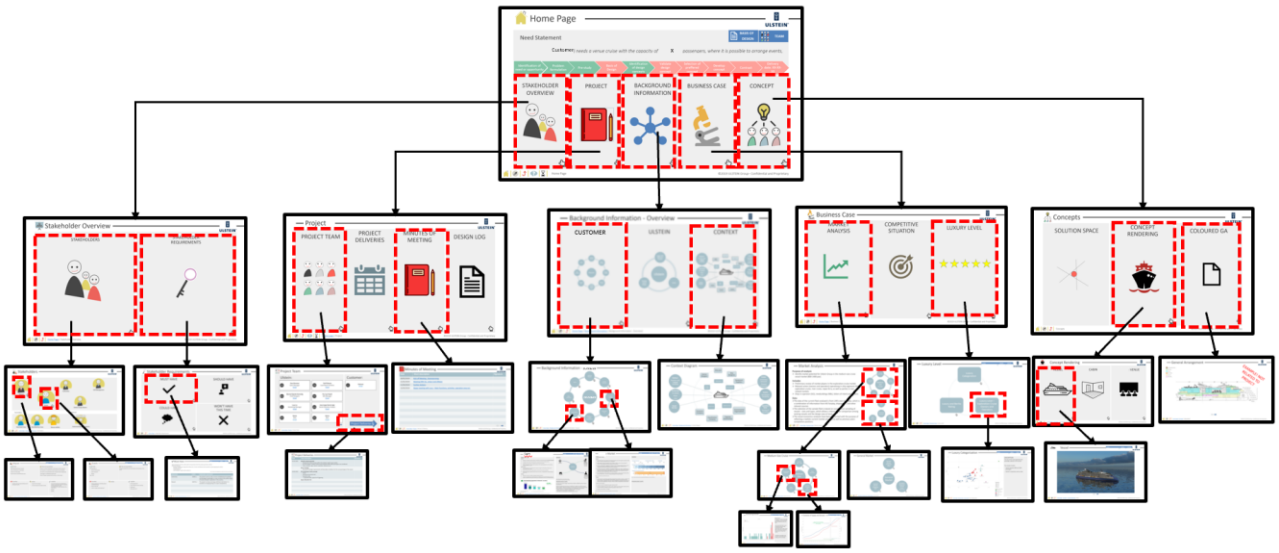

Figure 6 Hierarchy of IKA – Ulstein case

Case. We implemented the IKA at an early development project that started in February 2019. The project group consisted of three sales managers, two naval architects, one business analysist from UIN and one designer. The customer in the case is international and have no earlier experience in shipbuilding, but due to success in other industries the customer wants to see if it is possible to expand the brand and enter a new segment. The customer had a short list of requirements and pictures were used to communicate their vision. One of the challenges with the customer being international is that the project group have no direct contact with the customer and is dependent on the information gathered from the international salesperson.

The users (passengers) of the vessel is different from what Ulstein is used to, which means they need to gather information about both the culture and the specific activities the vessel should be designed for. Due to limited time, the development of the IKA follows the first phases from the identification of need or opportunity to the identification of design alternatives.

Step 1 - Observations. The first step in the process of implementing the IKA in the case was to observe the project meetings. The focus of the observations was to see how they communicate, what information they use, what they produce, and how they access and share project information. We used project documentation from earlier Ulstein projects in order to see what information they include and how they categorize it.

Step 2 - Develop document structure. Based on the observations from the project meetings and earlier project documentation, we developed the document structure of the IKA as the second step in the process. We developed the document structure with the aim to enhance the accessibility of the information needed in the project and to support the flow of project execution. A focus group consisting of 5 participants, shown in Table 2, discussed the first version of the structure made bade the researchers, and gave feedback on how to improve the structure and what to include/exclude. Figure 7 shows the developed document structure we use in the IKA.

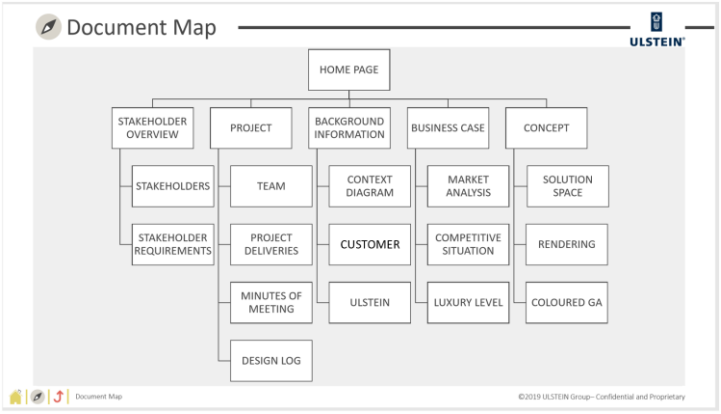

Figure 7 Map of document structure

Step 3 - Implementing case information into IKA. The third step in developing the IKA is to transform the documentation gathered and created by the project group and implement it in the IKA structure. We used the pre-design templates as a guideline on how to structure the content. After including the documentation into the IKA, we created a PDF version of the PowerPoint and shared it with a focus group. The focus group, consisting of 4 participants shown in Table 2, tested the first version of the IKA. The purpose of the focus group was to see the participants' perception of how the content was connected, the usability and the overall use of the IKA.

Step 4 - Adapting IKA and final test. In the fourth and final step of developing IKA in the case, we adapted the IKA based on the focus group results and new information generated in the case. A focus group consisting of 6 participants, shown in Table 2, received a PDF version of the IKA. The purpose of the final focus group was to discuss how the IKA can benefit future project work.

Results and Analysis

After the final focus group (focus group nr 3), we distributed questionnaires to the participants. We also distributed the feedback survey together with the IKA through email to some people that did not participate in the focus group, but had been a part of the earlier stages in the research. Table 3 shows the survey participants. The questionnaire contained 23 Likert scale questions and five open-ended questions.

Likert scale questions. Figure 8 displays question 1 to 5, and address the root cause; documentation is located on several platforms. Question 1 shows that the respondents thought it was easy to navigate through the IKA, and have an NPS of 4, which indicates four promoters. Question 2 address the current situation at Ulstein, and the result match the root cause analysis and interviews, where they stated that documentation is difficult to access. Question 3 to 5 have NPS greater than 0 and indicates that access and overview of project documentation will increase, and time spent searching for information will decrease by the use of IKA.

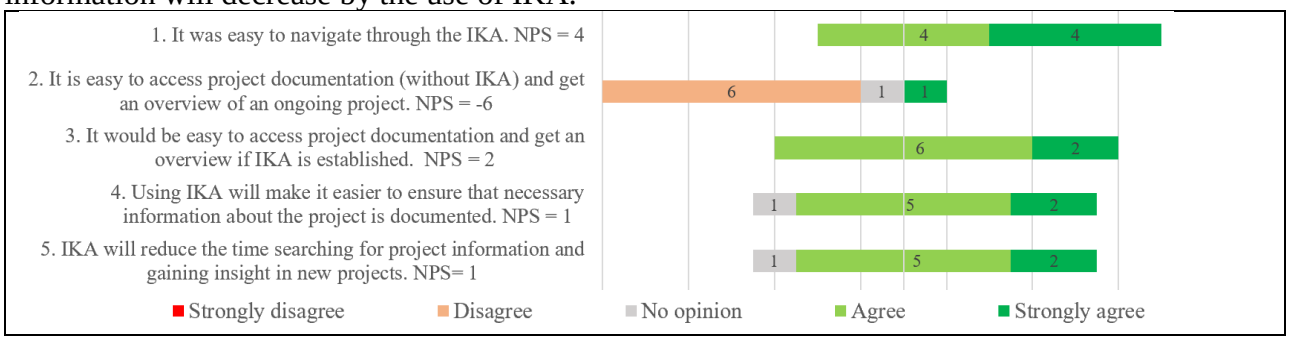

Figure 8 Feedback survey results - Project information

Question 6 and 7 shown in Figure 8 address the maturity of projects. The results indicate that the IKA is not to prefer when trying to get a view of the maturity of a project, but would still be a better option than today's method.

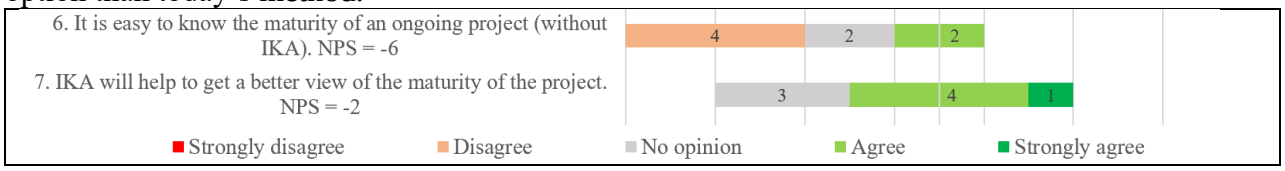

Figure 9 Feedback survey results - Maturity of project

The result from Question 8 to 11, shown in Figure 9, indicates that the respondents view the IKA as a good method to enhance common understanding between departments, in project meetings and the phases following the conceptualization phase, in relation to today's method.

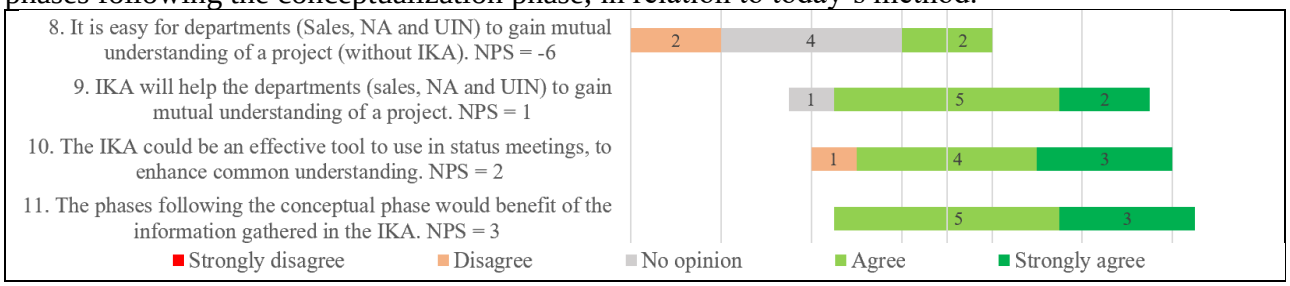

Figure 10 Feedback survey results - Common understanding

Question 12 shows that most of the respondents agree that focus on the customer is just as important as business and technology. The Question 13, 14 and 15, shown in figure 10, indicates that the IKA will help to gain mutual understanding of customer needs, make them focus more on customer needs than with today's method.

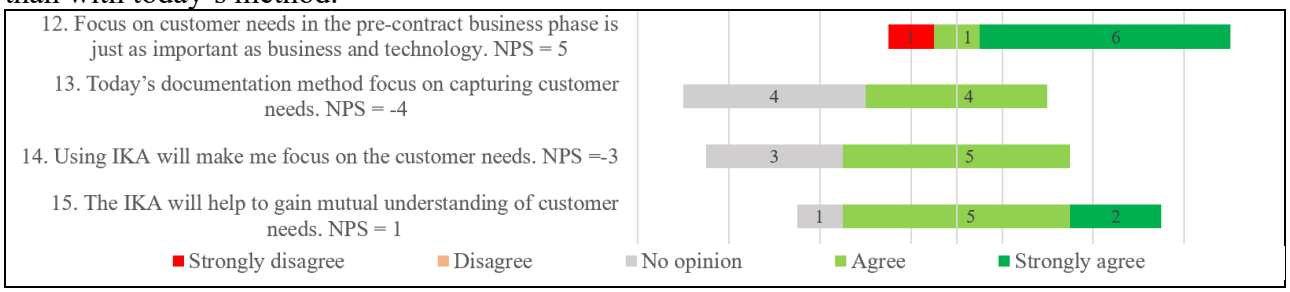

Figure 11 Feedback survey results - Customer needs

Figure 11 displays the result of question 16 and 17 and address how the IKA would enhance knowledge sharing, communication and collaboration between departments. With an NPS = -2 on question 17, the respondents do not think the IKA would enhance communication and collaboration between the departments, but it would be easier to share the knowledge.

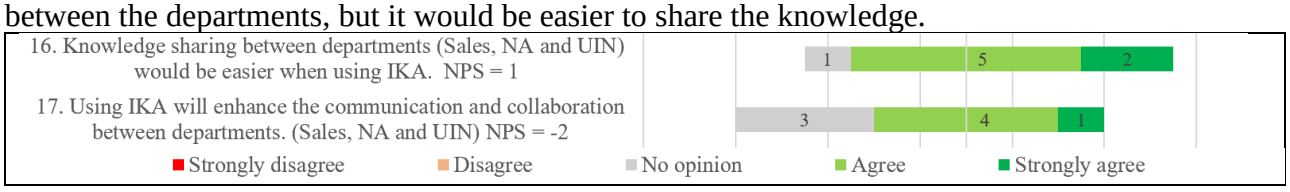

Figure 12 Feedback survey results - Knowledge sharing

Question 18 to 23, shown in figure 12, wants to discover if the respondents want to use it in future projects, and in what way they want to use it. The result of question 18 shows that the respondents disagree on whether they prefer IKA over a text-based report, and the answers cover the whole spectrum of the Likert scale from strongly disagree to strongly agree. The IKA, can according to the results of question 19, not replace today's documentation methods, but question 20 shows that seven out of eight respondents agree that it can be used as a supplement. Five of the respondents agree and

one strongly agrees that the IKA would be an effective method to use in presentations towards customers (question 21). The two last questions asked if they want the IKA to be established when entering a project and if they want to recommend the method. Five of eight respondents agree or strongly agree to the two questions, and three of eight have no opinion.

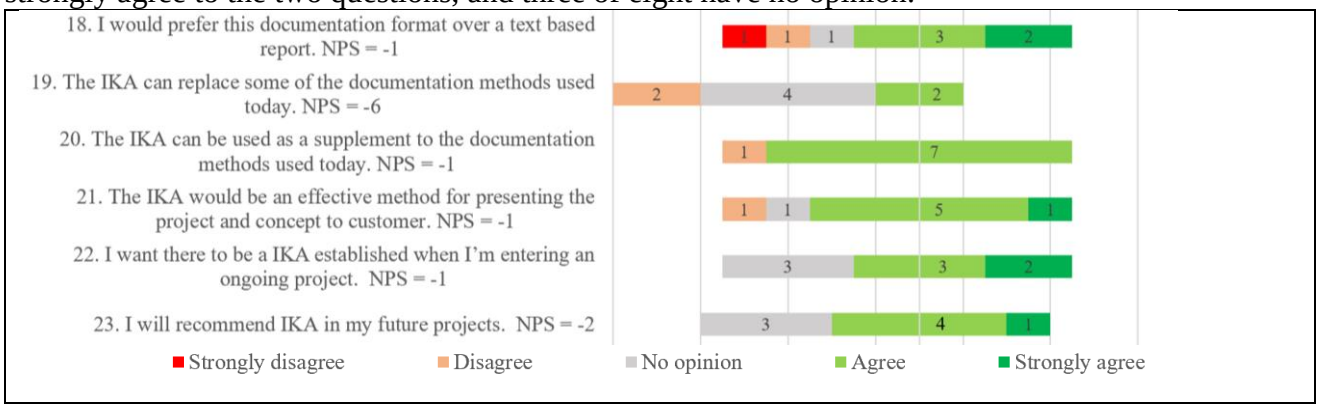

Figure 13 Feedback survey results - Using IKA in future

Open-ended questions. The five last questions of the survey are open-ended, where the respondents have the opportunity to elaborate their answer. The first four questions addressed specific topics, and the last question was voluntary and included to let the respondents share other thoughts they might have about the IKA. Table 3 shows the four first open-ended questions.

#	Question
1	How can IKA be beneficial to gain a mutual understanding of customer need in the early phases of the project?
2	Would a project benefit using about 20 hours to develop an IKA? How many hours is appropriate?
3	Please list your 3 top benefits with IKA?
4	Please list your 3 top concerns with IKA?

Table 4 Feedback survey - Open-ended questions

In this section, we will highlight the result of the open-ended questions. In the first question, the respondents stated that the IKA could be beneficial to gain mutual understanding by being a common platform where it is easy to share and access the same information. By focusing on the holistic understanding and high-level core information, it would steer focus on the most critical issues. The IKA could help in mitigating misunderstandings. One of the respondents points out the fact that the benefits from the use of the IKA also depends on the users and how they decide to use it.

The second question address the time spent to develop the IKA and what they think is appropriate. Most of the respondents answer that it depends on the project. When investigating the interest of new projects, usually takes about 30 hours, they need to get as much as possible out of the few hours distributed. To use 20 hours in this phase of the project is not realistic, but depends on the use of the IKA. If it is used instead of other ways of documenting, like taking notes directly in the IKA, it is more realistic to use it in that phase. The respondents also state that hours spent in developing IKA might be hours saved for others later on. After investigating and evaluating the interest of the project, the project team would have more hours to use towards the projects. In this phase, the respondents answer that it would be more beneficial to use IKA. If the project progress, the respondents states that IKA would be a useful tool for gathering information generated.

The respondents answer that the top benefits with IKA are that it is a common platform where it is easy to share, access and get an overview of project information. It reduces misunderstandings and facilitates a common understanding of customer need. It could be used as a presentation to keep the customer and less involved decision-makers up to date on the progression of the project. It is a good tool for communication and can make it easier for phases after conceptualization.

Seven out of eight respondents answered that the time required for development and maintenance is their top concern. Other concerns were handling document revisions, how to agree with the different

departments on what to include, who is the owner of the document, and how to incorporate the more in-depth documentation. One of the concerns is the resistance that can occur when introducing and making people use a new method. This statement reflects on the results from the root cause analysis, where one of the stated pain points is that people have scepticism and resistance to new methods.

Discussion

This study began with the intention of addressing three questions.

Which communication and knowledge sharing methods does Ulstein apply in the conceptual phase, and what are the pain-points of the as-is situation? When interviewing the employees in the initial stage of the study, one of them stated:

Ulstein's value is not in the buildings, offices or computers, but it is the knowledge and the mind of the people working here. When the employees leave after a day of work, Ulstein greatest asset walk out the door.

The view of the value people's knowledge is worth in a company is shared with Noruzi et al., where the knowledge is defined as the most valuable and strategic resource of a company and is the main contributors to company growth (Noruzi, Stenholm, Sjögren, & Bergsjö, 2018).

Based on the results from the root cause, shown in Figure 4, we learn that even if the employees see the value of the people's knowledge, there still exist challenges and pain-points in the communication and knowledge sharing methods in the conceptual phase.

The pain-points in the conceptual phase had two main causes. The first cause was that it is taken for granted that people know/have the right information. If we focus on the web of statements surrounding the first main cause, we see that it addresses human interactions and the ''soft skills'' in complex projects (blurred due to confidentiality issues). A research done by Azim et al. claims that the soft skills in complex projects, such as teamwork and communication, are just as important as the hardskills (planning and control). The statements surrounding the cause pinpoint issues regarding resistance of change. Trust is the most important factor in changes, and can according to Crowder & Shelli, be increased by knowledge sharing, communication, and transparency (Crowder & Shelli, 2013).

The second cause is that documentation is located on several platforms such as department folders, project folders, personal folders, web-based platforms, and email. It leads to much time spent searching for the right information. Nazim & Mukherjee stated that the three pillars for successful knowledge management are people, technology and process (Nazim & Mukherjee, 2016). Based on the interview result, Ulstein have the mindset into achieving successful knowledge management, but the technology and tools to facilitate, and the process of guiding could improve.

How can IKA enhance the understanding of customer needs? IKA can enhance the understanding of customer needs by being a platform where it is easy to share and access project documentation. With a focus on the high-level information, and reduce the level of technical details, the IKA can be shared both internally and to the customer to increase the understanding. When comparing the features of IKA with existing systems engineering approaches such as ConOps or OpsCon, we can see that there are similarities in the focus of customer needs in the early phases of project development. ConOps is used in early phases to enhance the understanding of customer needs by focusing on the goal and objectives of the system, boundaries, stakeholders, constraints, conceptual view of the system and is not to be excessively technical (Sols, 2014). IKA share the view of not to be excessively technical, but unlike traditional ConOps which is a text-based document, IKA focus on visual and interactive communication and a platform where it is easy to share. ConOps development process can take as long as 30 months, and considering the varying length of the

conceptualisation phase at Ulstein, it requires a more rapid tool that can be used early in the start of a new project in order to ensure common understanding (Ali Mostashari, 2011). The IKA is a living document that works alongside project development, and with conceptual phases potentially being as short as two weeks, this tool would benefit the early processes and be able to share the knowledge and understanding of customer needs in an earlier stage than the traditional ConOps.

The 6 of 8 respondents from the feedback survey strongly agreed that focusing on customer needs is just as important as business and technology. The survey result indicates that the IKA will make them understand and focus on customer needs in a greater way compared to the current method.

How can IKA facilitate collaboration and knowledge sharing in the conceptual phase? Borches states that sharing knowledge through architecture has been identified as one of the key success factors in software engineering (Borches, 2010). Some of the design principles when using A3A0 is that the information is simplified into two A3 pages. IKA shares the principles of limiting the information included and structure the content in interactive architecture (Røed Jensen, Muller, & Balfour, 2019). From the result of the feedback survey we learn that the respondents think the IKA would enhance the knowledge sharing between departments. We also learned from the feedback survey that the respondents viewed the IKA as an easier way to ensure that the different departments have a mutual understanding of the project.

Challenges. Challenges experienced while developing the IKA was to ensure that the hyperlinks in the document were correctly linked. When the IKA increases in pages, editing, and updating the IKA with new information could be time-consuming. The time required for development and maintenance was the main concern for 7 out of 8 respondents and reflect on the researchers' own experience.

The final IKA developed to the case at Ulstein had in total of 89 PowerPoint slides. Considering that the study only followed the first phases and that the communication with the customer was limited, it generated a lot of information. The process of limiting and deciding what to include could be challenging.

From the results of the feedback survey, we can see that respondents prefer the IKA over methods they use today. When answering the last questions regarding how they want to use the tool in the future, all the responses gave NPS below zero. This means they are not promoters of the tool. The conflicting results may have several reasons. If we use the result of the root cause analysis to understand, the reason may be in connection with that they do not have enough information on the IKA which leads to skepticism towards using it.

Validity. Due to limited time, the research was applied in one case during the first conceptual phases and did not follow the whole process. To compensate for the process step we did not follow, we used information from earlier projects to investigate the communication flow (minutes of meetings, notes, and emails) and documents generated.

We conducted seven interviews, had three focus groups with 5, 4 and 6 participants, and distributed questioners to 8 respondents. The sample size of the gathered data is small but is a representative selection of the three departments included in the conceptual phase. Some of the participants had more involvement in the study and was included in the interview, all the focus groups and feedback survey, while others were involved in one or two steps. After the final focus group, 6 out of 8 respondents received the survey a short time after trying out the IKA. This may also reflect on the result and the feedback survey, where it is natural that people with less involvement and knowledge about a new method is more skeptical.

The statements in the root cause analysis are not weighted but treated equally. In order to reduce the impact of not weighing the statements, we validated and discussed the results in a focus group

consisting of 6 participants. If the statements in the root cause analysis are too broad, it can be miss-understood for being a cause and hiding the real root cause.

Conclusion

The purpose and main contribution of this research are to study how the IKA may enhance collaboration and knowledge sharing of customer needs in the conceptual phase at the global shipbuilding company Ulstein. Ship design is a complex process that involves many disciplines, departments and people who need to work together to make the best solutions and design for the customer. To focus on collecting, understanding and documenting the customer expectations and needs, and to communicate and share these both internally and to the customer, could be crucial in order to get the contract and to prevent enhanced cost later in the shipbuilding process.

The initial research started with conducting a root cause analysis, where we discovered two root causes and effects of the pain-points in the current communication and knowledge sharing process. Our findings show that the main causes are; 1) It is taken for granted that people know/have the right information; 2) Documentation is located on several platforms. The main effects of these causes are; 1) Different interpretation of customer needs; 2) Information get lost. The result of the root cause analysis supported the decision of testing the interactive tool.

We developed and implemented the IKA in a case at Ulstein and shared it with a representative selection of employees from the conceptual phases. The main findings show that *the IKA facilitate common understanding* by making the project information easier to access and to navigate. The respondents stated that by having a better holistic view of the project, it *would enhance the understanding of customer needs*. The IKA *facilitates knowledge sharing* by providing a tool that is easy to use and share with others. We also discovered that the tool would benefit the following phases by helping them to understand and clarify the decision-making process done in the conceptual phase. To implement all the detailed information generated in a project, can be challenging, but the respondents agreed that even if the IKA does not contain all the details, it will give a better view and understanding of the projects than today's method.

Future work. In future research, we recommend testing how effective the use of IKA is in relation to projects success (contracts awarded)**.** Implementing IKA in more projects, and follow it through the conceptual phase, will make it easier to measure the total effect of the IKA. Due to limited time and no direct contact with the customer, we did not investigate if IKA had any effect on the communication and collaboration between involved parties, we recommend further research in this area.

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Biography

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