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Electing User Needs Related to Human Values through Illustrative ConOps - a new-energy case study

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Abstract. This paper investigates how to better understand end users' human values at an early phase of system design in an innovative new-energy project. By early involvement of end-user, companies can avoid making costly design mistakes that reduce the usability of the system. For the innovative system there were no end-users from where to directly obtain the operational knowledge. The paper has adopted research methods from the Design Thinking process, and uses industry-as-laboratory, conducting in-depth interviews with end-users from related applications. The research focuses on needs that originate from "human values" defined as an expressed emotional feeling addressing how the users perceive the system. The interviews resulted in 105 user needs translated into 17 relevant stakeholder requirements. The results showed that conducting interviews showing an illustrative ConOps gave 17% more chance of finding needs originating from human values compared to not using this attribute. This research proposes a process for integrating the human values into the early phase of systems engineering.

Introduction

The offshore renewable energy system, Deep Purple combines offshore wind and hydrogen energy to provide a stable and climate-friendly energy source for consumers. The project is now in the early stages where different design concepts are under consideration. The solution provider, TechnipFMC, is a major provider of systems to the oil and gas industry. Deep Purple is thus a project that is outside the company's core business.

This research focuses on the design of effective operations and maintenance. A specific issue is how the personnel can move around in the system in an effective manner. Another challenge is that the accessibility offshore is limited, and the required availability is high.

The Deep Purple system does not yet exist physically. This present a challenge since there are no previous concepts to learn from. The systems engineers were initially executing the design phase based on stakeholder requirements defined by the project team. In general, engineering teams seem to be focusing on feasibility and viability. The user's desirability often get lost in the engineering process.

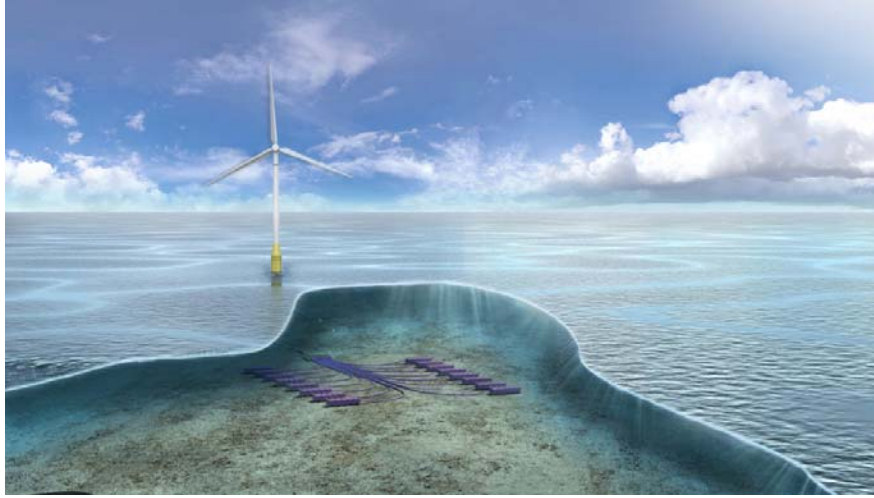


Figure 1: Illustration of TechnipFMC's Deep Purple System (source: TechnipFMC)

In the field of design, end-users are normally considered to be the experts as they have the interaction-experience with the applicable product or system (Tschimmel, 2012). Furthermore, the Design Thinking methodology has as a core element “empathize with the end-user” (Stanford, 2015). Research by Pinto et al. (2019), involving end-users and Design Thinking activities, increased the number of human valued stakeholder requirements from 2% to 15%. Such ideas have created the shift from designing "for users" to the human-centered approach of designing "with users" (Tschimmel, 2012). Evaluating designs with users and improving them based on their feedback provides to be an effective exercise to minimizing the risk of a system not meeting users' needs (ISO 9241-920, 2010, p. 7).

Muller (2009) stated that it is the responsibility of the Systems Engineers to involve the experience of the end-users in the architectural phase. The Deep Purple project team is therefore looking to perform activities that can improve the needs elicitation and requirement definition process by involving the end-users early in the design phase.

Specifically, this research evaluates ConOps and interviews as methods for need elicitation, and the methods' ability to extract relevant user needs related to human values. We define such human-value related needs as the needs originating from an expressed emotional feeling that address how the users want to perceive the system. We claim that, by conducting in-depth interviews of stakeholders with offshore operational experience, the Systems Engineer gains a better understanding of the end user's operational needs. This understanding provides input to the definition of relevant stakeholder requirements. Our claim can be split into:

- Using an illustrative ConOps in the interview process helps the participant to reflect on the questions.
- Using an illustrative ConOps in the interview phase contributes to the generation of user needs related to human values.

This paper is organized with a State of the art section with relevant theory and previous research. There is a lot of existing work done on this topic, however, this paper will not provide a comprehensive literature review. Then the paper describes research methods. We have used in-depth interviews and illustrative ConOps in the need-finding process. Feedback from participants and the researcher's observations are also part of the evaluation. After the result and analysis section, the discussion evaluates the finding and limitation of this research. The paper ends with suggestions for further research, and a conclusion that discusses the initial claims of this research.

State of the art

Systems Engineering: The transformation of the analysis of a need or opportunity into requirements is one of the many aspects that define Systems Engineering (Sols, 2014, p. 27). Systems engineering follows a stepwise process where the next step is affected by the previous step. Principally, the first three steps in the Fundamental Systems Engineering process involve identification of needs, translation of needs into stakeholder requirements, and translating stakeholder requirements into system requirements (Sols, 2014, p. 118).

Need Analysis: Before starting to solve a problem, the first step is to understand it. To understand the problem, performing need analysis of key stakeholders are critical. By misinterpreting the needs, one can end up taking the wrong decisions. These decisions influence the following steps, and little can be done afterward to make up for them (Sols, 2014, p. 126). Research performed by Tranøy (2012), showed that 74% of late design changes could be avoided if earlier need analysis had been performed. Not understanding stakeholders needs is a crucial factor for why late design changes occur, and projects experience cost overruns (Aasheim & Zhao, 2017). There are several approaches to identify needs related to operations. Anonymous surveys, personal interviews, and nominal group techniques can be performed both in a formal and informal context (Wasson, 2005, p. 104). It is through this process essential to stress that the interaction with the stakeholders should focus on identifying potential need and not requirements. Needs are generally bonded and specified by the requirements (Wasson, 2005, p. 105). If this relation gets misunderstood, it can lead to poor requirements that reduce the degree of innovation and limit the Systems Engineers possibilities to develop the best solution (Sols, 2014, p. 126).

Stakeholder Requirements: The cornerstone of the systems approach is the correct translation of a need into requirements (Sols, 2014, p. 138). Inappropriate and ill-defined requirements are one of the leading causes of why projects experience poor performance, delays, and cost overruns. For not to mention, the final design lacking the usability which the user initially needed. The stakeholder requirements should only reflect the capabilities and functionalities desired or wished by the user. If the requirements indicate the type of solution that may be adopted, the freedom of the designer gets taken away, and the best possible solution may not get identified (Sols, 2014, p. 139). Because users' needs endure longer than solutions, designers should focus on satisfying those needs rather than on producing a particular product (Becker, 1999).

Illustrative ConOps: Concepts of Operations (ConOps) is a document that describes the characteristics and intended usage of a proposed or existing system. The ConOps is helpful in the meeting of the minds before the requirement process begins (Lessio, 2016). The document is a user-oriented document that focuses on the boundaries and external interfaces of the system (Sols, 2014, p. 127). It is made to describe the system from the perspective of the users. Usually, the creation of a ConOps occurs in the development of a new system or product, upgrade on existing systems or product, or to create a strategy involving the whole life cycle of systems or product. Gabb (2014), concluded in his research that use of ConOps at the start of a large project is essential. This, because of the positive influence it has on the eventual success of a project partly because of the improved communication. Research on how to improve traditional ConOps is done by Lessio (2016). One of the findings was the involvement of relevant stakeholders in the development process. This involvement enabled faster development by using stakeholder's knowledge to decide which steps to involve. Another improvement option was to visualize the ConOps and use describing illustration to facilitate more interactive usage.

Design Thinking: Design Thinking is a methodology that inspires the full spectrum of innovation activities with a Human Centered Design mindset (Brown, 2008). Human Centered Design is an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs, and requirements (ISO 9241-920, 2010). *Usability* is defined by the

ISO 9241-210 (2010), as "The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". The combination of Design Thinking and Human Centered Design makes sure that the designer creates a solution that can be adopted by people, and that the solution is relevant for the intended people (Hoover, 2018). Design Thinking can be acted out through different process methods. The model of the Hasso-Plattner Institute is one of these process methods and consist of five iterative steps. The steps are empathize, define, ideate, prototype, and test (Plattner, 2013).

Human values: There is a strong need to integrate human values in Systems Engineering to achieve innovative solutions when designing complexed systems (Falk, n.d.). The IDEO approach emphasizes the importance of a balance between human values, business, and technology perspectives to achieve innovative solutions (Brown, 2008). These perspectives are known as desirability, feasibility, and viability. Where desirability reflects the user's perspective, feasibility encompasses the technology perspective, and viability refers to the business perspective (Chasanidou, Gasparini, & Lee, 2014). The design thinking process overlaps these perspectives and believes that the combination of all perspectives results in a more successful project (Pinto et al., 2019).

Sjøkvist (2019) and Pinto (2019), defined human values based on Muller's (2009) research about human aspects of systems architecting. They stated that emotional needs are influenced by both environmental factors such as culture and social aspects, and personal factors such as education, mental status, physical status, and preferences. Sjøkvist and Pinto defined these underlying values and motivations as human values in their research. Emotional need origins from underlying feelings such as fear, anger, anxiety, and frustration, to name a few (Mosby, 2009).

In Sjøkvist's research, the objective was to capture and communicate human values in the early phase of Systems Engineering. Sjøkvist observed that the concept of human value is hard to grasp, and difficult to measure, which resulted in the tendency to forget human values in concept generation. To maintain awareness of human values during the design phase, Pinto introduces "use case scenario canvas"- and "stakeholder analysis canvas"-templates in Semcon Devotek. The templates linked requirements related to human values to the "desirability"-box and the "experience"-box.

- Experience: how shall it look, sound, and feel. How shall the actor perceive the interaction
- Desirability: what are the emotional, cultural, and social wishes of the stakeholder? What shall the stakeholder be proud of?

Pinto observed during his research that Systems Engineers specify human values through the lens of Human Factors (ergonomics) and Health, Safety and Environment (HSE). This observation does not correspond to Sjøkvist's evaluation criteria for human values. Sjøkvist considered human value requirements as those that address how people experience the system or make it more desirable for the people who interact with the system. The research did not consider requirements derived from Health, Safety, and Environmental (HSE) regulations.

Research Methodology

This study used the design thinking process to perform industry-as-laboratory research. In the industry-as-laboratory research method, the researcher identifies problems through close involvement with industrial projects (Potts, 1993). The approach is applicable in Systems Engineering research as it allows the researcher to study the effectiveness of the human value method by active participation (Muller, 2013). In this research, the Design Thinking process got applied in an industrial setting, and the results have been observed and used to evaluate the initial claims (Muller & Heemels, 2007). The researcher of this study used data collected from in-depth interviews and surveys to evaluate the methods.

The interview participants are expert end-users, as experts can get the researcher quickly up to speed on the topic, give key insight to the relevant history, context, and innovations (IDEO.org, 2015). The

“user” is the people with human involvement with the machines or system at interest (Chapanis, 1996, p. 16). These people determine the effectiveness and usability of the system. In this research, the term "user" describes the target stakeholder for the need analysis, that is, operators with offshore experiences. As this research is involved in an innovation project in the early stages, experienced users do not exist. The need analysis involved users of similar system and systems that are operating in a similar environment.

The researcher evaluated the effectiveness of the methods by analyzing the needs derived from the data collected, and the feedback from the interview participants. The following sections introduce the data collection and analysis methods, in addition to a review of activities performed in the various Design Thinking steps.

In-depth interviews: An interview guide with semi-structured questions is used to keep the interview on track, as well as it let the participants probe around the questions asked (Berry, 1999). The interview guide consists of two parts, where part 1 consist of ten main questions regarding previous experience, and part 2 consist of six questions regarding the future Deep Purple system. In part 2 of the interview, the one concerning the future Deep Purple system, the researcher are testing the effect of using an illustrative ConOps as a supplement to the interview guide.

The participants get divided into two groups, with five participants in each group. Group 1 did not see the illustrative ConOps, and group 2 got to see the illustrative ConOps of the Deep Purple system. Table 1 presents the population of the interview participants. None of the participants in this research have been involved in this type of need-finding-activity before, nor were they familiar with the concept of illustrative ConOps.

Table 1: Interview participants with experience as technical service personnel offshore in the oil and gas industry.

#	Date	Position	Experience	Group
1	05.03.19	IWOCS EFAT Test Manager	22 years	1
2	12.03.19	Maintenance Engineer	12 years	2
3	14.03.19	Project Eng Manager (PEM) –Test	11 years	2
4	14.03.19	Specialist engineer	21 years	2
5	14.03.19	Senior supervisor	24 years	2
6	14.03.19	Service Engineer	6 years	2
7	14.03.19	Service Engineer	14 years	1
8	15.03.19	Technical adviser	25 years	1
9	01.04.19	WOCS island constructor	10 years	1
10	03.04.19	Workshop tech	42 years	1

**All participant participants are employed in TechnipFMC.*

Survey: An online survey is used for the second iteration with the participants to obtain comparable data. The survey is performed to obtain feedback from the participants on the method used and to confirm the finding from the first iteration. Two different surveys got prepared since the groups got exposed to different interview situations. The surveys consisted of five claims that the participants were asked to answer with Likert Scales, and additionally, two questions where the participants could answer using their own words. All interview participants were invited to take part in the survey. Five out of five participants from group 1 without illustrative ConOps and three out of five from group 2 with illustrative ConOps responded to the survey.

Evaluation method: To evaluate the effect of performing in-depth interviews of expert stakeholders, the researcher analyzed the needs generated, the feedback from the survey respondents, and the effort required in the process. When analyzing the effort required in the process, the researcher looks at the time used, and observations made during the interview.

A Likert Scale presents the results from the survey, where the Net Promotor Score (NPS) is used to evaluate the response. The participant can rate the survey questions from "Strongly disagree" to "Strongly agree." The NPS assumes that respondents that "Strongly agree" promotes this method of need-finding. The respondents who replied "Neutral," "Disagree," and "Strongly disagree," probably complains about the method (Reichheld, 2003). A positive score is considered to be NPS above zero.

The need analysis highlights two parameters. The first parameter highlights to which category, the expressed need belongs. Desirability, feasibility, and viability are the categories the needs can address. The second parameter highlights whether or not the needs are related to human values. Evaluation criteria from previous research by Sjøkvist and Pinto made the basis for this research human value definition. *Needs related to human values are those that originate from an expressed emotional feeling that addresses how the users want to perceive the system.* The result provides quantitative data to be analyzed.

The experienced Systems Engineer that took part in the interview process and designed the illustrative ConOps evaluates the need-finding method and the results. The evaluation got carried out through a survey where the Systems Engineer can answer using his own words.

Design Thinking: By following the Design Thinking steps (Figure 2), the goal is to evaluate the effect of the need-finding method and the use of illustrative ConOps as a tool.

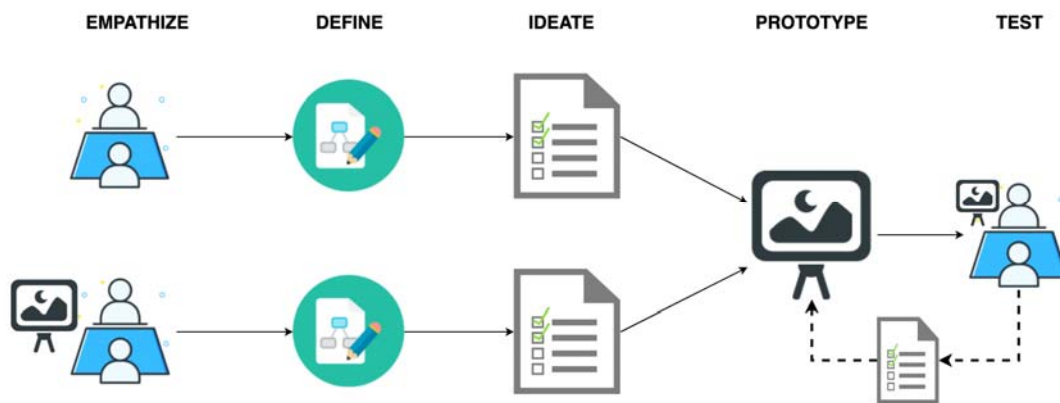


Figure 2: The Design Thinking approach used for this research.

Empathize: The researcher and a Systems Engineer from the Deep Purple project team conducted in-depth interviews to empathize with the users of the system. In-depth interviews are valuable in understanding the lived experiences of others and the meaning they make of that experience (Seidman, 2006). Previous research, performed by Pinto (2019), claimed this method is useful for this purpose. Figure 3 illustrates how the research conducts the interviews. Part 1, where the topic “previous experience with offshore operations”, was performed equally on all the 10 participants.

The participants got exposed to different methods in Part 2, where the topic was “future Deep Purple system”. Group 1 was interviewed only using an interview guide, and group 2 had illustrative ConOps (Figure 4) as a supplement to the interview guide. The participants were invited to study and perform sketches on the illustrative ConOps as they pleased.

Define: All the interviews got documented by using an audio recorder. The researcher transcribed the interviews to find the needs expressed and to compare the answers made by the participants. The following is an example on how a need is identified from the interview situation: The participant states that it is preferable to work with the same crewmembers on each offshore operations, and that using familiar equipment is a desire. This statement got translated into the need: “*The operators shall work in an environment where they feel comfortable.*”

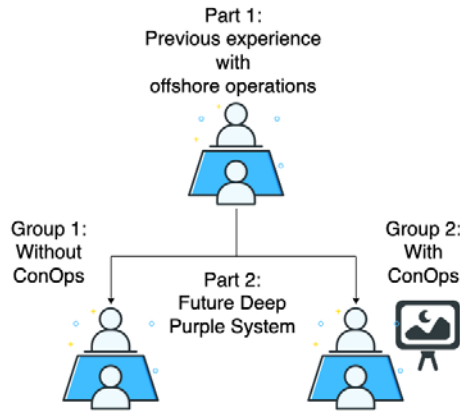


Figure 3: Illustration showing how the researcher conducted the interview process.

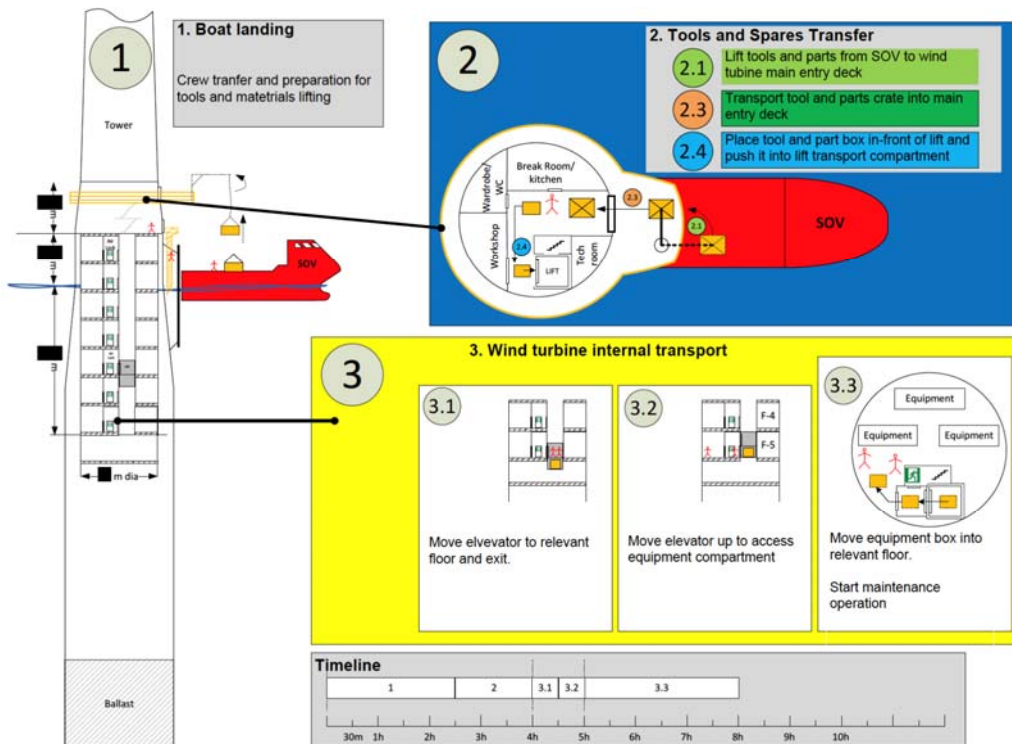


Figure 4 Illustrative CONOPS used in the interview process.

Three Systems Engineering experts made a separate evaluation on the first parameter. This evaluation is to which perspective-category the needs address (desirability, feasibility, or viability). The needs could be evaluated to address more than one perspective. The researcher of this study evaluated the second parameter. This parameter evaluated to which degree the needs can be related to human values. The evaluations were made to analyze the effect of the need analysis and the illustrative ConOps as a tool. The following is an example of how the evaluation of needs got conducted:

Need: *“The operators shall work in an environment where they feel comfortable.”*

The need exclusively represents the user’s perspective and therefore, categorized as desirability. Then the need was evaluated in regard to the human value definition: *Needs related to human values are those that originate from an expressed emotional feeling that addresses how the users want to perceive the system.* The emotional need is to feel comfortable in the work environment, which addresses how the users perceive the system. Therefore, the need gets evaluated as a need related to human values and belonging to the desirability category.

Ideate: The data collected from the different interview parts got gathered in this stage. Based on the findings from the previous stage, the needs considered most important by the participants was identified and translated into stakeholder requirements. If several participants mention a need, it got considered as an important need to address. An experienced Systems Engineer at TechnipFMC assessed and approved the proposed stakeholder requirements.

Prototype: The stakeholder requirements defined, were then used to make an updated version of the illustrative ConOps. The updated ConOps acts as a rapid prototype that visually shows the key aspects that were mentioned by the interview participants. Rapid Prototype is a quick formation of visual and experiential manifestations of concepts (Liedtka & Ogilvie, 2011, p. 141).

Test: The updated illustrative ConOps got tested to make sure that the previous findings are correct, and to get the participants thoughts on the need-finding method. The researcher tested the illustrative ConOps during a second iteration with interview participants. This iteration got done through an online survey, where two different surveys got prepared. The participants that had not seen the illustrative ConOps before could now see their contribution in an illustrative manner. This, to confirm the aspects involved and comment on how they experienced the illustrative ConOps. The participants who had seen the illustrative ConOps before, could now see the updated version and confirm if the changes made were correct.

Results and Analysis

This section presents the results from the need-finding process, the use of illustrative ConOps, the generated stakeholder requirements, and the effect of using a visual prototype.

Need finding: The results from the in-depth interviews performed on the expert users indicate that the in-depth interview approach succeeded to derive user needs from the participants. In total, 105 needs got derived from the interview process. Figure 5 shows the number of needs derived from the different interview parts.

Illustrative ConOps: This research wanted to see if the illustrative ConOps could help increase the involvement of the participants. The use of an illustrative ConOps as a supplement to the interview guide showed no apparent effects when it comes to deriving additional needs from the participants. Part 2 with illustrative ConOps, derived five more needs than part 1 without illustrative ConOps. To compare the need derived from the different interview parts, the Systems Engineering experts evaluated the perspective the needs addressed. Figure 6 shows the results of the evaluations. In the evaluation process, one need could be evaluated to address more than one perspective.

The need derived from part 1, regarding previous experience with offshore operations, indicates that the participants focus addressed more the viability perspective than the feasibility perspective. This indication is in contrast to part 2, regarding the future Deep Purple system, where the focus were more targeted towards the feasibility perspective. All need derived were evaluated to address the desirability perspective.

Stakeholder requirements: Of the needs derived from the need-finding process, nine needs were selected to be used to generate stakeholder requirements. Table 2 presents the needs that were considered as most important by the participants. The number of participants that mention a specific need is the criteria for a need to be considered as important. E.g., need number 3 in Table 2 was mentioned by participants number 3, 4, 5, 6, 8, 9, and 10.

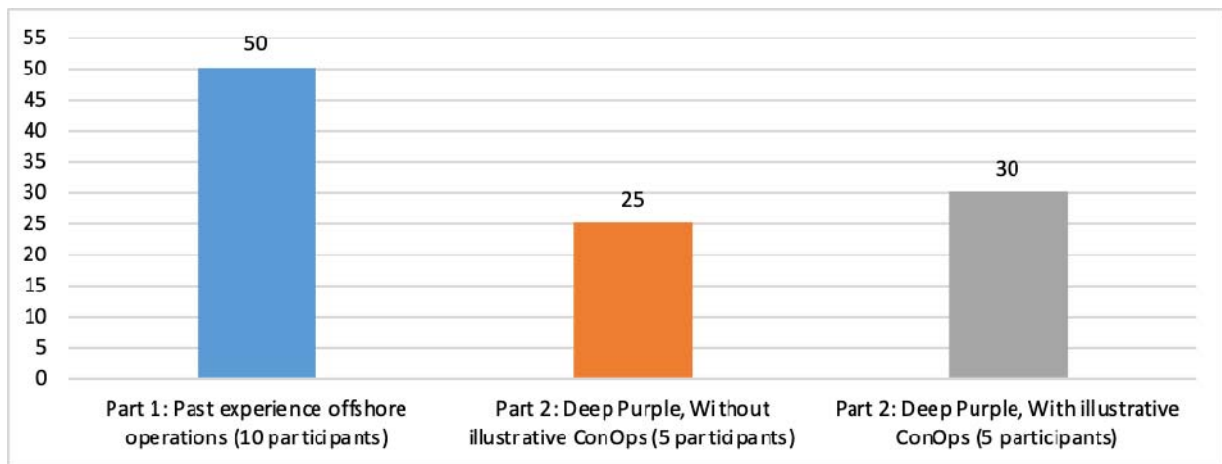


Figure 5: Illustration showing the number of needs derived from the different interview parts.

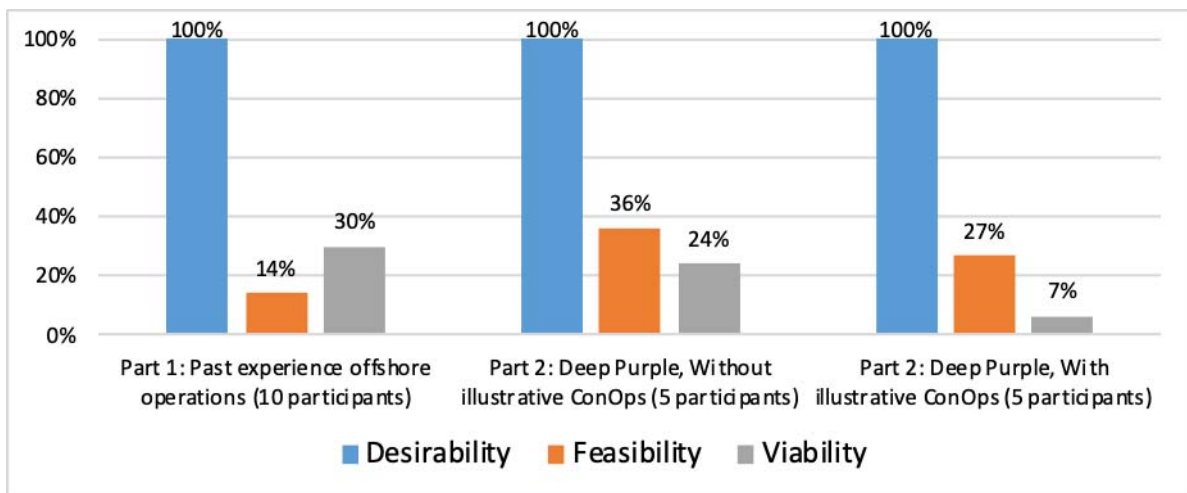


Figure 6: Illustration showing the percentage of needs derived from the different interview part evaluated to address different perspective. A need could address more than one perspective.

Table 2: Need chosen to generate stakeholder requirements.

#	Expressed problem or concern:	Need:
1	Easy to sign procedure	The procedure shall be easy to work with
2	Access to the tools needed	The system should provide the tools necessary to perform any operations
3	Personnel transport	The system must be able to transport people safely from SOV to WT
4	Able to contact land for support	The system operators must get access to support when needed
5	Knowing what work to be performed	The system shall facilitate properly planned operations
6	Knowledge about relevant tools and machinery	The user of the system should be familiar with the system before an operation
7	Spare parts	The system must be able to offer spare parts quickly
8	Handover between shifts	The system shall facilitate a proper handover between the operators
9	Safety on relations to get assistance when needed	The operator of the system shall not be alone in executions of operations

From the needs in Table 2, we generated 17 stakeholder requirements. Table 3 shows an example of how one need generated two stakeholder requirements.

Table 3: Example of a need translated into requirements.

Stakeholder(s):	3,4,5,6,8,9,10	Need code:	3
Expressed problem or concern:	Personnel transport	Need:	The system must be able to transport people safely from Service operation vessel to wind turbine
Stakeholder requirement code:	Stakeholder requirement:		
SHR-3.1	The system shall be able to transport operators from service operation vessel to wind turbine with 80% availability. (analysis of wave heights)		
SHR-3.2	The system shall provide a minimum of two options to transport people from service operation vessel to wind turbine.		

Human valued: Figure 7 shows the evaluation of needs related to human values. The results indicate that the illustrative ConOps triggered the participants to express need related to human values. 37% of the needs were related to human values in part 2 “with illustrative ConOps”. In contrast to part 2, “without illustrative ConOps,” where 20 % are related to human values.

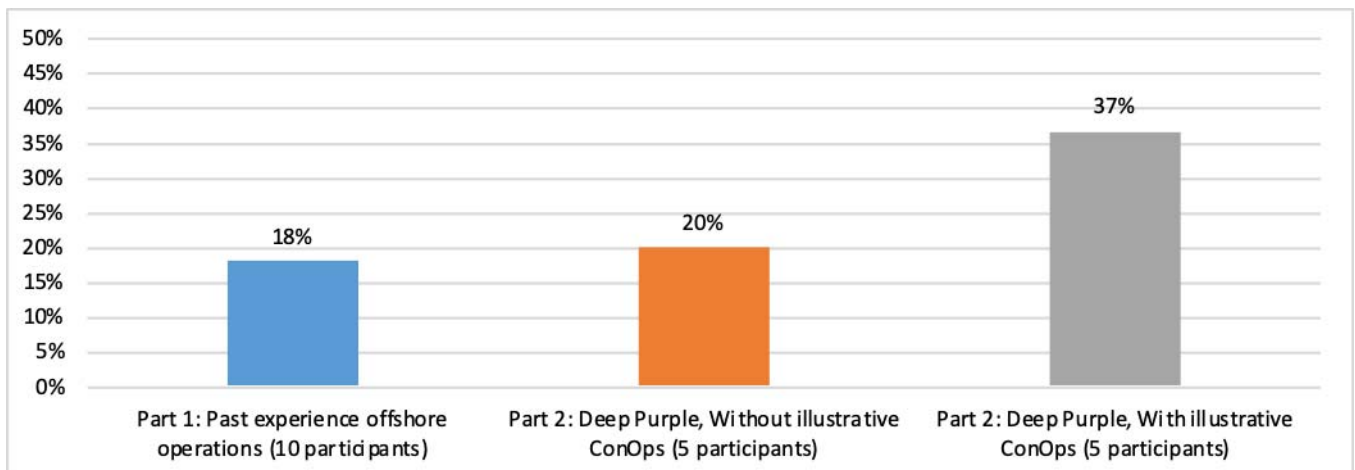


Figure 7: Results from the need analysis showing the number of needs related to human values in the different interview parts.

Survey: Two different charts illustrate the survey results. Figure 8 shows the result from the survey that got sent to the participants which had not seen the illustrative ConOps before. Five out of five participants responded to this survey. Figure 9 shows the results from the survey that got sent to the participants that had seen the illustrative ConOps before. Three out of five participants responded to this survey.

Question number 1 was the same in both surveys. The question examined if the participants were positive to the method used for need finding. The respondents that had seen the illustrative ConOps during the interview gave an NPS of 1, as 2 responded “Agree” and 1 respondent “Strongly agree”. The respondents that had not seen the illustrative ConOps before gave an NPS of 1, as 4 responded “Agree” and 1 respondent “Strongly agree”. This result indicates that the participants would promote this method of need-finding in the future.

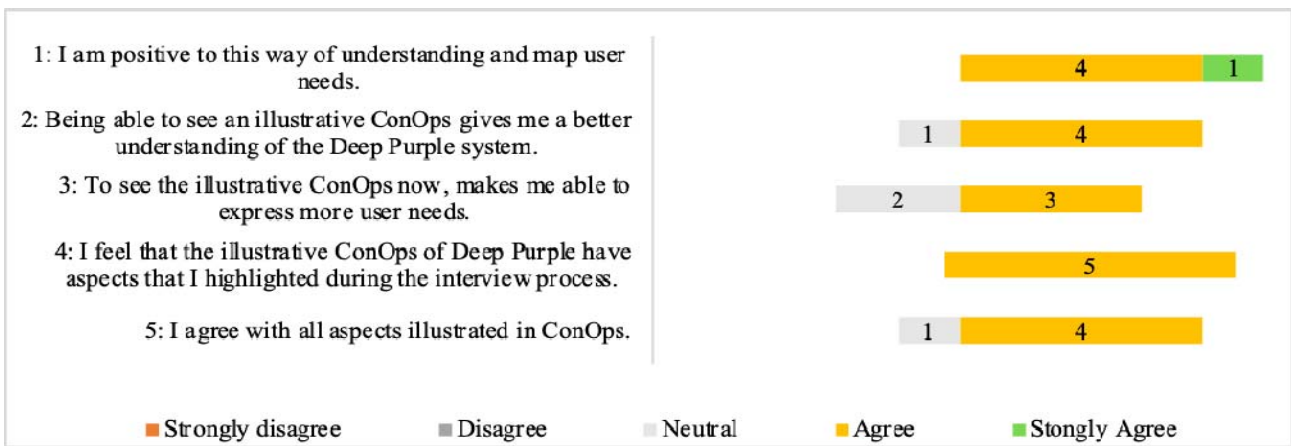


Figure 8: Result from the survey presented to the participants that had not seen the illustrative ConOps before. Five out of five responded to the survey.

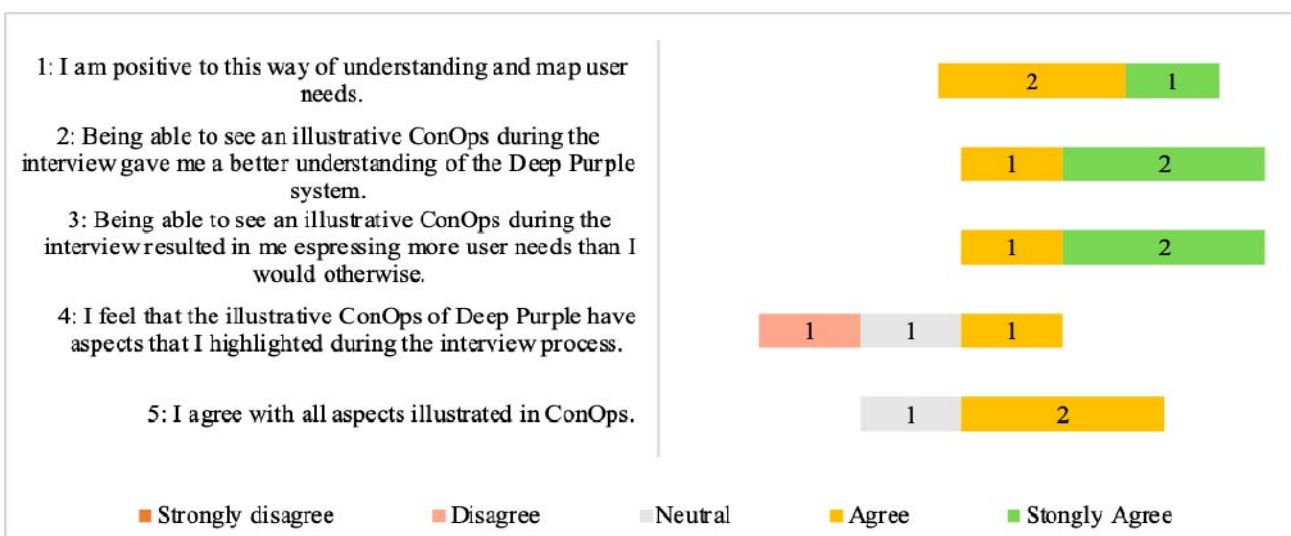


Figure 9: Result from the survey presented to the participants that had seen the illustrative ConOps before. Three out of five responded to the survey.

Question number 2 in both surveys, intended to investigate if the illustrative ConOps helped to create an understanding of the Deep Purple system. The respondents who saw the illustrative ConOps during the interview all “Agreed” or “Strongly agreed” that resulted in an NPS of 2. The respondent who saw the illustrative ConOps for the first time during the survey answered “Agree” or “Neutral”, which resulted in an NPS of -1.

For question 3 in both surveys, the intention was to investigate if the illustrative ConOps helped the participants to express more needs than they would have done without seeing an illustrative ConOps. The respondents who saw the illustrative ConOps during the interview answered either “Agree” or “Strongly agree” and resulted in an NPS of 2. The respondent that saw the illustrative ConOps for the first time during the survey answered “Neutral” or “Agree,” resulting in an NPS of -2.

Question 4 was the same in both surveys. The question intended to investigate if the expressed needs from the participants were correctly understood. The response from the participants that had seen an illustrative ConOps during the interview showed that one disagreed, one was neutral, and one agreed. The respondents that saw the illustrative ConOps for the first time during the survey, all agreed that they could see aspects that they had expressed.

In question number 5, the participants from both surveys answered either "Neutral" or "Agree." The question intended to discover if any mistakes or wrong interpretations were made in the translation from a need into stakeholder requirements.

One respondent used question 6 and 7 to elaborate. The respondent had not seen the illustrative ConOps before. On question 7: "*Do you have any comments on the method used to derive user needs or to the illustrative ConOps?*". The respondent commented that he/she felt that the illustrative ConOps was too simple to give any real answer.

Evaluation of need-finding process and result by experienced Systems Engineer: One of the interviewers in this study, is an experienced Systems Engineer that is involved in the Deep Purple project full time. An in-depth interview was conducted to investigate how this person saw the value of the results and the need-finding process. The person believes that the need-finding process discovered needs that would not have gotten identified if standard procedures got followed. The illustrative ConOps shows to be valuable in the preparation phase before the interview to create an understanding of the system.

The illustrative ConOps also showed to be valuable during the interview in helping to identify needs. The person also believes that the stakeholder requirements defined as a result of this research are going to get implemented in the specification of the project. When asked to share any other experiences during the process, the person provided a list:

- *Underestimation of the importance of user interview (the designer lacks practical experience but tries to put himself into the user role)*
- *Designer uncomfortable to admit/show/reveal a lack of understanding related to system user experience*
- *Travel Policy restrictions*
- *Access to tools and training for making ConOps*
- *The time required to perform the interviews and process the data*
- *Uncomfortable to speak with unknown/new people*
- *Differences in social rank (can impact time to get trust and mutual respect)*
- *Time to establish mutual trust and respect*
- *Distance to travel to meet the user physically*
- *Importance of meeting the user personally*
- *User uncomfortable to criticize solution*
- *Developer need to be good at questions and interviewing*
- *Different interests*
- *Knowledge and spoken terms*

Observations: Throughout the interview process, the interviewers took notes on how the participants reacted to this method of need finding. It is a shared understanding between the interviewers that involvement of the end-user in the design stage of projects is both welcomed and missed by the participants. However, there was a strong feeling that the participants expected a different involvement and a different focus of the interview questions. The fact that the questions concerned emotional aspects instead of technical or business-related challenges seemed to come as a surprise, as facial expression and small laughs indicated so.

The participants that got presented with an illustrative ConOps during the interview were also allowed to express their needs and make improvements by sketching on the illustrative ConOps. None of the participants used the options to make sketches, but all of them studied the illustrative ConOps carefully and pointed at it as they gave their answers.

Discussion

Need analysis: The results from the need-finding process and the evaluation made by the experienced Systems Engineer indicates that the method used, provided valuable results. There are, however, aspects that need discussion that could make the need-finding process more effective. The difficulties related to involving relevant interview participants, restrictions caused by confidentiality and cooperation agreements, will most likely be present in future projects as well. Difficulties of getting hold of relevant stakeholders to participate in interviews have resulted in the need-finding process to take longer time than expected. The different location where the participants are stationed also led to traveling for the interviewers.

The execution of the need analysis got performed by interviewing the participant with three different approaches. The first approach desired to capture the previous experience of the participants regarding offshore maintenance operations. The first questions were easy to answer for the participants, something that resulted in a more relaxed atmosphere through the rest of the interview. Rita Berry (1999), suggested asking experience questions at the start of the interview to establish a context for the participants that helps them address the opinion questions later on. The researcher felt that this advice proved to be valuable as the participants seemed to easily relate the questions regarding the Deep Purple system to their previous experiences.

The analysis indicates that needs derived from part 1, regarding previous experience with offshore operations, addressed more the viability perspective than the feasibility perspective. This finding contrasts with part 2, regarding the future Deep Purple system, where the focus was more targeted towards the feasibility perspective. This difference may be related to the fact that the possibility to influence the design from a technological perspective is higher in a design phase. The participants see this as an opportunity to share their ideas on how to make the system more usable. This opportunity may not come along often. When the topic is the current situation, the business-related focus can be related to pressure experienced daily from customers and owners to deliver on agreed time and quality.

In the second part of the interview, where the participants got divided into two groups, the general impression was that the participant that did not see the illustrative ConOps were more uncomfortable in the setting. Since the concept was new for them, and their knowledge about the Deep Purple project was limited, the ConOps effect of getting the participants up to speed was useful. Before starting to ask questions in part 2, the interviewer read a prepared paragraph. The purpose was to describe the future intended operative situation and asking the participant to imagine themselves as maintenance operators on the Deep Purple system. This tactic seemed to be a practical approach to guide the participants towards expressing user needs related to Deep Purple.

One of the observations made by the interviewers was that the participants seemed positive to be involved in the need-finding process. The survey respondent resulted in an NPS of 1 for both groups on the question related to the method used for need finding. This result indicates that the participants are positive to the method and that they most likely would promote the method in the future.

All the interviews got recorded and later transcribed. This activity is a time-consuming, but it proved to be vital in the process of analyzing the interviews. In average, it took four times the time the interview lasted to transcribe and highlight expressed problems or concerns. When an interview gets transcribed, one can easily search for similarities in the different interviews by using a search engine. The researcher also felt that writing down the sentences word by word, made it easier to spot the expressed problems or concerns as they get mentioned.

Illustrative ConOps: To make an illustrative ConOps at this stage in a project showed to be complicated. Not only because of the number of assumptions that had to be made, as mentioned earlier, but also because of the difficulties of deciding the focus. The illustrative ConOps used in this re-

search focused on describing the system and illustrating external and internal logistics. It seemed to be a too broad focus for the participant to manage during the interview. If the illustrative ConOps focused more on a specific part of the system, such as boat landing or the transfer from service operation vessel (SOV) to wind turbine (WT), it might have become more manageable for the participants. The participants were also allowed to sketch on the illustrative ConOps to describe their needs. No one used this opportunity. There could be a different reason why this happened. One reason may be the participant felt embarrassed about their artistic abilities and thus avoided to sketch. Another reason may be that the participants perceived the document as "too fine" to get destroyed by their sketches. It is also possible that the A3 document that the illustrative ConOps got presented on, lack available space for the participants to sketch on. It is therefore important to consider how the illustrative ConOps facilitated for the participants to express a need if one is not to limit it to only verbally expression.

When presenting an illustrative ConOps in an interview situation, some of the aspects that got illustrated can be perceived as solutions by the interview participants and thereby limit their creativity. The interview participant may also feel uncomfortable to criticize the work of others in a situation like this. It is therefore important to emphasize that the illustrations shown in the ConOps are suggestions and speculation about an unfinished system.

The first draft of the illustrative ConOps was tested internally before using it in an interview situation. The document got presented on two A3 documents. This tactic seemed to be unpractical in an interview situation as the participant then would have to move their eyes over a wider area as they studied the document. By reducing the information to fit into one A3, the participants had an easier job using the document to answer questions from the interviewer. The first draft also had more writings and symbols than the final one. These got removed as it gets assessed as unimportant information and to be disturbing for the participants.

When the illustrative ConOps got presented to the participants, the interviewer shortly described the content of the document. The participants then got time to study the document before the rest of the interview continues. In the time the participant studied the document, the interviewer waited in the same room as the participant. It may seem like some of the participants did not get enough time or peace to study the illustrative ConOps properly. Even though the participants got told to use the time they needed, the presence of the interviewers may have had a stressing effect on them. A different approach should be considered to avoid this.

The response from the survey gave some interesting results related to the use of illustrative ConOps. On the question, if the illustrative ConOps helped with creating an understanding of the Deep Purple system. The NPS of 2 from the participants that had seen the illustrative ConOps during the interview, indicates that the participants would promote the use of illustrative ConOps for this purpose. The participants that saw the illustrative ConOps for the first time during the survey gave an NPS of -1. The effect of the illustrative ConOps had on helping the participants to express needs gave an NPS of 2 for those how saw the illustrative ConOps during the interview. For the respondents who saw the illustrative ConOps for the first time during the survey gave an NPS of -2. This result may indicate that the illustrative ConOps is a more suitable tool to extract user needs in an in-depth interview than in a survey. A reason for this may be that the participants could discuss the illustrative ConOps with the interviewer during the in-depth interview, an opportunity that was not present through a survey.

One of the survey respondents commented that the illustrative ConOps was too simple. The researcher wanted to present an illustrative ConOps that showed that the Deep Purple concept was not finished, and that the participant still could affect the design. This may be the reason behind the participants comment. The comment can nevertheless be interpreted as a more detailed version of the illustrative ConOps could be used in future situations.

Human values: The results from the evaluation of needs related to human values, indicates that the participants expressed more need related to human values when the illustrative ConOps was present. One reason for this result may be that the illustrative ConOps made it easier for the participant to imagine themselves in the system and thus triggered the expression of human values related user needs. This theory gets supported by the results from the survey that indicates that the illustrative ConOps helped the participants to come up with more needs during the interview. The researcher believes that the illustrative ConOps removed many of the uncertainties the participants had about the system. This effect made it more natural for the participant to express needs related to human values earlier in the interview.

Visual prototype: The survey indicated that the aspects illustrated in the visual prototype, both represented the expressed needs of the participants and that they agree that the aspects involved are needed. One of the respondents disagreed in seeing aspects that he/she mentioned during the interview. As the visual prototype only, highlighted needs rated as the most important by the interview participants, somebody's contributions may have gotten neglected. The effort laid down in updating the illustrative ConOps and getting feedback on it through a survey can be considered minimal compared to the value it creates. The value of quickly testing and confirmation of derived needs is high as it reduces the chances to make costly design errors caused by misinterpretations. Due to time constraints and the complexity of meeting participants personally, the second iteration got made through an online survey. Ideally, meeting the participant personally would be more beneficial as it makes it possible to see their reactions and ask for declarations where uncertainties arise.

Method applicability: The applicability of this method for mapping user needs and human values can be utilized in different types of projects. Regardless of whether the engineer designs a system known in the market or whether it is an innovation project. The end user's perception of the system is an important factor when evaluating the degree to which the design works.

The validity of research: The number of respondents to the survey and the interviews limits the validity of this research. In-depth interviews got performed on ten expert stakeholders, and eight of these responded to the survey. The expert stakeholders experience in the field is rated as high, which increases the relevance of the results. The results can be considered as tendencies rather than quantifiable results, as the number of responses is too low of the results to be processed statistically and the fact that only one company was involved in the research.

The assessment of needs related to human values got made by the researcher alone. The definition used in this research is based on previously definitions from similar work and can be interpreted differently from person to person. In order to enhance the validity of the results related to the evaluation of humane values, the evaluation should be performed by more people. There are limitations to the research method used in this paper, as the active role of the researcher and the projects Systems Engineer in the industrial case can give a biased conclusion.

Further Research: The researcher recommends future research on the use of illustrative ConOps, as a result of the experiences from this research. This recommendation involves the use of illustrative ConOps as a tool in the interview process, where a more interactive use of the document should get tested. This research's proposed for the participants to express their ideas by performing sketches on the illustrative ConOps document. The researcher believes this would have been a suitable setting to engage the participants in such an activity, and that it could have provided valuable data for the project (Lessio, 2016). As the participant involved in this research avoided to make sketches, the research cannot conclude this matter.

Conclusion

By conducting in-depth interviews of stakeholders with offshore operational experience, the researchers found 105 relevant user needs, and the experienced Systems Engineer from the Deep

Purple project obtained a better understanding of the end user's operational needs. This understanding provided input to 17 stakeholder requirements.

Using an illustrative ConOps in the interview process helps the participants to reflect on the questions asked. The survey results show an NPS of 2 on the questions if the illustrative ConOps helps to create an understanding of the system and to express more user needs. An illustrative ConOps in the interview phase contributed to the generation of user needs related to human values. The analysis of the results of the interviews shows that 37 % of the need derived in part 2 “with the use of illustrative ConOps” to be related to human values. In comparison to 20% in part 2 “without illustrative ConOps” were related to human values.

This research contributes to the first two steps of the Fundamental Systems Engineering process, the “need identification”, and “definition of stakeholder requirements”. By following the Design Thinking process, the research has successfully derived relevant user needs and stakeholder requirements in the early stages of an innovation project. Also, the research has shown how to implement human values in the early phase of an innovation project through the use of illustrative ConOps.

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