Early Validation of Stakeholder Needs by Applying Co-creation Sessions

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Abstract. This paper investigates the application of co-creation sessions as a method in the early phases of development projects. The target is to do an early validation of stakeholder needs prior to project start. Co-creation sessions engage key stakeholders to share knowledge in collaborative exercises to gain a mutual understanding of the problem and build a solution landscape. We study three co-creation sessions in early phase development projects by using interviews and feedback surveys in an industry-as-laboratory approach. The co-creation method is based on design thinking techniques, system oriented design and other visual tools. The sessions are facilitated to provide active participation of key stakeholders, achieved by using hands-on activities. The results imply that co-creation sessions contribute to anchor, align, and validate stakeholder needs, but do not necessarily elicit stakeholder needs. The study indicates that co-creation sessions increase customer engagement and can potentially lead to new development projects.

Introduction

Co-creation sessions. The concept of co-creation has evolved from the term participatory design (Spinuzzi, 2005) during the last decade. Essential is the participatory engagement in design ideation, creative problem solving and decision making (Jones, 2019). Conducting co-creation sessions will include several stakeholder perspectives in the early development process. The chance of capturing key stakeholder needs may increase due to the involvement of key stakeholders and their early contributions. Co-creation has developed from structured brainstorming sessions and creative problem-solving. It has no formally core theory or starting-point, as it has evolved across several design disciplines and evolved differently within the fields of business, design, and systems. Jones (2019) argued that the concept of co-creation is hard to compare due to variable performance in different contexts and can include methods within facilitation, creative organization, generation of co-design and dialogic.

Lemmens, Donaldson, & Marcos (2014) argued that co-creation in a customer-supplier relation can achieve a positive experience where the customer has the opportunity to participate in each step of the development process through the means of a two-way dialogue. To define the solution together with the customer, the customer must engage in the process by providing information and knowledge

about the system of interest. The customer will be involved as an active partner, increasing customer engagement, and building a long-term relationship based on co-creation. In comparison, in traditional selling, the customer is a more passive source of information (Lemmens, Donaldson, & Marcos, 2014).

Co-creation sessions have been mentioned in a few occasions in a systems engineering context by: value co-creation in the field of service systems (SEBoK, 2018b), systems engineering supporting digital co-creations (Uehara & Matsuo, 2018), and in collaborative product-service systems engineering, including customer and stakeholders in the value co-creations (Pezzotta, Cavalieri, & Romero, 2017). Kjørstad, Falk, Muller, & Pinto (2019) implied that co-creation sessions are an effective method to communicate innovative ideas and concepts and do early validation of user needs. They also introduced a key driver graph to illustrate the main impact factors of early validation of user needs through co-creation sessions.

Company. Semcon Norway AS is an engineering consultancy providing product development services for clients in fields such as energy, maritime, industry and infrastructure. The company is a part of the Semcon Group, which is an international consultancy company offering product development based on human behavior. For the last decade, Semcon Norway AS (hereafter called Semcon) has executed early phase workshops called co-creation sessions as a part of their innovation consultancy. Out of around 100 projects a year, co-creation sessions are conducted in approximately ten.

Cases. Semcon facilitates co-creation sessions with companies in different fields, with problems and projects with varying levels of complexity. To capture this diversity, we conducted the research on multiple cases, studying three co-creation sessions:

> **Case A) Automotive.** A small production company doing vehicle modifications. The company have a large variety of products in their portfolio and strive to improve their sales and production processes.

> **Case B) Livestock farming.** A company doing research and product services for effective livestock farming. The company wants to know how digital tools can contribute especially within logistics. Their challenge is to improve their production and logistics to meet their customer's needs.

> **Case C) Tourism.** A cluster organization providing tourist services. The cluster wants to decrease administrative costs, increase customer satisfaction, and increase business opportunities by means of digitalization. Their challenge is to create a common digital platform to improve administrate costs.

Problem. Use of co-creation as a way of working has evolved within Semcon during the last decade. Traditionally, customers handed over problems for Semcon to solve as consultants. There is a risk involved in a direct handover from the customer, where needs or opportunities have not been validated before project start. Often, the clients provide a given solution based on their own technical understanding and need, without eliciting other stakeholder needs or perspectives. As a result, this can lead to the wrong solution being developed without an early validation of the actual need from the stakeholders.

In our research, we investigate how co-creation sessions as a method may improve early validation of a given idea or opportunity from a customer. The sessions focus on finding new perspectives and real needs from different key stakeholders. By including multiple stakeholders with diverse experience, background, and viewpoints and with individual perspectives and needs, there is a greater chance to correct the direction of the development early.

Research question. In this paper, we aim to answer the following research question: "*How will co-creation sessions contribute to validate stakeholder needs during early development projects*"? We also look into the following sub-questions:
- *How to involve and get contributions from key stakeholders?*
- *How to elicit stakeholder needs through co-creation sessions?*
- *How to anchor and align stakeholder needs during co-creation sessions?*

Firstly, we present state of the art within early validation of stakeholder needs, discussing relevant literature. Then we describe the chosen research methodology and how co-creation sessions have evolved and been conducted at Semcon. Three co-creation sessions cases are described, before the results from interviews, feedback surveys and observations from the co-creation sessions are analyzed and discussed. In the conclusion, we answer the research questions and suggest further research.

State of the Art

Systems Engineering. Within the domain of systems engineering, there are several recommended approaches to assess and validate needs. The model *Committed Life Cycle Cost against Time* is essential to describe how early decisions without the right information and analysis, can affect the project's cost and time schedule (INCOSE, 2015). However, the Systems Engineering Handbook do not describe how to validate the initial needs, initiating the project. In later stages tools supporting needs is better described. Rapid prototyping and Concept Of Operation (CONOPS) is used to facilitate awareness and create a common understanding of user needs and stakeholder requirements.

Kossiakoff, Sweet, Seymour, & Biemer (2011) described that a need can derive from a current system's operational deficiency, new technology, or a market opportunity. During the *Need analysis phase*, Kossiakoff et al. (2011) defined four steps (*operations analysis, functional analysis, feasibility definition and needs validation*) to demonstrate the validity of the operational or technical need, as well as presenting feasible approaches to fulfill the need within a reasonable level of risk and affordable cost. Despite the well-formulated process description, Kossiakoff et al. (2011) did not describe the involvement of key stakeholders at this point, nor more detailed descriptions of tools or methods to elicit stakeholder needs.

The systems and software engineering standard, ISO/IEC/IEEE 15288:2015(E)*,* describe the system life cycle processes in four segments*.* The Technical Processes segment describe actions throughout a system's life cycle. The segment describes an action before the Stakeholder Needs and Requirements Definition Process, called a *Business and Mission Analysis Process*. The purpose of this step is to define the business or mission problem or opportunity, characterize the solution space and to determine potential solution classes. The process interacts with the organization's strategies, including strategic goals and plans, the organizational concept of operation, and identified problems or opportunities. The process will provide important input to the next action step *Stakeholder Needs and Requirements Definition Process* focusing on eliciting stakeholder classes and needs, transforming them into stakeholder requirements. The standard emphasizes eliciting needs directly from the stakeholders or based on domain knowledge and an understanding of the context. However, the standard does not give any recommendations of tools or methods to use.

The SEBoK (2018a) stated that there are several ways of collecting stakeholder needs and requirements, by example structured brainstorming workshops, interviews and questionnaires, simulations and visualization and prototyping. Based on the work of Shoji Shiba and Noriaki Kano, Faisandier (2012), Fig. 1 shows how to understand the maturity and origin of stakeholder needs and how to improve the system, product or service based on this maturity.
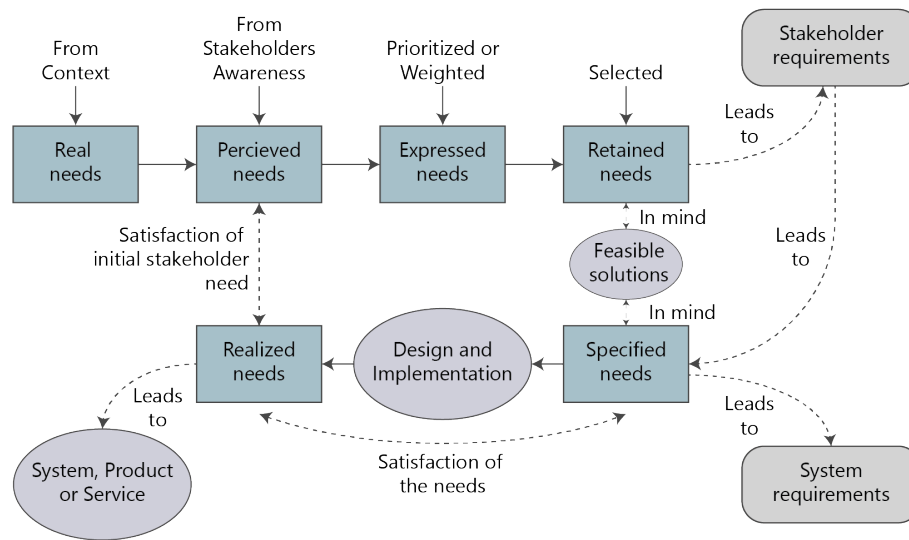
Fig. 1 The Cycle of Needs, adapted from Faisandier (2012).

The model can be used to explain the input, output and process of eliciting stakeholder needs to develop a system, product, or service. The model describes that real needs are elicited in the context of the system, while perceived needs are based on stakeholder's perception. This can be a need based on an opportunity or operational deficiency, as also described by Kossiakoff et al. (2011). The expressed needs are based on constraints or generic actions from analysis of the expected operation. A selection of the expressed needs is prioritized and evolved into retained needs to define a more feasible solution ending in stakeholder requirements. Again, we found no explanation of how needs are elicited nor validated in the early phases of development projects.

Design Thinking is a methodology to work in a holistic manner focusing on improving the user experience. Design thinking integrates the people's need with the possibilities of technology and the requirements for business success to create innovations (IDEO). Design thinking was defined and theorized by Rowe, Cross, Schöhn, Nelson & Stolterman (Cross, 2006; Cross, Dorst, & Roozenburg, 1992; Nelson & Stolterman, 2012; Rowe, 1987; Schön, 1982). Through its migration to management and business supported by IDEO (Brown & Katz, 2009) and described by for example Boland and Collopy (Boland & Collopy, 2004) the term has grown into a popular concept in which any business and organization could benefit to work inspired by the designer's thinking and ways of working (Tschimmel, 2012).

Tschimmel (2012) argued that design thinking is an effective toolkit used in any innovation process, combining creative design approaches with traditional business development. In her research, Tschimmel analyses and discuss five of the most known models within the domain of Design Thinking applied in business and innovation. The five models are: *The 3I Model, The HCD Model, The Model of Hasso-Plattner Institute, The Double Diamond Model* and *The Service Design Thinking Model*. Co-creation as a method is mentioned in several of the models. The models from *The Hasso-Plattner Institute* and *The Double Diamond model* emphasize the use of multi-disciplinary participants in brainstorming sessions or ideation processes. Despite the more user oriented approach and a great offer of tools, design thinking lacks more of the technological focus that has a solid foundation in the systems engineering literature.

Applying Design Thinking in Systems Engineering has been argued in several kinds of literature such as Tomita, Watanabe, Shirasaka, & Maeno (2017), Sjøkvist & Kjørstad (2019) and Kjørstad, Falk, Muller, & Pinto (2019). The literature indicated that traditional systems engineering processes do not highlight the importance of focusing on user needs early in the development stages but focus on business or technology perspectives. Design thinking can be used to capture and understand human values, such as stakeholder needs, in development projects as a part of the systems

engineering process (Sjøkvist & Kjørstad, 2019). Design thinking techniques are a good approach to uncover and capture needs using different tools and methods (Hasso-Plattner-Institut, n.d.). This in comparison to systems engineering literature, that often lacks explanations and tools to eliciting stakeholder needs.

System Oriented Design (SOD) is an approach within the field of systemic design (Sevaldson, 2009). Central in SOD is the gigamap tool. Gigamapping is using pens and large sheets of paper in collaborating groups to map, contextualize and relate complex systems, mapping interactions in the systems environment, current and future state visions (Sevaldson, 2019). Mapping interactions of the system and key stakeholders can potentially reveal unknown needs. Sevaldson (2019) argued that gigamapping is a central tool for co-operation, where the experts, users and other stakeholders together create dialogues across their specialized cultures and terminologies. Goldschmith (1994) discussed how visualizations extend the mental imaginary and by using visualizations, different aspects of the system appear. The problem domain will be expanded to possibly include and discover new aspects of the system. To analyze the results from the gigamaps, tools such as ZIP-analysis are effective. The ZIP stands for *Zoom, Innovation and Potential,* helping the participants to derivate strategies, ideas and interventions (Sevaldson, 2012).

Research Methodology

Industry-as-laboratory. In this research, we have chosen an industry-as-laboratory approach to conduct the study (Potts, 1993). This approach uses an industrial setting to test and evaluate the application of new methods in systems engineering (Muller, 2013). The researchers evaluate the method within the context of the industry using a combination of qualitative research methods such as observations, interviews, and surveys. Since Semcon is a multidisciplinary company working with complex projects, the industry-as-laboratory approach is more suitable than conventional mono-disciplinary research (Muller & Heemels, 2007), looking at the problem in a holistic manner more than looking into a solution for one single, practical problem.

In-depth interviews. We conducted in-depth interviews with Semcon employees with experience as participants or facilitators in co-creation sessions. The interviews contributed to gain insight into how co-creation sessions have evolved at Semcon, how the method is perceived and how it validates stakeholder needs. Table 1 shows an overview of Semcon employees interviewed for this research. All participants consented to be audio recorded and for their statements to be gathered and used as information for this research.

Table 1 In-depth interview participants.

Number	Role in Semcon	Experience in Semcon
1	Systems Engineer & co-creation session participant	1-5 years
2	Systems Engineer & co-creation session participant	1-5 years
3	Sales & co-creation session facilitator	10 + years
4	Systems Engineer & co-creation session participant	10 + years
5	Sales & co-creation session facilitator and participant	5-10 years
6	Sales & co-creation session facilitator	10 + years

During the interviews, we used a semi-structured interview guide and drew the answers on a roll of paper to create engagement and consensus with the interviewee. A structured survey was used to gather comparable data and we asked for the elaboration of the replies for greater insights. The survey statements provide data on the current state of co-creation sessions at Semcon, presented in the Likert scale for analysis and comparison (Likert, 1932).

Feedback survey. We used a feedback survey in two of the three cases. The co-creation sessions in case A were conducted before a feedback survey was planned for this research. However, observations together with oral and written feedback from participants and Semcon employees, are

used as qualitative results. A feedback survey was sent to the participants after the co-creation session in case B and C to gather the participants' experience, their thoughts on particular tools and the focus on stakeholder needs during the session. The Likert scale was used in the survey with a rating from strongly disagree to strongly agree (Likert, 1932). We analyzed the feedback surveys with a Net Promoter Score (NPS). The NPS help separate promoters from non-promoters, where we assume that the respondents answering "strongly agree" are promoters, "agree" are neutral and from "neutral" to "strongly disagree" are likely to be non-promoters of the statements (Muller, 2013).

Yin (2018) argued that using multiple sources in research will help to corroborate the findings in the study and strengthen the validity of the results. Using multiple sources, as observations, in-depth interviews and feedback surveys will provide multiple measures for the same phenomenon. This approach is called triangulation (Yin, 2018).

Key driver graph. Inspired by the work of Kjørstad et al. (2019) we developed a key driver graph to analyze how the different tools and techniques used in the co-creation sessions contribute to early validation of stakeholder needs. Key driver graph derives from systems architecting (Heemels, et al., 2006). It is used to understand the stakeholder needs in relation to requirements, thereby linking the problem and solution domains and seen as a fit approach for our analysis.

Co-creation Sessions at Semcon

Co-creation session development. Co-creation sessions at Semcon are an early phase development session conducted before a development project starts. It started in the company a decade ago in the fashion of brainstorming sessions. Since that, co-creation sessions have evolved into a structured process, now executed mostly on new customer relations at a strategic level. Methods and tools have been collected from several kinds of literature on, e.g. design thinking, innovation management, SOD, and systems engineering. In the start there were two Semcon employees specializing in facilitating co-creation sessions. During the last three years, several employees are involved both as participants and facilitators due to the increased expansion of co-creation sessions.

Two levels of co-creation sessions. Semcon runs two levels of co-creation sessions. A *business level* focusing on the business strategy of the company, and a *technology for human level* to develop concepts or future projects with the customer. The two levels can be run as a sequence or as individual processes. Both levels are divided into four steps as seen in Fig. 2.

The duration of each level can be from four to six work weeks; where there is a preparation phase prior to the session, and a processing phase after the session. The co-creation session is executed in one to three days.

Fig. 2 Co-creation session process described at two levels: *business* and *technology for humans*.

Facilitation. Co-creation sessions utilize two facilitators. When documenting the results from the co-creation session, one facilitator monitors the group discussions, while the other facilitator document

findings by pictures, notes or on documents in the room. The facilitators plan the co-creation sessions carefully using a detailed plan down to the minute with the resources and tools needed for each step.

Tools and Techniques. The tools and techniques applied in the co-creation session are selected based on the need of the customer and the theme of the session. The tools have evolved from literature from design thinking, SOD, lean, systems engineering and innovation management. The exercises are hands-on, meaning that all participants can contribute and share their thoughts, knowledge, and ideas with e.g. sketching, drawing and low-fidelity prototyping.

Participants. Semcon includes key stakeholders in the co-creation sessions, such as: the client, customers, users or operators, external experts and Semcon employees. Most of the participants are usually from the customer's organization. Mixing the background of the participants is desired, including both operators of the system and management perspectives. Semcon also invites third-party external experts when Semcon lacks depth-knowledge or need new perspectives on a specific topic. Usually, Semcon includes their own employees as participants as they have the mindset of innovation processes. They are familiar with the setting and can guide the other participants through the exercises in the session.

Deliverables. Usually, the deliverables from the co-creation session are digital versions of concept descriptions, gigamaps, infographics or a documentation and knowledge sharing tool, such as an IKA (Interactive Knowledge Architecture). An IKA is a digital knowledge base shared between the customer and the project team, working as a communication platform (Jensen, Muller, & Balfour, 2019).

Cases

In this paper, we base our research on three cases using co-creation sessions. Table 2 gives an overview of the clients and the content of the sessions.

Table 2 Co-creation session cases

CO-CREATION SESSION CLIENT	FRAME	THEME	PARTICIPANTS	DURATION
A)	Automotive	Securing future business	Customer site = 5, Semcon = 2, external expert = 1	1 full day each (morning to evening)
B)	Livestock farming	Business strategy	Customer site = 5, Semcon = 2, external experts = 2	2 half days (lunch to lunch)
C)	Tourism	Digitalization of the customer journey	Customer site = 14, Semcon = 1, external experts = 2	2 half days (lunch to lunch)

Case A) Automotive

Semcon facilitated two co-creation sessions for this company. One at a business level and another one at a technical level. The company assembles cranes and hooks on chassis. They strive to improve their sales and production processes to secure their future business.

For preparations, we visited the client's production facilities conducting interviews and observations. We interviewed management and production personnel to ensure eliciting different stakeholder needs. Then we observed and documented core operations for the business. Later we interviewed customers and suppliers as well as branch magazines. All the findings were used to build the problem landscape[1].

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[1] The problem landscape is defined in Semcon's co-creation process in the *technology for human* level. Building the problem landscape means looking at the problem in a broader perspective, by collected input to gain a greater

The participants for the first co-creation session included five people from the client's management, one external expert in change-management and two Semcon participants. To introduce the participants to the group, we used a warm-up exercise. The exercise is used to make the participants feel comfortable being outside their normal work environment, but also to familiarize with each other. The participants worked in pairs to build a Value Proposition Canvas (Strategyzer, n.d.). The objective was to identify pains, gains, and value proposition to understand different customer needs. The participants also built the current Business Model (Strategyzer, n.d.) for the company. After lunch, the participants got new input from the analysis done prior to the session, before building the future business model based on the new input. The group did a ZIP-analysis (Sevaldson, 2012) where the results pointed out four potential areas of interest which were further developed into concepts.

As a result of the co-creation session, the four areas of interest were rephrased and stated as key areas in the future strategy. The results and knowledge captured from the first session became an integrated part of the preparation of the second session. In the second co-creation session, the focus was on technical solutions. Three new participants were involved; one from the customer site and two participants from Semcon with more technical perspectives. A summary from the last session was presented, together with an overview of the market share and revenue prepared prior to the session. Competitors were also discussed to understand more of the market segment.

The group was divided into two teams due to group size, where the teams focused on the how to establish new customer relations, nurture old customer relations, mapping of the current customer journey, strategy with their main supplier and production flow mapping. The result of the co-creation session was a graphical representation of the updated strategy, together with an innovation roadmap containing stepwise actions based on the four main areas from the strategy.

Case B) Livestock Farming

This company is doing research and product services for effective livestock farming. The main challenge for this company is to improve their logistics to meet their customer's needs. The co-creation session was the second co-creation session with this client. The first co-creation session is not part of this research but focused on the value proposition and the business model.

To prepare for the session, the project team had been at field visits at the company's production facilities. Based on information the company provided, a journey map was made with process descriptions with actors, resources, tools, durations, and locations. The journey map was hanging on the wall in the facility and used frequently during the co-creation session.

The participants at the second co-creation session included five people from the client's administrative and operational site, two participants from Semcon with system architecture knowledge, and two external experts, one within innovation and one within logistics.

The first day, started with a participant introduction, where the participants interviewed each other. Then the results from the previous co-creation session were presented. The journey map was presented, which also led to a plenary dialogue with questions, especially from the new participants. Later, the participants were divided into pairs, working on challenges and opportunities from the journey map. Each challenge or opportunity was processed in a 5-why's approach to gain deeper insights. After lunch, a pause exercise was used called Helium stick to let the participants focus on another topic and to get the participants to collaborate as a team in a hands-on exercise (Design Thinking for Museums, 2014).

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understanding of the actual problem. Gigamapping is one tool used to visually construct an understanding of the environment surrounding the system of interest.

New groups were established and each participant brought ideas in a short-term or long-term into the groups. The ideas were processed before presented in the plenum and voted on. Three short-term and three-long term ideas were chosen before the group went for a social dinner. The social dinner is to get familiar and socialize outside the context of the session.

At day two, the groups worked in sprints with developing the ideas further. Each group worked ten minutes on an idea before the groups rotated. In this fashion, all participants were familiar with the ideas and built on each other's contributions. The groups did a SCRAMPER, a method to solve a problem using directed questions aiming to evolve on existing solution (Eberle, 1996), to improve the ideas further. Finally, the ideas were presented in the plenum for discussion of further actions. The deliverables from the co-creation session were digital versions of the concept descriptions and journey map, together with the result from the previous co-creation session with the Value Proposition and Business Model Canvas.

Case C) Tourism

The client is a cluster organization providing tourist services. Their challenge is to create a common digital platform to improve administrate costs. The co-creation session in case C is a sequel from a previous co-creation session executed about half a year earlier. The previous session focused on the wide possibilities with digitalization as a tool to improve the customer experience. This co-creation session focused more on the implementation of technology.

For preparations, input from the previous session together with trend research was used to understand the tourist's planning habits and needs. No field visits or planned interviews were conducted due to resource constraints. The participants came from a management level from the cluster organization. Semcon had no participants other than the facilitators. Two external experts were invited, within innovation management and smart locks.

The first day started with an introduction of the participants. As an ice breaker activity, the participants were sketching portraits of each other without looking at the paper. This exercise lowers the pressure when it comes to sketching, something that is important when engaging in visual dialogues. Then the external experts made presentations to give the participants inspirations and new insights. The participants used this insight as well as their existing knowledge and experience to generate a journey map focusing on three technology topics. Later, they voted on the most interesting problem domains focusing on three perspectives: *what gives value to the customer and the cluster network*. The participants presented their results in plenum using A3s, post-it notes or digital photos of their maps.

Six themes based on the work from the group that day were presented during the social dinner as topics for day two. The topics were meant to prime the participants overnight.

At day two, the groups worked in sprints on the six topics, like in the co-creation session in case B. The participant built on each other's ideas and everyone got insight into the topics. The topics were presented before they were combined into three concepts. The groups worked on detailing the concepts before they were presented, and action points were placed at an innovation timeline. The deliverables from the co-creation session were a digitalized innovation timeline with the action points, as well as a recommendation of pilot projects.

Results and Analysis

Interview results. A section of Semcon employees (Table 1) who have been involved in co-creation sessions was formally interviewed to capture their thoughts and experiences. Some of the main findings are shortly discussed here. When asked, "*How do we make sure that several stakeholder perspectives are heard during a co-creation session,*" one response was that this is done by facilitation and proper planning. "*We do this co-creation session primarily for the customer, but also*

for ourselves. There can be a user perspective, but if that is not giving any value for the customer, then we shouldn't focus on it," referring to who is the key stakeholders in the system. Another statement was, "*People don't talk. You don't need people to talk to make them share what they know. What we want is to make them interact with us. Interaction doesn't necessarily mean talking,*" referring to the use of hands-on activities using other tools than only dialogue e.g. writing, sketching, and building. An idea can make sense while talking but building low fidelity prototypes makes the participants aware of constraints the participants had not thought of before testing or sketching it.

When asked about the benefits of the co-creation session, several of the interviewees stated the importance of including the right stakeholders in the co-creation session. "*It is always good to gather the right people in the same room and start a discussion. To get the right stakeholders from the customer site to talk to each other is valuable in itself*". A perception from the interviews is that co-creation sessions are breaking down the formal company structures, allowing the customers to talk to colleagues they usually do not talk to due to their busy everyday life.

A survey was used in the interviews to discuss some statements regarding co-creation sessions. Fig. 3 shows the responses regarding the focus on stakeholder needs during co-creation sessions.
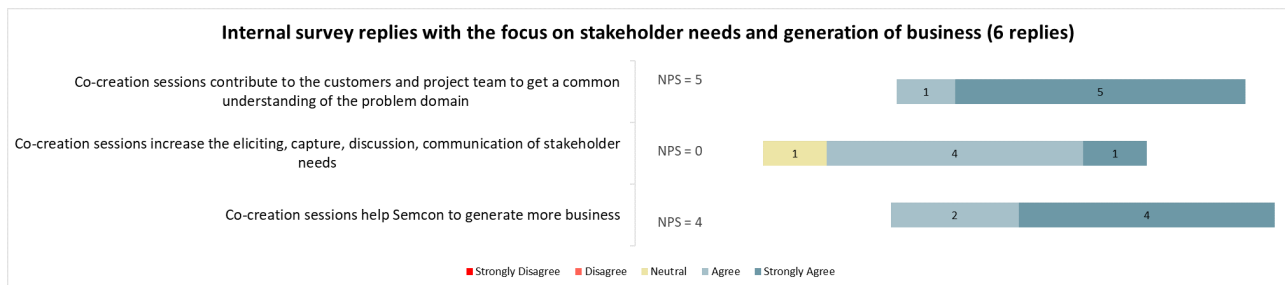

Fig. 3 Results from an internal survey during interviews with Semcon employees

- The results show that the Semcon employees think co-creation session contribute to getting a mutual understanding of the problem landscape with an NPS of 5 out of 6. When the participants have a mutual understanding of the needs of the system it can contribute to elicit and validate stakeholder needs. A comment from one interviewee was that "*Co-creation session itself does not give a better understanding, but our process on highlighting the problem helps the participants to do so*."
- The Semcon employees are positive, but not convinced that co-creation sessions help to elicit, capture, discuss and communicate stakeholder needs as reflected in the NPS of 0. One of the comments from the interview was the following statement: "*It is dependent on the facilitation. The facilitation needs to plan to identify stakeholders, add use cases and perspectives.*"
- The survey result shows that Semcon employees are positive that co-creation sessions generate more business for Semcon. When asked in the interviews about co-creation sessions as a sales tool, one reply said, "*What they are, is a wonderful tool to strengthen relations and to build trust. As far as we know, you would reply positively much faster with someone that you trust. Co-creation sessions are a good way to build this trust.*"

Observations from the cases.

Case A) At the first co-creation session stakeholders were mapped and analyzed by using Osterwalder's Value Proposition Canvas (Strategyzer, n.d.) and Business Model Canvas (Strategyzer, n.d.). The two canvases, as well as the facilitation, guided the participants to focus on customer segments to elicit stakeholder needs from the different segments. Feedback from the Semcon participants was that the customer participants enjoyed working with the systematical canvases.

For the second co-creation session, the focus on customer segments was not present and the new participants missed connections made in the first session. However, one of the most significant

findings from the first co-creation session was to focus more on their main supplier was used in the second co-creation session. One group made a customer *journey map* with little guides and no template. The response from a Semcon participant was that it was hard for the other participants to document their discussions when they were not following a template. Since the customer participants are not used to the co-creation session processes, *more guides or examples are needed* to document and share findings. Being forced to use well-defined templates can be a good technique to force the process of thinking of several perspectives.

Case B) The co-creation session used a journey map during the co-creation session. It was in great details and created a lot of *good discussions* for the new participants. The participants got a *common understanding* of the company's processes and problem domain. One comment was that the focus shifted during the co-creation session from focusing a lot on the company's processes and the challenges regarding logistics, to also focusing on the customer and the customer experience. The shift was not intentional but evolved naturally by developing the concepts at day two of the co-creation session.

Case C) In this co-creation session, a journey map was used with the time dimension of before, during and after the customer stay. The groups focused on the problems in the three dimensions: the customer, the tourist sites, and the cluster network. The groups had differences in the level of documentation. A fictive competition, where one of the other groups were "leading" in the number of post-it notes, made a motivation for the other two groups to generate more post-it notes.

The involvement of *external experts* to give input was only partially successful. This is because, one of the experts was not primed on the content, nor his involvement in the session as a guide in the group exercises. This was due to poor communications with the facilitators prior to the session. An option is that the facilitators could have collected input by interviewing the external expert prior to the session to give a summary in the co-creation session to the participants.

Feedback survey results. We sent feedback surveys to the external participants at the co-creation sessions in case B and C. Fig. 4 shows the case B responses related to stakeholder needs.
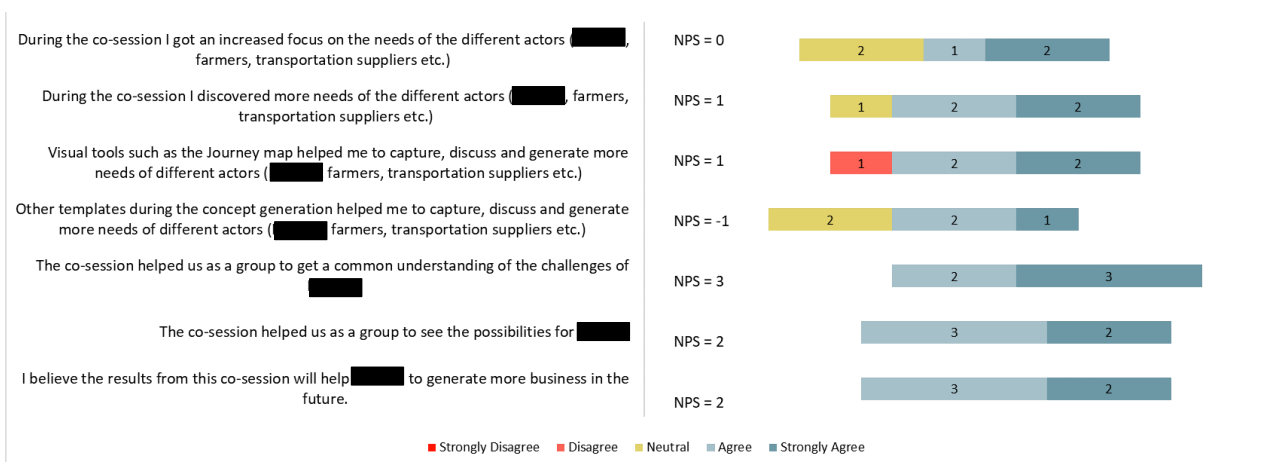
Fig. 4 Results from participants at the co-creation session in case B

- The results show a less positive response to an increased focus on stakeholder needs, compared to the results in case C. The reason for these results was stated in one of the interviews as it was not an intended focus. The focus was on the company and their own logistics chain, rather than the farmers, end users or other stakeholders.
- In regard to tools used to get more focus on the stakeholder needs, the NPS is positive regarding the journey maps, but other concept generation templates have a negative NPS.

However, due to the low number of replies, we need to further test the methods to conclude if the methods are useful or not to capture, discuss and generate more stakeholder needs.
- The participants thought that the co-creation session helped the group to create a mutual understanding of both challenges and possibilities. They think the results from the co-creation session may contribute to generating more business for the company in the future.

Fig. 5 shows the responses from case C to a section of the feedback survey related to stakeholder perspectives.
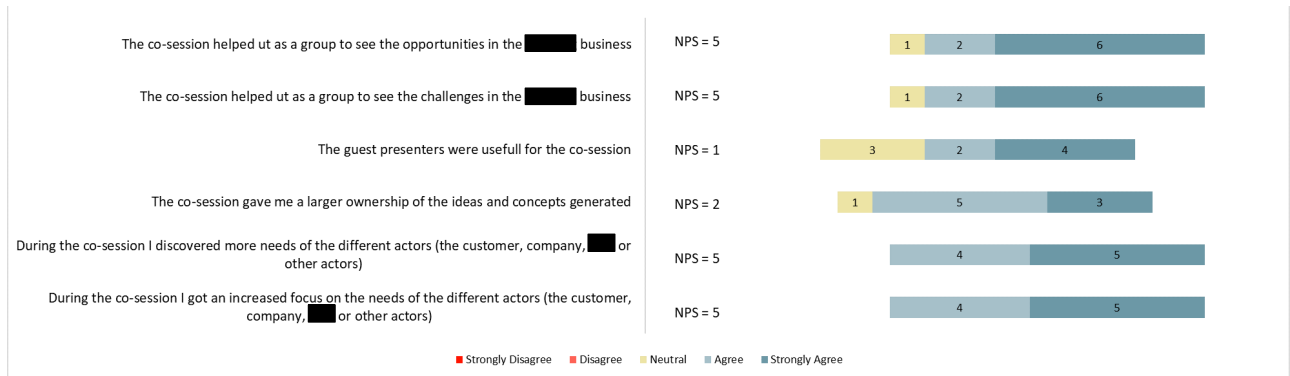
Fig. 5 Results from participants at the co-creation session in case C

- The group felt that the co-creation session helped to get a mutual understanding of both the challenges and the opportunities of the tourist business with an NPS of 5 out of 9.
- The participants were more divided in the feedback regarding the benefit of the presentations from external experts. We can explain this by poor communication and expectation management by the facilitators prior to the session.

The results show that the participants in case C experienced an increased focus and discovery of more needs from different stakeholders with an NPS of 5 out of 9.

Key Driver Graph. In this research, we use a key driver graph to analyze co-creation as a method to validate stakeholder needs. The key driver graph in Fig. 6 is based on the interviews, feedback surveys, observations, and the key driver graph by Kjørstad et al. (2019).

Fig. 6 Key driver graph of validation of stakeholder needs through co-creation sessions

DAY 1:

| Meet & greet: lunch | Introduction | Group work: mapping of problem domain | Voting | Presentation & summary | Internal summary | Socialization: dinner |

DAY 2:

| Introduction | Group work: sprints | Presentation & voting | Group work: concept work | Presentation & summary | Closing & socialization: lunch |

description of activitites

- The participants arrive. There is a common lunch while getting to know each other.
- Introduction of the participants using a warm-up exercise. Introduction to the agenda and rules. Presentations from external speakers with content for the ideation.
- The group are divided into smaller groups working on topics based on the presentation and discussions. Participants first share individual thoughts, then work together with ideas in the group.
- The smaller groups do an internal voting of which topics to proceed working on.
- The groups present their ideas in plenum and discuss their findings.
- The desicion makers from the customer choose the direction of day two based on the ideas from day one.
- The groups gather again to meet for dinner and/or social activities. During the night the group get a reminder of the topics for day two.
- Day two starts with a funny warm-up exercise. Then the topics and agenda for the day are presented.
- The groups constitute themselves into new groups and start working in fast sprints on three to six topics. The groups rotate, so everyone have worked on the topics and built on each others ideas.
- The groups present their work in plenum, starting a common discussion before the ideas are voted on.
- Based on the voting, each group get one idea they will develop further into a defined concept.
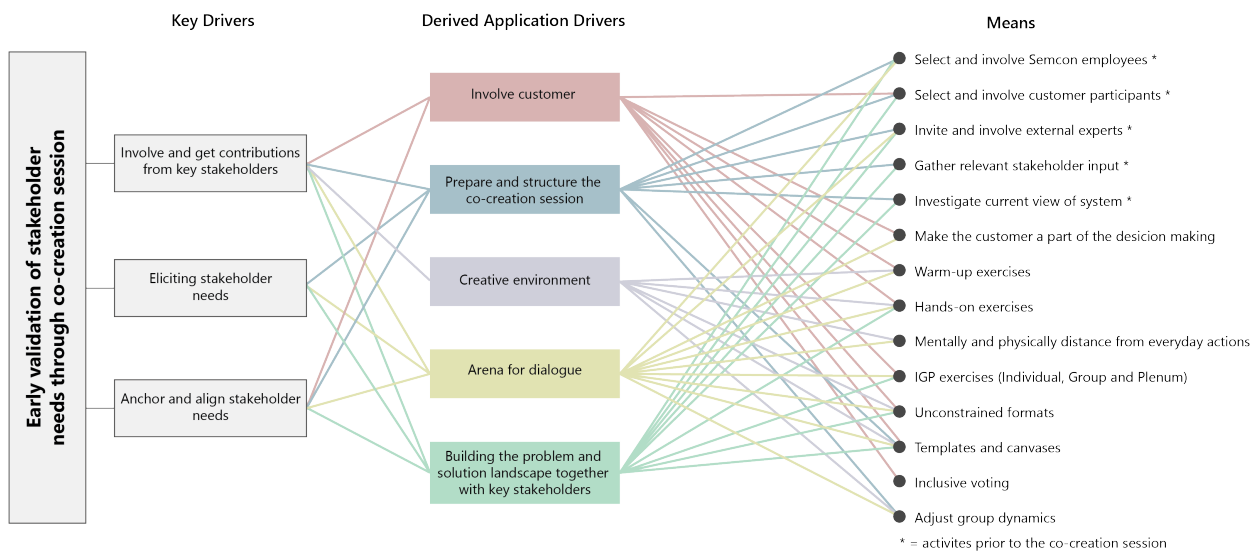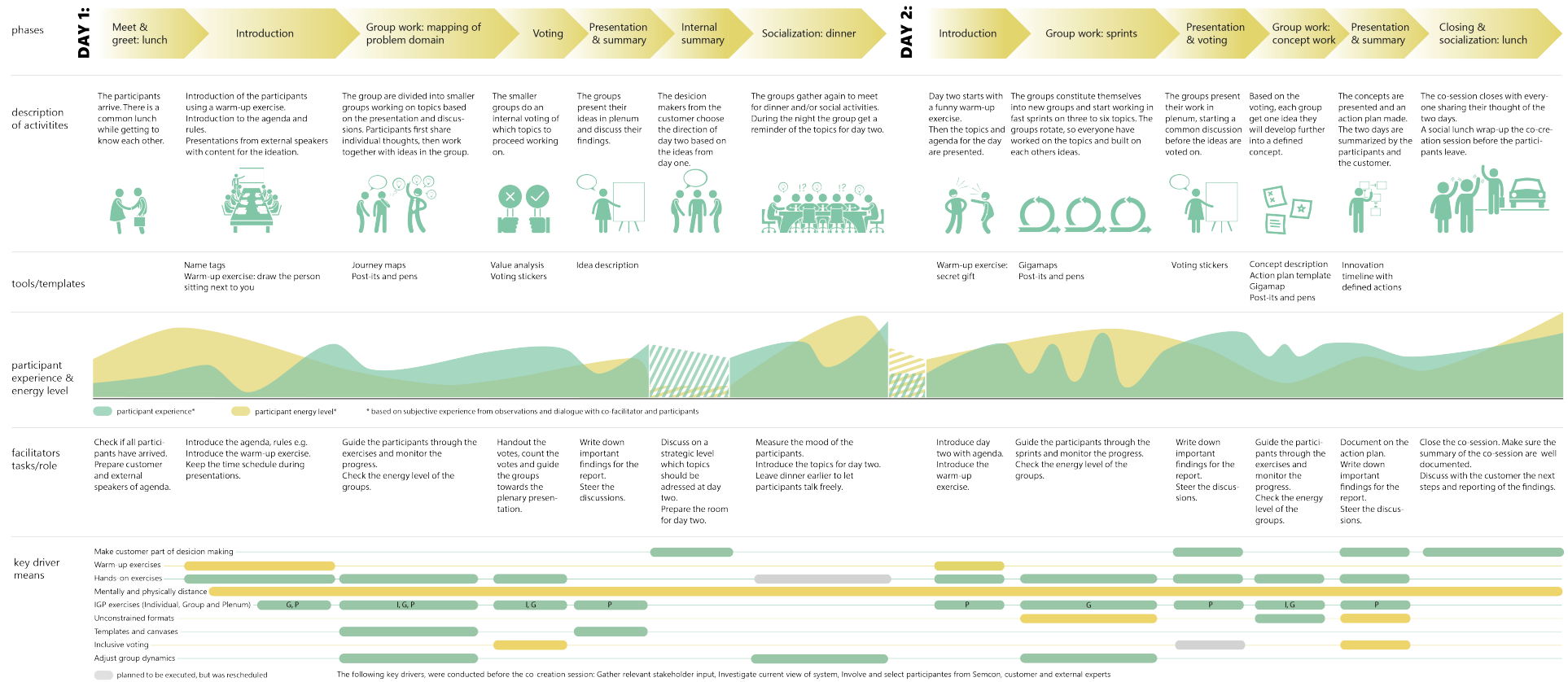- The concepts are presented and an action plan made. The two days are summarized by the participants and the customer.
- The co-session closes with everyone sharing their thought of the two days. A social lunch wrap-up the co-creation session before the participants leave.

tools/templates

| | Name tags / Warm-up exercise: draw the person sitting next to you | Journey maps / Post-its and pens | Value analysis / Voting stickers | Idea description | | | Warm-up exercise: secret gift | Gigamaps / Post-its and pens | Voting stickers | Concept description / Action plan template / Gigamap / Post-its and pens | Innovation timeline with defined actions | |

participant experience & energy level

- participant experience*
- participant energy level*

* based on subjective experience from observations and dialogue with co-facilitator and participants

facilitators tasks/role

- Check if all participants have arrived. Prepare customer and external speakers of agenda.
- Introduce the agenda, rules e.g. Introduce the warm-up exercise. Keep the time schedule during presentations.
- Guide the participants through the exercises and monitor the progress. Check the energy level of the groups.
- Handout the votes, count the votes and guide the groups towards the plenary presentation.
- Write down important findings for the report. Steer the discussions.
- Discuss on a strategic level which topics should be addressed at day two. Prepare the room for day two.
- Measure the mood of the participants. Introduce the topics for day two. Leave dinner earlier to let participants talk freely.
- Introduce day two with agenda. Introduce the warm-up exercise.
- Guide the participants through the sprints and monitor the progress. Check the energy level of the groups.
- Write down important findings for the report. Steer the discussions.
- Guide the participants through the exercises and monitor the progress. Check the energy level of the groups.
- Document on the action plan. Write down important findings for the report. Steer the discussions.
- Close the co-session. Make sure the summary of the co-session are well documented. Discuss with the customer the next steps and reporting of the findings.

key driver means

- Make customer part of desicion making
- Warm-up exercises
- Hands-on exercises
- Mentally and physically distance
- IGP exercises (Individual, Group and Plenum) — G, P / I, G, P / I, G / P / P / G / P / I, G / P
- Unconstrained formats
- Templates and canvases
- Inclusive voting
- Adjust group dynamics

- planned to be executed, but was rescheduled

The following key drivers, were conducted before the co-creation session: Gather relevant stakeholder input, Investigate current view of system, Involve and select participantes from Semcon, customer and external experts

Fig. 7. Journey map of case C

The graph in Fig. 6 links the tools and techniques *(means)* used in the co-creation sessions to the sub-questions (the *key drivers*) in this research. Fig. 7 visualize the journey map for case C and shows how the means impact this co-creation session. The *derived application drivers* in Fig. 6 explain how to realize the *key drivers* with the help of different means. For the sake of readability, the derived application drivers are in different colors to show the links between the key drivers, derived application drivers and the means. If we read the graph in Fig. 6 from left to right we see that *Involve and get contributions from key stakeholder* is a key driver for early validation of stakeholder needs. One of the derived application drivers is to *Involve Customer.* This is again linked to several means, as for example *Select and involve customer participant.* The graph can also be read from right to left. The means *Hands-on exercises* will contribute to the derived application driver *Involve customer, Creative environment, Arena for dialogue* and *Building the problem and solution landscape together with key stakeholders*. The means *Hands-on exercises* will contribute to realizing all three key drivers.

In Fig. 6, the means on the right-hand side represent the impact factors of validating stakeholder needs through co-creation sessions.

- *Select and involve customer participants.* In all the three cases, the participants were selected based on their experiences, profile and role in the system of interest. Semcon participants were chosen based on the group dynamics to balance the groups or to give input within a field of knowledge.
- The different techniques of using *unconstrained formats* or *templates and canvases* are used in various settings. *Unconstrained formats* e.g. gigamapping indicate to be suitable for *building the problem and solution landscape together with key stakeholders*, creating an *arena for dialogue,* greater *involvement of customer stakeholders* and to make a *creative environment.* As seen in case A, *templates and canvases,* e.g. the Business Model Canvas can be of good help to guide the participants. However, they require more time to be *prepared and structured* prior to the co-creation session.
- Planning and dividing the session into *IGP (Individual, Group and Plenum) exercises*, impact the *arena for dialogue* by letting participants communicate in different ways (individually reflections, conversations and ideation in smaller groups or plenary presentations and discussions). Using IGPs also contribute to *building the problem and solution landscape together with key stakeholders* by having the possibility to team up in a participatory fashion. It can *involve the customer* by letting the customer participate and share knowledge with *hands-on exercises*.

Discussion

Eliciting stakeholder needs. As stated in the ISO/IEC/IEEE (2015), stakeholder needs are elicited directly from stakeholders, or based on domain knowledge, context understanding or previously identified gaps. The stakeholders involved in co-creation sessions are primarily key stakeholders such as customers, users, Semcon employees and occasionally external experts. The involved stakeholders have domain knowledge or context understanding. The study indicates that eliciting stakeholder needs from operators and users are primarily collected as a part of the preparations prior to the session. If the objective is to elicit stakeholder needs, then a more traditional systems engineering approach in combination with interviews and field visits as described by Sjøkvist and Kjørstad (2019) might be more effective than a co-creation session. The indication in this research is that co-creation session aligns and anchor the matured needs with key stakeholders, as shown in the (Faisandier, 2012) model in Fig. 1.

The value of a co-creation session. We have experienced that co-creation session creates an arena to share a common ground and get all key stakeholders on the same page. Through the session, knowledge, authorship, ownership, and future visions are shared with the participants. This sharing

happens through the involvement from the participants through prepared exercises and structured ways of collaboration, using tools and techniques from the domains such as design thinking (Tschimmel, 2012) and SOD (Sevaldson, 2009). In the session, the customer becomes an active participant, building personal relations by doing inspiring warm-up exercises, solving complex problems and create innovative solutions together as a team.

As described by Lemmens et al. (2014), our study implies that co-creation sessions increase customer engagement, in comparison with traditional sales where the customer is more of a passive source of information. Building trust through the session help to make an entrance higher up in the organization, making Semcon a strategic partner. The method potentially saves costs and reduce risk in development projects, by the early validation of stakeholder needs prior to project start.

Participants. Co-creation sessions strive to create engagement for the participants, as described by Jones (2019). We have observed the importance of motivated, engaged and involved participants in getting the desired outcome. A concern is that key stakeholders are left out of the session unintentionally, and their statements or input are not replaced, which might leave essential information behind. A significant task for the facilitator is to consider the group dynamic and change if needed. We experienced that frictions between participants can destroy the creative and positive environment, making it hard for participants to share their insights. Observations indicate that group dynamics and hierarchy might influence the voting sessions. Due to this, the facilitators can make suggested changes during or after the session, if they think the group made decisions based on wrongful assumptions.

We learn from observations that using visual tools help the participants to elicit, anchor and align stakeholder needs by understanding the problem landscape and building the solution landscape. Instead of discussing and forgetting, the groups need to give consensus of written statements, making an early validation within the group. As illustrated in the key driver graph, unstructured formats open for creativity, while templates and canvases guide the participants into more concrete solutions.

The validity of the research. The low number of replies from the feedback survey and the interviews limit the validity of this research. For the internal in-depth interviews, we chose six Semcon employees with known experience with co-creation sessions and systems engineering. We consider the results from the surveys and interviews not to be quantifiable results, as the survey numbers are too low to be regarded statistically. The role of the main researcher in this paper has been participant observer as a facilitator for several of the cases. The conclusions given can hence be biased. However, the results are triangulated as Yin (2018) described with interviews, feedback surveys and the researcher's observations during the cases. Results from multiple sources are compared and analyzed to increase the confidence in the results.

Conclusion

The research question asks, "*How will co-creation sessions contribute to validate stakeholder needs during early development projects*"? with the following sub-questions:
- *How to involve and get contributions from key stakeholders?*
- *How to elicit stakeholder needs through co-creation sessions?*
- *How to anchor and align stakeholder needs during co-creation sessions?*

Our research indicates that key stakeholders such as the customer will be involved as *active participants* in co-creation sessions. Their knowledge and input will contribute through *collaborative* and *hands-on exercises*. Co-creation sessions are creative *environments* with inspiring and fun warm-up exercises, exploration of potentials and they are an *arena for dialogue* for key stakeholders. The participants get a *physical and mental distance* from everyday life and the chance to share their insight and knowledge with colleagues. External experts and Semcon participants bring *new perspectives*.

This study argues that co-creation sessions primarily do not elicit stakeholder needs. Preparation activities such as *interviews* and *field visits* elicit stakeholder needs that can be presented in the sessions to be analyzed, processed and validated. However, the feedback survey results from case C indicate an increased focus and discovery of needs from different stakeholders. In this case, the topic, preparations, and the use of journey maps contributed to *increase the focus* on different stakeholder perspectives.

Stakeholder needs indicate to be anchored and aligned during the co-creation sessions, by *individual reflections*, *group exercises* and *plenum discussions* leading to *inclusive voting*. The participants together *build a mutual understanding* of the problem and solution landscape using *unconstrained formats*, *templates, and canvases*. The study indicates that these visual processes form a consensus in the group that eventually will contribute to validating the stakeholder needs.

Our research explores how to do early validation of stakeholder needs by applying co-creation sessions in early phases of development projects. Our study implies that co-creation sessions increase customer anchoring and alignment of stakeholder needs, which may lead to potentially new development projects.

Further Research. We recommend to further investigate co-creation sessions in the field of systems engineering as a method for early validation of stakeholder needs. More research is needed to evaluate how effective it is, and to see if the method is useful in other companies or contexts. Internal co-creation sessions in a product development setting can also be of interest to investigate further if the same tools and methods can be used for other purposes in product development than validation of stakeholder needs. Some processes within the session could also be of interest for further research, for example to look deeper into the consequences of inclusive voting.

Acknowledgements

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Biography

Malin Guntveit worked as a systems engineer within early development projects at Semcon Norge AS since 2017. She is often involved in the early phases of product development projects, conducting stakeholder analysis and facilitating co-creation sessions. She graduated from the Systems Engineering Industrial Master program at the University of South-Eastern Norway in 2019. She also holds a bachelor's degree in mechanical design engineering from 2016.

Marianne Kjørstad holds a Master of Science in product design and manufacturing from the Norwegian University of Science and Technology, and a Bachelor's in mechanical engineering from the University of South-Eastern Norway. She has a broad industrial experience from working over ten years with engineering, testing, and commissioning of complex systems to the ocean space. Currently she is pursuing her PhD on early phase systems engineering and systems architecting with focus on innovation within Norwegian high-tech industry.