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Idea Development Method, Applying Systems Design Thinking in a Very Small Entity

Tommy Langen
University of South-Eastern Norway
Department of Science and Industry Systems
Tommy.Langen@usn.no

Elisabet Syverud
University of South-Eastern Norway
Department of Science and Industry Systems
Elisabet.Syverud@usn.no

Abstract. Very Small Entities (VSE) delivers a substantial percentage of the world's product and services. These agile and innovative companies approach their market in a flexible, informal, and human-centered approach. Their transformation from startup phase to an established company can be problematic. As they grow, the VSE must put more emphasis on incorporating formal organizational structure and processes to cope with the increased size and complexity. Failure in adapting often results in a negative market effect. Systems Design Thinking (SDT) is a combination of Systems Engineering, Systems Thinking, and Design Thinking. There is an increased awareness that the perspectives of SDT bring value to organizations. However, the advantage of SDT is not well understood for VSEs that are in the maturing phase. In this work, the researchers explore the value of SDT for very small enterprises transitioning from infancy to adolescence. The article presents a new method for idea development based on SDT principles and tailored to the needs of a VSE. Case-based research is applied in a small company to understand the needs and verify the desirability, feasibility, and viability of our proposed method. The results suggest that an SDT approach improves the company's ability to capture and develop ideas and can help grow the company.

Introduction

More than 98 % of enterprises in Europe can be classified as Micro (≤ 9 employees) or Small Enterprises (≤ 49 employees). These small companies contribute significantly to the world's products and services (Moll 2013). A Very Small Entity (VSE) is an "enterprise, organization, department or project having up to 25 people"(ISO/IEC 29110 2016). VSEs produce and maintain software and components for systems, either as an individual provider or as a contributor to an even larger and more complex system. Standards and systems engineering processes made primarily for large organizations and projects might be costly to incorporate and unfit for VSEs. However, it might be a necessity in today's competitive and technological environments. Research shows that VSEs finds it difficult to relate their business needs to these standards and implement them into their business practices (O'Connor 2014).

It is common for most entities to tailor their processes and tools to fit a particular stage in the life cycle. For VSEs, process tailoring is crucial, even with their challenges of scarce resources and limited infrastructure (INCOSE 2015). VSEs advantage lies in being innovative through flexibility, having a direct and active communication form with intimate relationships, and a flat structured way of working (Basri & O'Connor 2011). Problems arise when a VSE is transitioning from the startup phase (infancy) to an established company (adolescence). As they scale up, more emphasis is put into becoming a more structured organization, by introducing methodologies and processes, to cope with its larger size and complexity (Muller 2011). The formal structures that arise through scaling is a contradiction to their former cultural advantage of being small and agile.

The innovators and pioneers of the VSE will see their roles change when they transfer into middle and senior management positions as the company grows. The company must maintain control of the increased volume of various tasks, coworkers, and stakeholders. Simultaneously, designers and engineers will take over the primary role in developing new products and services. However, they might not have the same innovative mindset and drive as the original entrepreneurs.

Product Development. The early product development phase (a.k.a. fuzzy front end) includes identification of problem and opportunity, exploration and collection of information, idea generation, and concept development. The phase is iterative from prescreening of ideas until allocation of funding for development. It is in the fuzzy front end where companies save the most time with the least amount of resources. (Reid & De Brentani 2004).

Innovation. "Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace." (Baregheh, Rowley & Sambrook 2009). Successful innovation is the overlapping area of *desirability* (i.e. do the user/customer want it), *feasibility* (i.e. is it technical or organizational achievable) and *viability* (i.e. does it give a return of investment) (Brown 2008). Figure 1 illustrates the sweet spot of innovation, found in Design Thinking. The sweet spot represents the common understanding of innovation, with extra emphasis on the human-centered approach (Kelley & Kelley 2013).

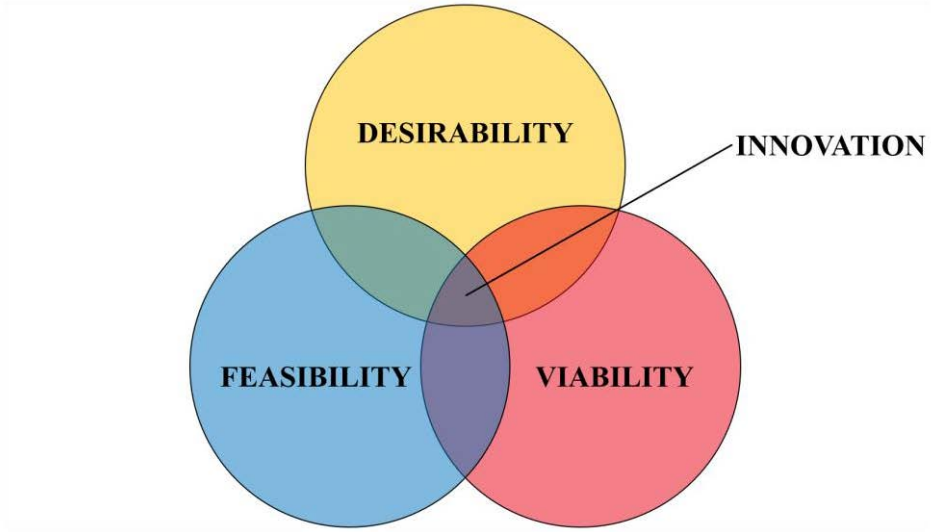

Figure 1. Sweet spot of Innovation

Systems Design Thinking. Various domains apply Systems Engineering (SE), Systems Thinking (ST) and Design Thinking (DT). SE is analytical and data-driven, ST applies a systematical and organizational approach, and DT emphasizes the creativity with a human-centered focus. There is an increased awareness among organizations that a combination of these three aspects brings value. However, the value is not well understood by the organization and the integration of methods, processes and tools is described as challenging (Greene 2019).

The SE and DT principles have some complementary and similar mindsets; thus, a combining approach can give enhanced insight into a situation. The complementary effect of SE is the use of analytical processes and the focus on component interactions. SE emphasizes on the solution by using stakeholder management, requirement engineering, cross integration, verification, and validation. The supporting effect from DT is its use of intuitive processes with emphasis on the problem domain. DT directs us towards interacting with the user, assess the usability, and suggest radical new products, services, and business models (Lewrick, Link & Leifer 2018). Research suggests that ST exist within both SE and DT. ST applies individual and holistic systems views while considering technical and

social interaction. The framework addresses complexity through flexibility and tolerance of uncertainty with integration and alignment of systems. Greene (2019) refers to the combined integration of SE, ST, and DT as Systems Design Thinking.

Problem statement. Research shows that VSE growth imposes a risk of the company becoming slow, bureaucratic, and less innovative while lacking the resources and infrastructure to adapt. Failure to make the transition from infancy to adolescence will result in a sales volume drop. A resource-scarce entity can generate high value by investing in the early phase of new product development. To be successful when developing products and services, it is essential to hit the sweet spot of innovation. However, small companies lack methods that allow them to consider both growth challenges and innovation opportunities. The concept of SDT has the characteristics of aiding VSEs in this type of situation. The use of SDT to tailor the VSE idea development processes is not understood.

Research Question. This research explores the possibility of using SDT when tailoring a process for a VSE. We want to measure the success of the method through user desirability, technical feasibility, and business viability. We ask the question; *Can a Systems Design Thinking method aid in capturing and developing new ideas in a VSE?* The research question is broken down in three sub-questions:

- How does a Systems Design Thinking method affect the ideation phase?
- Which attributes are critical for a VSE in the ideation phase?
- How is the desirability, feasibility, and viability of a Systems Design Thinking method in a VSE?

We base the research on a case study of a VSE. We developed the SDT method based on literature and the identified needs of the case company. The first author observed work process, interviewed employees, conducted workshops, and performed surveys at the company. The field work formed the basis for the method developed in this research.

Literature

Three Canvas Model. Several tools help the innovation of new product development, such as *Business Model Canvas* and *Lean Canvas*. *The Three Canvas Model* is an agile tool based on Design Thinking in an agile environment. It consists of three charts, where each format focuses on satisfying either desirability, feasibility, or viability. The tool has shown capabilities in team understanding, communication, learning, and it gives an overview of essential aspects. Constrains are the time needed to fill out the canvas's, the recommendation of having it implemented into a framework, and its lack of comprehending complex technical systems (Link & Lewrick 2014).

A3 Architectural Overviews (A3AOs). Borches (2010) designed the *A3AO* for knowledge sharing. The tool is useful for communication of architectural knowledge by giving a more in-depth insight into a system. The *A3AO* is a two-paged A3, where one side is the summary of certain system aspects, and the other visualizes the models. The layout makes it easier to understand the system and assessing the consequences compared to traditional text documents. This tool is suitable for use in new product development. However, in terms of innovation capabilities, *A3AO* lacks the overlapping combination of desirability, feasibility, and viability.

ISO/IEC 29110. VSE operates in a more informal and less documented way (O'Connor 2014) compared to larger organizations and enterprises. Therefore, the industry saw a need to develop processes aimed to increase the quality output for VSE. The creators developed the *ISO/IEC 29110* to be lightweight and easy to implement for VSEs. It incorporates product life cycle processes from systems definition to project closure. The standard ensures this by relying on systems engineering concepts, standards, and proven practices (ISO/IEC 29110 2016). Additionally, it gives guidance to lower the entry barrier. *ISO/IEC 29110* extracts systems engineering processes and principles from

ISO/IEC/IEEE 15288 and *ISO/IEC/IEEE 12207*. Although, the standard aids in life cycle stages, the valuable fuzzy front-end is lacking attention in these standards.

VSE Process Characteristics. A VSE consists of several common characteristics, needs and competencies. What differentiates VSE from its larger counterpart is being unstructured, risk-oriented, and highly impacted by negative market effects. Additionally, they have high flexibility, informal managerial processes, limited learning and knowledge absorption capacity, and focuses on human capital for competitive advantage (O'Connor 2014). Laporte and Vargas (2014) stated the following VSE process needs: They require low-cost solutions, readily usable processes supported with guides, templates and tools, standardized communication, help in growing their capabilities, ability to identify quick wins, and guidance in selection and implementation of practices.

Research Methodology

This study used industry-as-laboratory approach to identify problems and understand the soft and complex nature of human behavior. By creation and evaluation of solutions with an emphasis on the environment, rather than focusing on what could work in theory (Potts 1993). This is a suitable method in systems engineering research (Muller 2013). Through an understanding of the context of the environment, the solution can help solve real and practical problems. Observation and firsthand feedback from the company employees help the researchers in optimizing and validating the suggested solution. We applied systems modelling to help in the structuring and narrowing down of a complex problem into small, solvable modules. Our research approach used principles from Muller's *Modeling and Analysis process* (Muller 2018), Figure 2. We collected the data through qualitative methods, presented in Ritchie (2014), and quantitative methods through surveys.

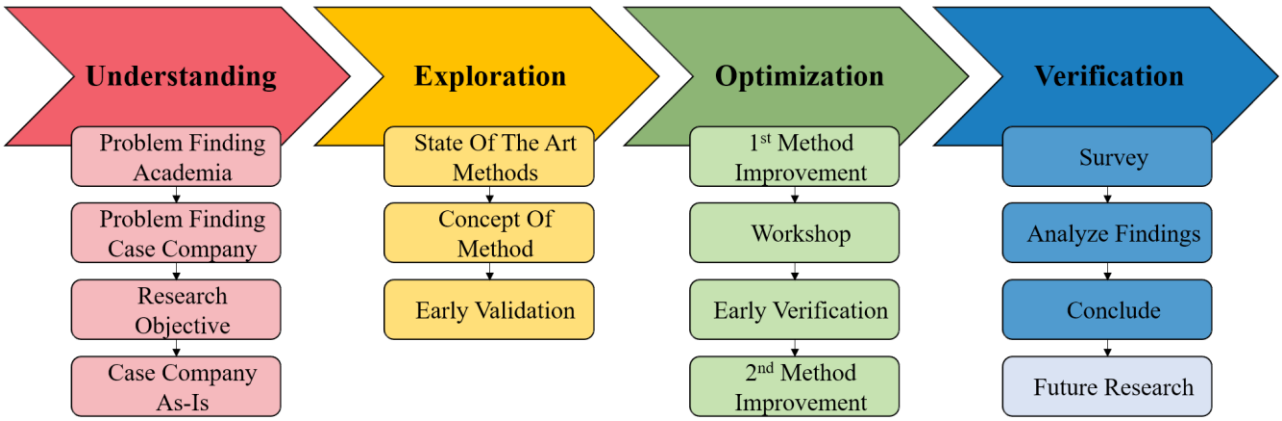

Figure 2. The Performed Research Steps

Understand. The first step in the research was to find the current knowledge gap in the literature. The researchers studied SE body of knowledge and consultations with subject matter experts. We compared the knowledge gap with problems in the industry by investigating a case company. By conducting a stakeholder analysis, we mapped the most influential employees. These employees got interviewed to get an understanding of the company's various challenges. We formed research objectives and defined research questions based on these findings.

We performed a case company analysis through formal and informal interviews of their employees, with observations of their environment. The purpose was to get an understanding of their as-is situation, culture, internal processes, and their needs. We evaluated the company's fit by comparing the findings to the problem stated in the literature. By conducting a company analysis, we found its internal and external strengths, weaknesses, opportunities, and threats. Its competitive advantage and capabilities formed the basis for later exploration and optimization of the suggested solution.

Exploration. We synthesized solutions with a foothold in SE, ST, and DT methods and the problem statement, to understand the potentials from the literature and the case company. The research achieved further exploration by literature review and discussions with experts. We compared the methods, processes, and tools, to recognize their fit for purpose, based on the earlier understanding of the needs and problems. We molded these findings into an early concept design, built on established methods in the literature and local adjustment towards the case company.

We presented and discussed the concept solutions with main stakeholders for early validation. Input from these activities formed a developed concept by obtaining fit for purpose feedback, and insight through newly discovered needs and suggestions for improvement.

Optimization. Further development, based on input from early validation, resulted in an optimization of the method. With an enhanced version, the method's tools were given to three employees for a function test, to check its desirability and viability. We performed a function test in a controlled environment through a workshop meeting. The study used real ideas in the experiment with the relevant stakeholders, followed by discussions.

After the workshop, we sent a survey to each participant for early verification. We used these for additional optimization and final adjustments of the method, the process, and its tools.

Verification. A survey was sent to the employees to verify the desirability, feasibility, and viability of the suggested method. The results were analyzed and synthesized according to the problem statement. The researchers discussed the finding's contribution to systems engineering body of knowledge. We concluded the research gap, the results, and the findings with notes of limitations of the study. We suggested future research based on knowledge gaps and opportunities.

Interview and Observation. We built much of the findings on in-depth interviews and observation in a qualitative form. The types of interviews were general and open-ended interviews, in addition to informal conversations (Turner 2010). This type of qualitative data collection was needed, as statistical procedures would not be easily converted from the soft and complex nature of human behavior and thought. The in-depth interviews combined some structure in the form of a focused topic, with some movement by asking open-ended questions on a surface level. The answers lead to new paths, and we asked further follow-up questions to get a deeper and more comprehensive understanding. The interviews and observations were conducted primarily face-to-face and later in the study through video conference.

Survey. The purpose of the surveys was to get an understanding of the suggested idea development method's communal validation and verification satisfactory and analyze the results. We sat the questions on a 5-point Likert scale (Likert 1932) with statements related to the suggested method, process, and tools. Related to the problem statement, we based the questions on desirability, feasibility, and viability. We used the Net Promoter Score (Reichheld 2003) to analyze the Likert scale results. This research states results above zero as positive. Those answering either "strongly disagree", "disagree" or "neutral" were being detractors to the statement. While those who were answering "agree" were passively satisfied and "strongly agree" promoters.

Case Study

This study performed in a real industrial situation to increase its reliability and relevance to the industry. We had to choose a VSE that was past the initial startup and in the entrance of the maturing phase (Infancy to Adolescence). The case company had to develop products and services in a technical domain from Problem/Need to End-of-life phase. Due to time and resources, the research aimed at a detailed study of one problem case, in one case company over four months.

The case study focused on implementing a method containing process and tools. Which emphasized on the ideation and conceptual phase of product development in a relevant company. We developed the method, process, and tools to fit the case company. The goal was to enhance and nurture their innovative capabilities. The research measured the desirability, feasibility, and viability of the method, process, and tools, set in their current situation.

Case Company Description

The case company, *Gapit AS*, is a Norwegian software and automation VSE established in 2016. They deliver product and service solutions for monitoring, analyzing, and visualizing big data in industrial sites. The company links the gap between various independent components and equipment through reading their data and integrates these through software and hardware. With 12 employees, they develop products based on customer needs for small and large companies in the segments of data centers, infrastructure, and medical sectors. Their developer teams consist of automation engineers, with supporting functions within sales, administration, and user experience. The developing time of their main deliverables ranges from weeks to a month. Their first years has been about learning, finding its strategic place in the market, developing products and services.

The case company's competitive edge lies in its focus on human relations and loyalty. Their position comes from tight collaboration and excellent customer relationship. With over-performing by delivering higher quality than expected on the agreed deadline, the case company has maintained its external relationships. The company has a high level of innovative capabilities and has been capitalizing on delivering novel design solutions.

The case company is classified as a VSE Entry profile within software and systems engineering, according to *ISO/IEC 29110 Generic Profile Group*. We based this classification on that *Gapit AS* has approximately three years of operations. Furthermore, most of their developments are small projects conducted by less than six people per month. As the case company is involved in multiple projects simultaneously with more than one work team, they have a resemblance to be an *Intermediate Profile* as well.

Gapit AS is experiencing exponential growth in customer and client orders. This puts tension on the current company size. This effect comes from earlier investments, which is now capitalizing all at once. Their current vision is to scale up to meet the increasing demands. As sales volume will continue to boom, it will put a strain on their current way of working. If they are unable to make a successful transition, they might see a decrease in their sale (Figure 3. Bathtub Curve)(Muller 2011). According to studies, an "observed curve" in markets shows a drop in phase transitions.

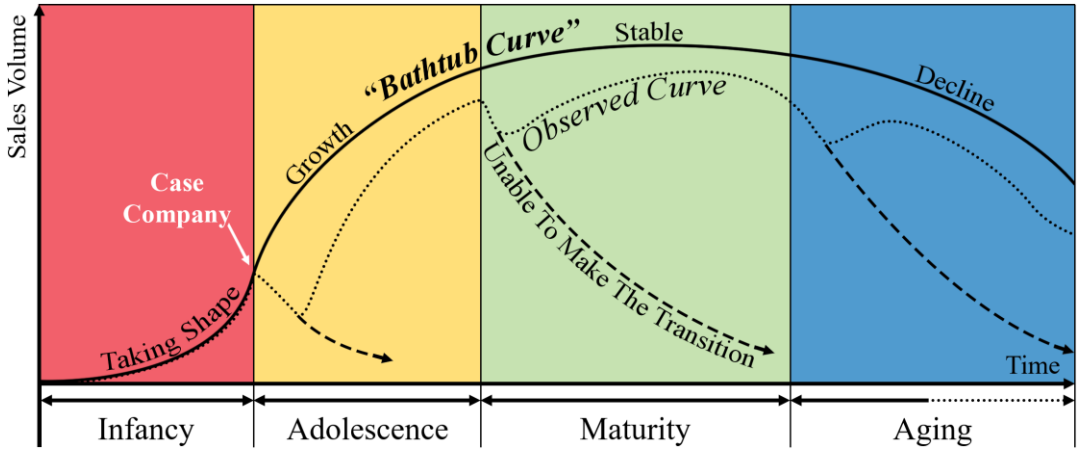

Figure 3. Bathtub Curve

Product Development Process

At *Gapit AS*, product development and project executions are dynamic. Everyone performs their tasks in a sequence they see fit. This is because they do not have a formal product life cycle process in their organization. However, the researchers observed an informal process by looking at similarities in how they conduct their projects. The company's observed product life cycle process has a strong reassembles to the agile software development method (Figure 4. Case company Product Development Process). It is common for the developers to have early customer involvement and co-creation on the concept. Small projects have one product development iteration, and larger projects have multiple. The development teams are self-organized and adaptive to change along with the project execution.

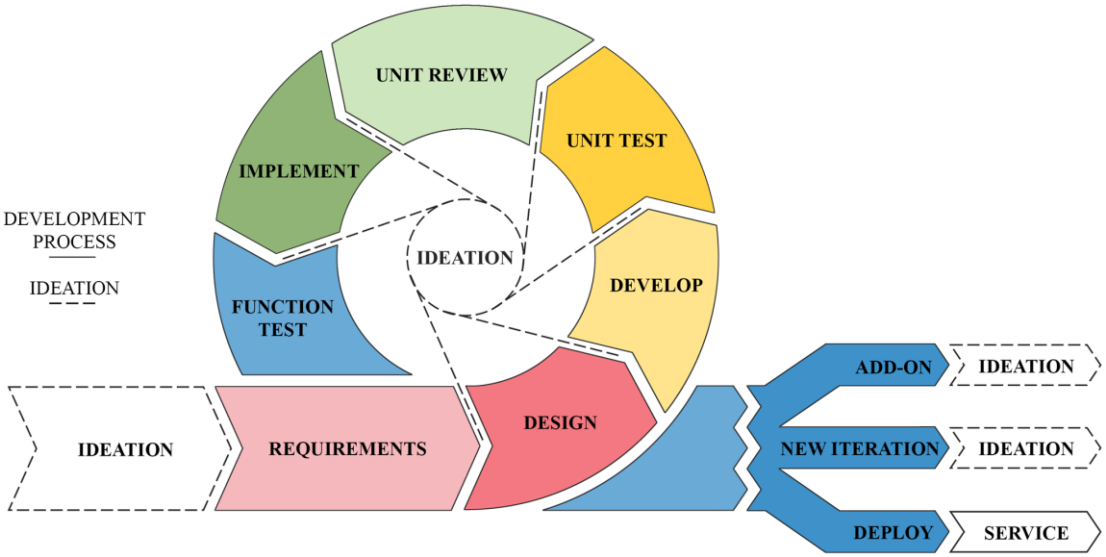

Figure 4. Case company Product Development Process

Project starts with a specific need request from a client or by a suggested solution from the company. The need is developed in the requirement-phase, to get an overview of the client problems and opportunities at the business and operator level. The findings are converted into a set of requirements, and they develop a concept design. The systems requirements and design are taken further into software and hardware development. The suggested solution is tested and reviewed internally before implementing into the real system. A functional test is conducted to verify its reliability and functionality. After an iteration, the next step is a new iteration, if additional development is needed. If the system is operating according to requirements, the system is deployed into the operational phase. *Gapit AS* provides service after the deployment. New functionalities to the system (add-ons) might be sold to the customer, which will kickstart a new development cycle.

Creating a Systems Design Thinking Method

The case company's need is to maintain its competitive advantage of being innovative. They fear that with scaling up the company, the innovator-spirit will stand for less of a percentage of the company. The most innovative people in the company will get too caught up in upper management tasks. Which means the other employees must step in to maintain the innovation culture. Their current process of capturing ideas is limited, and there is a wish it could be better. They want it to be easier to decide on which ideas to take further. As the current situation indicates a lack of structure and work method related to capturing and systematically developing ideas. Mainly in the early phase of developments, but also throughout their project development and cross-product portfolio. Figure 4 illustrates this with the "dashed" ideation before, during, and end of their life-cycle process.

When ideating on a concept, one must think of different aspects. This is difficult if the innovator lacks awareness or care for views outside his/her domain, e.g. a technical engineer disregards the market value of an idea. As more of the innovations will come from the non-pioneers, there is a need for a standardized tool that captures the ideas. Additionally, encouraging a focus on the critical factors in a valuable idea, shared in a presentable format.

The proposed solution is a SDT idea development method, with a foundation in the VSEs needs (Laporte & Vargas 2014). It incorporates theory, processes, and tools based on SE, ST, and DT principles. We introduced a solution influenced by *Three Canvas Model*, an agile DT based toolset (Link & Lewrick 2014). And the *A3AO* framework, a concept for the systems paradigm (Borches 2010). The *Three Canvas Model* lacks some focus on the technical and systems aspects, which is an essential factor for a software company operating in a complex environment. The *A3AO* is a comprehensive and time-consuming tool relatively to a VSE and lacks business and customer focus. We considered the attributes that were not included too detailed and comprehensive compared to their value. Those attributes that we included, we simplified while maintaining their purpose. The suggested method is based on research findings from interviews, observations, workshop, and survey from the case company.

The Idea Development Method

Method. The purpose is to embrace user desirability, technical feasibility, and business viability in their innovations. Meanwhile, being simple, fast, and valuable, to maximize the likelihood for a VSE to use it in its ideation phase. The method aids in communicating, documenting, and developing ideas. It gives an overview of their innovations through three tools and a process for guidance.

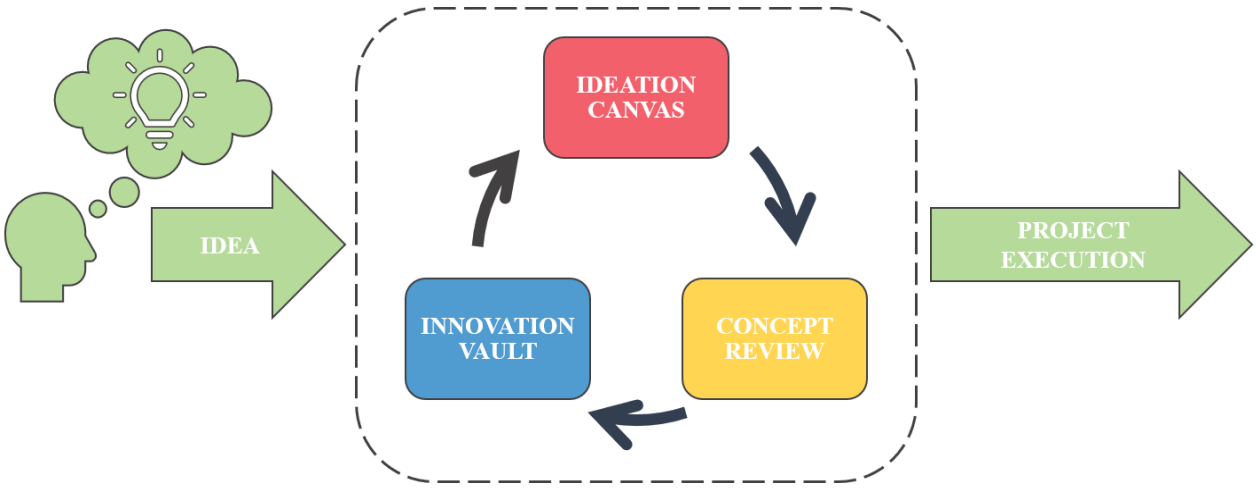

Figure 5. Idea Development Process

Process. We suggested a simplified process for formalizing the major steps (Figure 5. Idea Development Process). When having an idea, the process suggests using the toolkit in an iterative process. Followed by realizing the concept into a prototype or project execution. After each time an innovator has used a tool, it improves the idea. The new knowledge gained would further be enhanced when put into the next tool in the process. There is flexibility in choosing which tool to begin with, but usually starting with the Ideation Canvas is ideal. A sponsor would decide when to realize the idea.

Toolkit. Three tools emerged based on principles from the *Three Canvas Tool* and *A3AO*. We included and converted only the most significant factors into a new 1-A3 sized template with two supporting tools. The purpose of this simplification was to reduce the time spent on learning and utilizing the method. Figure 6 illustrates all three tools in one user-interface. The aim is to give innovators and decision-makers a standardized, understandable, and easily accessible toolkit for swiftly and reliably

taking good choices for the idea. Each tool has traceability and revision control for maintaining an architectural overview of the idea.

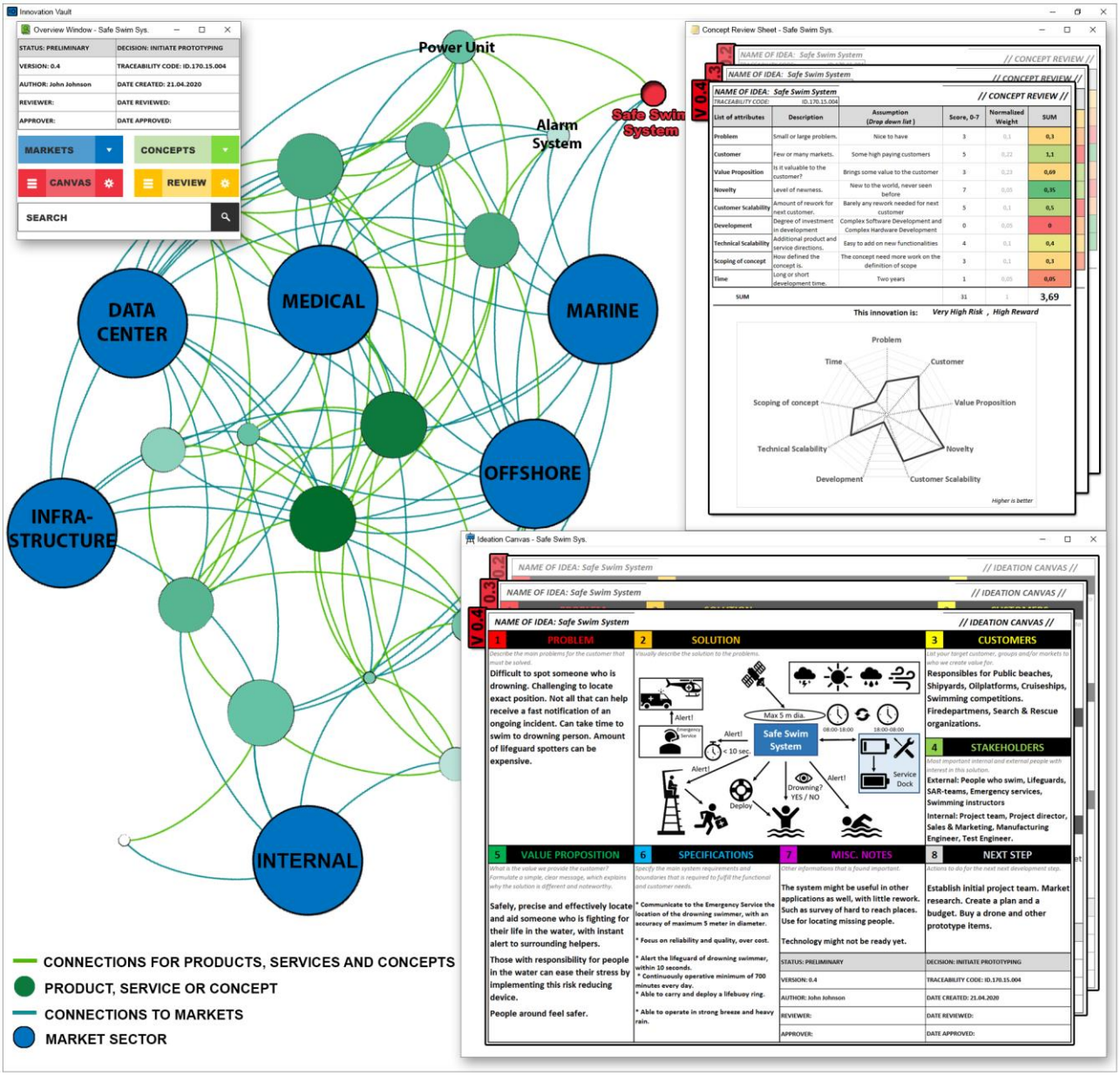

Figure 6. Toolkit

The Ideation Canvas gives the innovator the possibility to put the idea into a standardized visual tool for ideation development and communication. The Ideation Canvas consists of eight sequence-numbered boxes to be filled, emphasizing on key attributes from market to technical domain. Each box has a description of how and what to fill in. The tool can be used in Excel, or to be printed on an A3 paper with room for post-it notes. Suitable for ideation workshops.

The Concept Review sheet is a checklist tool that shows the potential of an idea in a quantitative representation. This design is to quickly gain an understanding of the strengths and opportunities of the idea. The innovator selects, from drop-down menus in Excel, assumptions on the idea related to the key attributes from the Ideation Canvas. Each of the nine assumptions is calculated, based on the weighted rating given by the company's strategy, and returns a score. The summarization of all the assumptions returns a risk vs reward statement of the idea. We included a radar-chart to give a visualized glimpse of the performance. It also highlights which attributes to develop further to improve the idea.

The Innovation Vault is a database-tool for storing products, services, and ideas in a visual representation. In this tool, it is possible to get an overview of the various systems and their connections with the company and markets. The visual database consists of circular nodes, representing a product, service, or an idea. Each node contains the Ideation Canvas and the Concept Review sheet. In addition to other necessary functions such as author, status, connections, traceability, and revision control. Each node indicates a *Market* (where the product or service can be sold to) or an *Innovation* (product, service, or idea), and the connection indicates a relationship. A high color density on an innovation node indicates many connections. An increased distance between innovation and market nodes indicates less market potential. Based on the Concept Review score, the size of the innovation node changes; thus, a big circle illustrates a considerable potential. It will also be possible to have the Innovation Vault in a listed format for more traditional navigation. We presented the tool with the software *Gephi* (Bastian, Heymann & Jacomy 2009).

Results and Analysis

Exploration

Systems Overview. We observed a growing challenge of systems overview and communication due to multiple offices, and an increase in customers and idea generation. To mitigate these challenges by increasing systems awareness, we introduced the Innovation Vault and a stakeholder map-section in the Ideation Canvas. We discovered that an original idea could spur into branches of ideas to target various markets or solutions. Therefore, we included traceability and revision control. Feedback suggested a need for digital remote access for the toolkit. This capability would be beneficial when ideas emerge during field trips to customers.

Resource- and user-friendly. Observation suggested that having a resource- and user-friendly process and tools would be useful. This focus could increase the probability of using the tool, not only before a project but also during a project if new ideas emerge. We discovered that there could be a valuable addition in using the toolkit in hindsight as a lessons learned tool. Our research suggests that a light-weight process and tools would better fit the company's agile work environment and culture.

Formalization. A need from the company was to have a formal process for their ideation tasks, as each employee perform innovation in their unique way. Their absent of a formal process resulted in not knowing how to proceed with their ideas or best go forth. It was a wish to have a common process for capturing, storing, and developing ideas. As the case company was in a growing stage, the suggested process needed to be flexible towards future scaling. When *Gapit AS* becomes bigger and more resourceful, they can add new tools to cope with their growth and need. The method must have the possibility of being implemented to the company’s current as-is situation, as well as their to-be, shall it have any value.

Communication. From interviews, we heard that the company has made wrong prioritization and ideas has disappeared. A discovered need was to have the ability to easier distinguish the best ideas among many concepts, thus easier prioritize which idea to allocate resources to first. Additionally, a wish was to check the viability of an idea, both early and later in its development, to determine if the concept shall have more resources. We saw that an important aspect was the ability to communicating the idea and its value to internal stakeholders and external customers. A wish from management was to have a visual and easy to understand communication form for quick decision-making. The research suggested that it was necessary to present ideas in a standardized way for increased familiarity. We introduced the Ideation Canvas and Concept Review sheet for this reason. Feedback suggested to add a radar-chart and a “risk vs reward”-statement to the Concept Review sheet, and a visual solutions-box in the Ideation Canvas. This glimpse would increase the perception and decision of the idea.

Optimization

The research performed an early verification to get feedback for toolkit optimization. We did a run-through of the tools with three employees. Two were highly innovative senior members and one with less experience. We did the test by making each participant fill out the Ideation Canvas and the Concept Review sheet individually with one of their own ideas. To check the intuitiveness of the tools, the participants did not get any guidance on usage. They all used 30 minutes each to complete their task. After they put their ideas into the tools, we ran a meeting to simulate a scenario of someone having an idea and want to share it with colleges for input.

We explored three different ideas in the meeting. The first presentation, discussion, and improvement to the idea took 41 minutes, performed by the lesser experienced member. The other two following ideas took 20 minutes each, and an equal amount of time on each tool. In all three sessions, valuable input and discussions came from everyone. Typical inputs were adding potential customers, asking critical questions, how to test the concept, thus improving the idea. The total time was about 1 hour per idea. However, concept complexity and user's experience with the toolkit would be a factor for the contingency of time usage.

After the meeting, the participants had the chance to give input related to optimizations of the tools. We added their input to the final concept. The participants received a survey of eight questions on a 5-point Likert scale. The questions focused on the desirability and viability of the tools. The survey results indicated that the tools needed some more development to be more user-friendly. They also noted some change in adding/removing the most suitable features for the case company. The findings further showed that the Ideation Canvas tool was the direction to go when it came to communicating ideas with others. The results also revealed that they preferred others to use these tools, for means of communicating ideas and developing them. However, they were more reluctant to use it themselves. Everyone was positive in using it next time they have an idea.

Verification

The main results presented is a 10-question survey from the case study. Those questioned were Head of Products (1), Automation Engineers (4), Head of Sales (1), and UX designer (1). The seven employees from the case company represented 60 % of their workforce. We presented the method on a poster with an explanation on how to use it, and they had access to the Ideation Canvas and Concept Review sheet. The survey focused on the desirability, feasibility, and viability of the idea development method.

Desirability. We needed to map the likelihood of employees willingly using the method by own accord. Therefore, we asked about the method's user-friendliness and how much time they felt they needed to invest in using it (Figure 7. Survey of Desirability). The answers are leaning towards a neutral majority related to the user-friendliness of the tools. The results also show a moderate feeling towards investing time in using this process. We categorized the responders as reserved in wanting to spend effort using the tools.

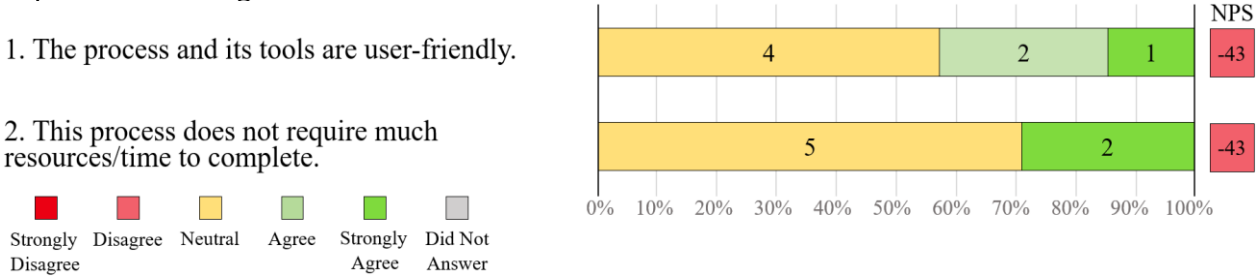

Figure 7. Survey of Desirability

Feasibility. To identify the potential the method had in implementation into the company as-is and to-be, we asked questions related to communication, implementable, and scalability. The answers show that the method gives a boost in communication (Figure 8. Survey of Feasibility). Additionally, the method fits well into their company and into any stages of their project developments. Their opinion is that there is potential to build upon the method. The results indicate that the participants encourage implementation of the method into their organization.

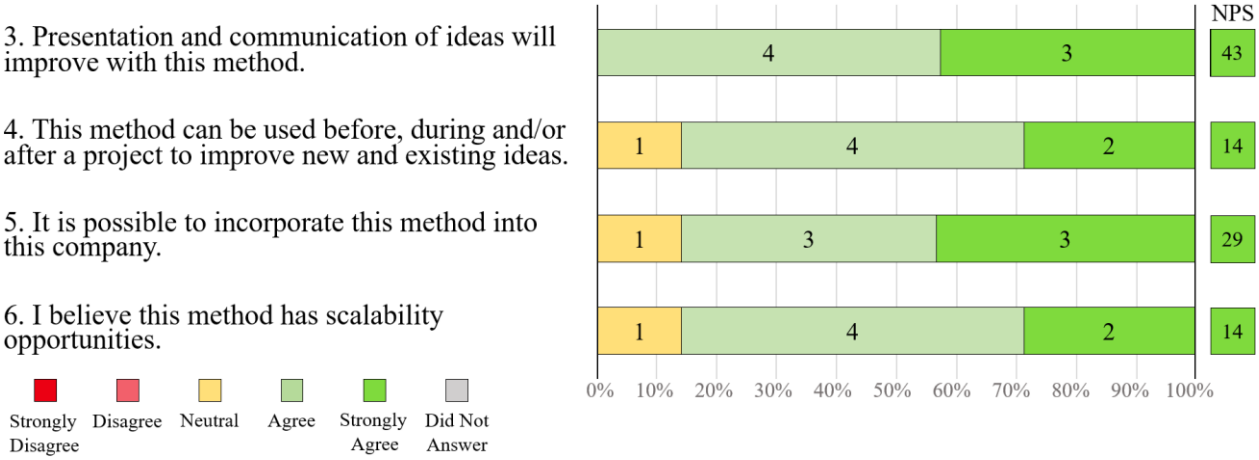

Figure 8. Survey of Feasibility

Viability. We asked four questions related to the performance of innovation and systems understanding of ideas to measure the viability of the method. The results (Figure 9. Survey of Viability) indicated that the method has a potential in increased performance of idea development. It also shows a strong probability of easing the prioritization of ideas. The method is useful in improving the understanding of how products, services, and ideas fit together. We also see that it can boost the understanding of technical and market-related factors in the ideation phase. The participants are promoters of the method's viability.

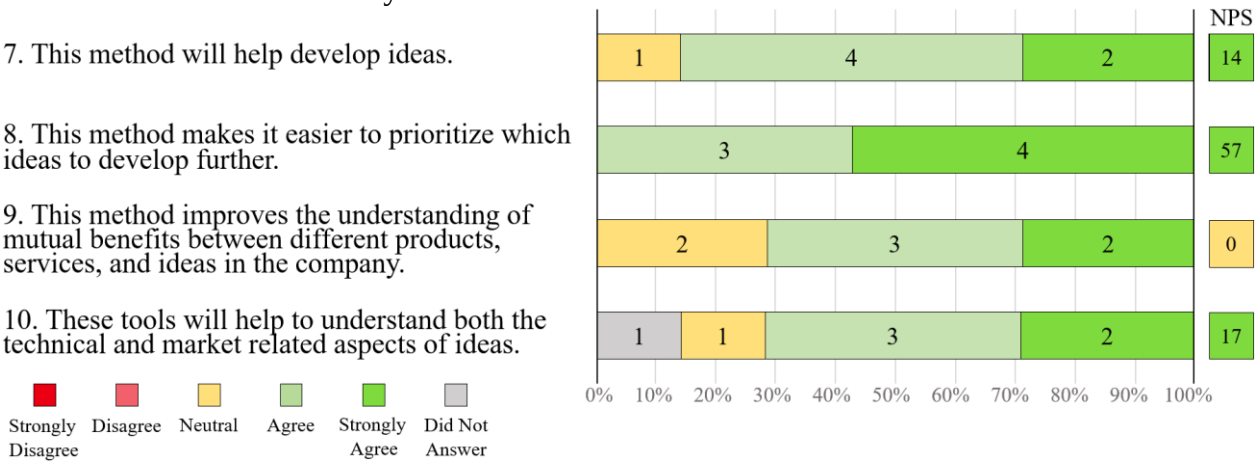

Figure 9. Survey of Viability

Discussion

The young and growing case company lacked structured processes and methods, which corresponded with their informal and direct nature of working. One of their competitive advantages was being innovative. Even though they were aware of their lack and need of an innovation process, they had not implemented one. *Gapit AS* needed a way to capture, share and communicate ideas. A suggested solution was to create a method using SDT principles.

The case company share similarities to other software and automation VSEs, and resemblance for entities transitioning from infancy to adolescence. The findings in this paper could, therefore, be applicable for other similar organizations as well.

Systems Design Thinking in the ideation phase. After the exploration and optimization of the process and its tools, we saw that an SDT method affects the ideation in several ways. The findings suggested that strengthened communication, easier prioritizing of ideas, and enhanced systems overview were the prominent factors. We observed that an SDT method improved the ideas during the ideation phase in early new product development. Also, findings suggest that implementation fits any product life cycle stage. Some indications insinuate that the method is useful as a lessons learned tool to see what did and did not work on previous ideas. In comparison to the case company as-is situation, the method improved the ideation process by formalizing it. We saw indications of the method having the foundation for further scaling of its process and tools, due to its simplicity and flexibility. This capacity could be of benefit when transitioning from adolescence to maturity. We conclude that there is a substantial benefit to applying SDT in any ideation phase in a new product development process. Combining SE, DT and ST principles functioned well for creating an interdisciplinary method due to similarities and complementary elements.

VSE critical attributes. The research found the general critical attributes for VSE processes, stated by Laporte and Vargas (2014), to be applicable in the ideation phase. The case company needed guidance in the selection and implementation of a process for capturing and sharing ideas. Their need resulted in the development of a new SDT method that could fit their as-is situation. We saw a preference towards uncomplicated and straightforward tools, using existing and familiar software such as Excel. Participants wanted a readily usable process, accompanied by guidance, sequence numbers and examples in the tools. They saw a benefit in having an easily available tool, accessible from anywhere the user might be. A wish from the decision-makers was to have a standardized communication form when sharing ideas. They also wanted to include market and technical aspects. To grow the innovators' capabilities and to direct them towards including strategically valuable elements, we found it helpful to add specific attributes with a weighting system. Based on the need for swiftly identify quick wins, we included a radar-graph and risk vs reward statement for fast decision making. Based on *Gapit AS* needs for the ideation phase, we conclude that their critical attributes are the same as the general VSE process requirements. We did not discover additional attributes for the ideation phase, beyond the general critical attributes for VSE processes.

Survey results. We ran an initial workshop and survey for early verification on the Ideation Canvas and the Concept Review sheet. The results showed a desire to have it used for developing and sharing ideas and improving the communication of ideas in the company, compared to their original method. Each participant spent below 30 minutes applying their idea into the tools, and 1 hour in total, including the ideation with colleagues. As this was their first time using the idea development method, with no guidance, we suspect their efficiency would increase next time. The practical study suggests that the tools are user-friendly and requires little resource usage.

The results from the final survey suggested that those with more experience with innovation were generally more positive to the idea development method. We understood this to mean the method spoke more directly to innovative people. However, we saw a difference between the perception of a process and the first-hand experience. Those whom we are certain of having used the tools were strong promoters. Therefore, we advise increased encouragement and learning of the method for the remaining employees for holistic organizational benefit.

Desirability. The results show that the desirability of this method lacked due to its usability and resource usage. However, none responded negatively. Some comments mentioned that all processes would take more time than their as-is, which were no process. However, they acknowledged that

investing time in the method would benefit in the long run. The findings suggest that VSEs are reluctant in using new processes. We assume if the participants had used the method in a project, the results would lean towards strong promoters, but this needs further research.

Feasibility. We assume that an SDT idea development method would fit in *Gapit AS*. The findings from the feasibility study indicated that a strong majority would promote an implementation. Comments from the employees indicated a belief that it would generate value. We can also presume that the shape of the method makes it suitable to scale with the case company future growth. We believe this indicates that other VSE could implement and benefit from an SDT idea development method.

Viability. We see that the method has viability when it comes to developing ideas. The survey results presume that the method can distinguish good and bad ideas, as well as improving and aiding in developing the idea itself. The participants expressed that the method had some usability related to the understanding of interconnecting systems.

Systems Design Thinking in VSE. We can consider an idea development method, developed on the principles of SE, ST, and DT, to be strongly feasible and viable in new product development in a VSE. When incorporating the critical attributes of the VSE, an SDT method can enhance processes. However, the desirability-results showed a need for improvement due to moderate acceptance. It is somewhat uncertain if it is the suggested method that needs improvement, or if it is the ability to convince the VSE employees. Findings suggested reluctance in incorporating an additional process due to the fear of time-consumption. Although the employees saw the value and fit of the method, a bottom-up initiative would presumable not happen. We see this as an indication that management needs to be the promoter of such implementations. To incorporate the necessary organizational structure to meet scaling challenges, a VSE needs strong leadership.

Limitations. We consider the results to be applicable for proof-of-concept, with quantitative relevance inside the case company. However, not for VSEs in general, as the numbers should be more numerous and broader. With a strong focus on qualitative research methodology, subjective interpretation is a factor to consider. The credibility of the research would greatly be improved if the method would be used over several projects in different organizations. We could have had improved the accuracy of the study by including research on management enforced implementation of the method. The research focused only on a small company and excluded other variants of VSE, like independent departments and projects.

One could argue that it does not matter how good a method is if it is not found, implemented, and used. *ISO/IEC 29110* aids VSEs in this regard. However, it is not widespread, and it lacks focus on early new product development. We could find some revealing answers by investigating deeper into how VSE can become aware of existing methods, processes, and tools.

Conclusion

In this paper, we studied how an SDT method can capture and develop new ideas in a VSE. The researchers performed a case study by tailoring process and tools for a VSE scaling from infancy to adolescence. This study presents a new method for idea development based on principles from SE, ST and DT elements, case company needs, and critical process attributes for VSEs. We measured the success criteria for the method for its desirability, feasibility, and viability.

We found that SDT gives an advantage to the ideation phase when applied to the new product development life cycle. The SDT benefits the phase by improved communication and prioritization of ideas, through systems overview and process formalization. From observations, interviews and surveys, we conclude that the idea development method, based on SDT principles, is highly feasible and viable to the case company. Our findings show that the method can be tailored to the organization and is flexible for future company growth. Additionally, it is valuable in capturing and developing

ideas. The results show that the critical attributes for VSE in the ideation phase are: Low-cost solutions, readily usable processes, standardized communication, help in capability growth, identifying quick wins, and implementation guidance.

The case company represents a typical software and automation VSE, therefore, we presume our findings are applicable for similar entities with added tailoring. The method is customizable to fit other VSE, such as adjusting for the company-specific strategy. The literature states that SDT is not yet completely understood. However, this research gives some insight into the value of using SDT in general applications and specifically towards VSEs. We found SDT to function well due to similar and complementary elements from SE, ST, and DT.

Future Research

The industry and academia would benefit further investigation of the potential within SDT in VSE environments, as our study indicates advantage and fit. We suggest implementing and researching the idea development method on various VSEs and their product developments processes over an extended period. It would be interesting to see the potential of the idea development method in other industries, as well as independent departments and projects. We recommend improving the process and its tools due to its initial novel state, especially the user desirability. Discovery suggests that the idea development method has potential as a *lessons learned* tool, which would need further exploration. We tested the method through web communication without any significant obstacles. Although, we suggest further research in exploring potential barriers during online idea development. The authors advise new research in the use of dynamic visualization in database overview, as various stakeholders saw great potential in this idea.

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Biography

Tommy Langen is employed at University of South-Eastern Norway (USN) as a Research Assistant. He holds a Master of Science in Systems Engineering with Industrial Economics and a bachelor's in mechanical engineering with Product Development from USN. He has several years' experience from the Subsea Oil & Gas industry, working from early concept to testing of complex systems. Currently he is performing research on use of data in early phase systems engineering with focus on innovation and human factors.

Elisabet Syverud received her MSc in Aerospace Engineering from the University of Kansas, US, and her Dr.Ing in Thermal Energy from the Norwegian University of Science and Technology in Trondheim, Norway. She started her industrial career in 1993, and has worked in multiple roles in the oil&gas and defense industries for almost 20 years. Since 2019, she is Associate Professor of Systems Engineering at University of South-Eastern Norway in Kongsberg, Norway.