Balancing Effectiveness and Innovativeness in an innovation process: A case study at Volvo Car Group

Master of Science Thesis
in the Quality and Operations Management Program

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CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sverige 2017
Report No. E 2017:093

MASTER'S THESIS E 2017:093

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Cover:

Developing an innovation process itself is an innovation process. The cover image illustrates the process of innovation and thoughts we have had along the way. The colorful thoughts with a fish shape imitates the design thinking process with a continuous process of co-creation with people. Inspirations then jump out like a dynamic crap fish. Our final process image (Figure 24) also has a fish shape. Special thanks to Qiaoyi Tong for the cover design.

亦可作"鱼跃龙门"之解。在此特别感谢佟巧一为本毕业设计项目设计的封面。

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Göteborg, Sweden 2017

ABSTRACT

With rapid change of trends in the highly competitive market of automotive industry, innovation is a way out. However, many challenges come along with a process of innovation. One primary challenge is to be effective while innovating, since innovativeness and effectiveness is often believed to be reversely correlated. Together with a need from industry where the research is performed at, the half-year thesis project is dedicated to fill a gap between idea generation to preparation of a product concept by an effective innovation process in Special Product & Accessories department at Volvo Car Group. Besides three classic data collection methods for qualitative research, a special but not widely used method is adopted in this thesis which is conducting a series of workshops for data collection as well as data synthesis and analysis. The high flexibility and customizability in designing the workshops brings in opportunities to study hinders and challenges in the department. Each workshop is sophisticatedly designed with distinct purposes respectively and the method of conducting workshops is reflected and discussed. A number of frameworks: Design Thinking, Agile, Stage-Gate®, as well as hybrids of them is researched and referred to during the development of the innovation process. Furthermore, the possibility to find new ways of combination is continuously on discussion. The final innovation process developed is a hybrid of these three frameworks which consists of 3 major phases, 4 gates and 13 steps. The frameworks are hybridized in a way that Design Thinking is specifically for guiding the workshops and become the structure for the final innovation process; The Agile philosophy of iteratively improving appears consistently in each phase; And the process owns a Stage-Gate® backbone.

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LIST OF ABBREVIATIONS

ACD - Advanced Concept Development

ACF - Advanced Concept Finalized

AE - Advanced Engineering

AR - Application Readiness

CR - Concept Readiness

GIG - Global Innovation Generator

GTDS - Global Technology Development System

HMW - How Might We

ICF - Incubation Concept Finalized

IKO - Incubation Kickoff

IR - Idea Review

NPD - New Product Development

POV - Point of View

R&D - Research and Development

SP&A - Special Products & Accessories

TKO - Technology Kick Off

TS - Technology Strategy

VCG - Volvo Car Group

VPDS - Volvo Product Development System

1 INTRODUCTION

This chapter gives an overview of the problem description, the purpose of the study, established research questions and brief description of the case study involved in the thesis.

1.1 Problem description

With increasing competition and rapid changing trends in automotive industry, it is no longer sufficient for companies to simply lower costs or offer quality products in order to sustain success, since the global demand of the business will embrace a plateau (Global Auto Report, 2017). However, the industry is facing pressure from growing customer expectations as well as stricter environmental and safety requirements (Ili *et al.*, 2010; Hoppe and Schmitz, 2017). For surviving and reinforcing their positions in the market, companies strive for opportunities to gain long term profits through obtaining larger market shares or entering into new market segments, due to that there is strong relation between market share and return of investment, thus profitability (Buzzell *et al.*, 1975). Certain capabilities such as growth of creative ideas, technology integration, and fast-to-market consolidate a company's profitability and bring higher chances of growth to the company. These capabilities are induced from and important in effective innovation (Clausing and Fey, 2004). Hence, innovation in business environment starting from idea generation to industrialization becomes extremely crucial. Idea generation is found to be a relatively simple part of innovation compared to refining, developing and finding support for these ideas (Bjelland and Wood, 2008). However, to develop the ideas into concepts and finally get a number of them industrialized is not an easy task and requires effective steps for success (Clausing and Fey, 2004).

A challenge for innovation in automotive industry is the tendency to sustain innovation attempts from failing in early phases, especially for larger firms (Pisano, 2015). Morris (2014) states that innovation can encounter greater resistances for large firms, since these firms have existed structures, rules and ways of working that could stifle innovation. In addition, coordination, maintaining efficiency and sustaining profitability in a large-scale organization is relatively difficult (Morris, 2014). However, organizations need to exhibit coherence and be consistent in way of working according to Hernes (2007). They adopt processes for governance of output. Large-scale organizations need a process to bring in viable inputs for product development with innovation. The process cultivates innovative ideas as seeds and making sure that a number of them would sprout and bear fruit. It contributes to sustaining the innovation environment and reducing innovation risk (Birchall and Green, 2006). Meanwhile, developing a standard process that enables creativity is possible but challenging due to the paradox between standardization and creativity, formalization and innovation (Shalley and Gilson, 2017; Benner and Tushman, 2002).

1.2 Aim

The aim of this thesis project is to develop, test and refine an innovation process for automotive industry in a way that combines effectiveness and innovativeness.

1.3 Research questions

In order to develop an innovation process, the current situation of innovation typically in the Special Products & Accessories (SP&A) department at Volvo Car Group (VCG) needs to be studied which generate the first research question:

1. *What is the current state of the innovation process at Special Products & Accessories in VCG?*

There must be reasons that innovation is worked under and lagged in the current situation. Therefore, it is necessary to understand the barriers and challenges of the innovation work in the department.

2. *What are the challenges in the innovation process at SP&A in VCG?*

Because the change which would bring by the new innovation process is massive, there is a need to ensure that the future process will be implementable. Furthermore, two key words in the topic of the thesis project is "effectiveness" and "innovativeness". The understanding of effectiveness and innovativeness will be studied and outlined in this report. Different perspectives in the case study will also be addressed in order to develop an innovation process that brings desired results to various users (of the new process) in automotive industry. Afterwards, the desired state of the innovation process should be depicted in detail. As a result, the third research question is:

3. *What does an effective and innovative innovation process look like in automotive industry?*

1.4 Delimitations

The thesis employs a single case study research design and thus it is suitable for analytical generalization. Since the case study is conducted in SP&A department at VCG to develop, test and refine an innovation process, the result will be able to be analytically generalized to automotive industry. Due to the limitations of generalization and focus on automotive industry, the research delimits from generalizing results to other industries. The process is limited with the range from idea generation to advanced concept finalized for a product.

1.5 Case description

VCG with its headquarter in Gothenburg, is a Swedish premium car manufacturer. It has a people-centered brand Volvo with long historic reputation of safety and it is owned by Zhejiang Geely Holding Group since 2010. The production of VCG started in 1927 (Volvo Car Group, 2017). In 2016, Volvo Cars sold 534,332 vehicles in more than 100 countries worldwide. Top five markets of the company were Sweden, USA, China, UK and Germany, capturing 60% of total market size.

(Volvo Car Group, 2016) VCG had approximately 30,000 employees around the world in 2016, out of whom approximately 61% were located in Sweden. (Volvo Car Group, 2017).

The study on innovation process is carried out at SP&A department in VCG, which is located at the headquarter. The department employed 158 people in February 2017 (Larson, 2017), which included product planning, research and development (R&D), manufacturing, marketing, sales, human resources, business intelligence as well as quality and operations management representatives. The products of the department are categorized in special products or accessories. Special products include police cars, Volvo Ocean Race cars, luxurious variants of existing base cars, etc. Whereas accessories include lifestyle collection of clothes, bags and other accessories for driver as well as accessories for cars such as rims, styling equipment, infotainment and connectivity products, child safety equipment, packaging equipment, etc. The department has made tremendous contribution to profit VCG over the years. And now, it is seeking for other ways of development, for instance through accelerating innovation work and keeping the momentum to innovate.

The vision of VCG – *"To be the world's most progressive and desired premium car brand"* (Volvo Car Group, 2016) – acts as a guideline for all the departments in the organization. The aim is to provide clear message to employees, business partners and customers about desired future outcome.

In 2017, VCG have stated three additional purposes – *"1) No one should be seriously injured or killed in a new Volvo by 2020; 2) Put 1 million electrified vehicles on the roads by 2025; 3) Give back approximately 1 week of quality time per year through a new Volvo car by 2025"* (Volvo Car Group, 2017) – that lead the whole organization in upcoming years. It means, that the SP&A department, as every other department in VCG, has the responsibility to comply with the vision and purposes in decision making and action taking for achieving stated purposes on time. In order to be vision and purposes oriented, the department needs to offer innovative products and solutions that fulfill and preferably exceed the needs of existed and new customers.

Main activities of the SP&A department are planning and developing special products as well as accessories, which cover the whole spectrum of product innovation from incremental to radical. The early-phase technology development process used in the department is called Advanced Engineering (AE) in Global Technology Development System (GTDS). The delivered technical solutions of AE can be transferred to Volvo Product Development System (VPDS) which is the generic new product development processes system at VCG. In another situation, AE study can be triggered to initiate during new product development process. Every base car development at Volvo employs this group-wide applied and sophisticated process of VPDS. The department structure and its loose connection to base car development gives the department a certain degree of freedom for developing novel and innovative solutions. Meanwhile, the character of independence brings challenges to the department in terms of lacking support from other units of the group. Being a supplementary to the base car development making the department passive in the development process. Because of the loose connection, it is essential to fulfill the VCG and the department management expectations to both special products as well as accessories side.

2 LITERATURE OVERVIEW

This chapter gives overview of relevant theories behind the research and later development of the innovation process.

2.1 Innovation

Innovation is claimed to be as old as human activity (Cruickshank, 2010). Though, the first definition of the term innovation was provided by Schumpeter (1934), who viewed it as new combinations of existing resources (Mowery *et al*., 2005). At that time Schumpeter provided five cases of innovation: new product introduction, novel manufacturing methods, investigation of new markets, new sources of supply, and novel ways of organizing business (Hidalgo and Albors, 2008). Throughout the years, innovation research has provided plurality of innovation definitions. For example, innovation is viewed as a problem-solving process (Dosi, 1982), a learning process (Dogson, 1991) as well as an ability to define "rules of the game", which makes it possible for the organizations to enter new markets and challenge current market leaders (Brown and Eisenhardt, 1995). More recently, innovation has been defined as *"process of turning opportunities into new ideas and of putting these into widely used practice"* (Tidd *et al*., 2005 p.66) as well as "*implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations."* (OECD and Eurostat, 2005 p.46). The latest definition from Oslo Manual (OECD and Eurostat, 2005) has created a holistic view of innovation, which requires a convergence and retainment of a set of different knowledge (Hidalgo and Albors, 2008).

In order to ease the understanding of the term innovation, a clear distinction is made between innovation and invention. According to Mowery *et al*. (2005), *"invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice"*. Furthermore, the distinction is also made between innovation and new product development (NPD). However, the terms are closely related and often interchangeably used (Elmquist, 2007). Unlike the plurality of innovation definitions, the definition of NPD is more uniform both in business and engineering aspects, where it is a complete process of turning a market opportunity into a product for sale (Krishnan and Ulrich, 2001). In addition, NPD does not necessarily yield innovation (Carlgren, 2013). All in all, this thesis focuses on innovation, which means that generation of practical implementations of inventions are of interest.

Similarly, to plurality of innovation definitions, there are various ways of categorizing innovation. For example, some have looked innovation through its type, others through impact, degree of novelty, how innovation work takes place in organizations (open/closed innovation) or some other property. Innovation categorization through types focuses on different levels and is divided into four categories: product innovation (creation of technologically new or significantly improved products), process innovation (development of new way of product creation), market innovation (implementation of new or significantly improved marketing methods and strategies) and organization innovation (implementation of new organizational method) (OECD and Eurostat, 2005). On the other hand, if categorization is made based on impact of innovation, then distinction between incremental and radical innovation[1] is done. Incremental innovation means improving already existing solutions, whereas radical innovation occurs when an organization starts doing something that it did not do before (Norman and Verganti, 2014). Furthermore, Cruickshank (2010) suggests that radical innovation is often inefficient in its initial stages and efficiency of products, services, processes, etc. is achieved by passing the process of incremental innovation. Another possibility to characterize innovation is through the degree of novelty of innovation, which differentiates if the solution is new to the firm, new to the market, new to the industry and/or new to the world (Edison *et al.*, 2013). Moreover, during the recent century, the distinction between open and closed innovation has accrued to the categorization. According to Chesbrough (2003), companies employing closed innovation model go through the whole innovation process internally, whereas using open innovation model presumes employment of both internal and external knowledge and other resources to develop and launch innovative solutions. Even though, several different ways of categorizing innovation are existing, this thesis avoids judgement of which one of these is most necessary or beneficial for an organization. In turn, the focus is on creating an innovation process that depending on the organization's needs would be able to generate innovation in different above-mentioned categories.

2.1.1 Innovation management

Innovation is a part of core renewal process of every company, though it is not something that comes automatically to organizations. On the contrary, it requires sophisticated and active management (Bessant *et al.*, 2005). Furthermore, Oke (2007) defines innovation management practices as habitual practices of organizations to manage an innovation process. The author adds that an organization needs to employ effective practices to deliver innovation. Such activities range from planning and employment of idea generation tools and R&D processes to project and knowledge management as well as other business processes (Hidalgo and Albors, 2008). In addition, Bessant *et al*. (2005) emphasizes that the core of effective innovation management is in holistic management of whole internal innovation process. It means that being particularly good only in one part of the internal innovation process, for example ideation or risk management, is not enough.

Innovation management is necessary due to complexity and uncertainty of novel situations **(**Tidd, 2001). Though, innovation management is not always simple and problem free. For example, Cormican and O'Sullivan (2004) bring up four key reasons for problems in product innovation management: lack of customer focus, lack of shared understanding, poor portfolio management as well as poor communication and knowledge transfer. Based on extensive literature study about radical innovation in large European and US companies, Assink (2006) presents five barriers of radical innovation: adoption, mindset, risk, nascent and infrastructural barriers (see Figure 1).

[1] The term radical innovation is sometimes interchangeably used with the term disruptive innovation. In this thesis, the two terms are considered as synonyms and to avoid confusion only the term radical innovation is used.

- The adoption barrier includes problems that occur when companies focus on improving existing successful solutions rather than creating radical innovations in a long term. Furthermore, companies are struggling with organizational dualism, where stable and successful business models with fine-tuned effective processes are the unsuitable ground for radical innovation. Large organizations are also perplexed with excessive bureaucracy, meaning that flexibility and creativity is hindered by overabundance of rules and procedures. Which leads to suffocation of new initiatives and deviations from standards, because variety is seen to undermine the status quo. (Assink, 2006)
- The mindset barrier, deals with inability to unlearn, which hinders radical innovation by inhibiting overcoming pre-judgements and obsolete mental models on individual as well as organizational level. Another problem is lack of distinctive competencies, which means that current core competences hinder acquisition of novel ones, resulting in situation, where these core competences turn into core rigidities. Moreover, concerns over obsolete mental models and theory-in-use arise, because creation of radical innovations is inhibited when tacit knowledge in organization is developed based on outdated interpretation of the world. (Assink, 2006)
- The risk barrier occurs, when organization steps into learning traps, by acquiring inward focus that strengthens “not invented here” syndrome. The threat to fall into traps is great for the organizations which attempt to hold on to demeanors of stable environment in the time of changes. In addition, lack of realistic revenue and ROI expectations hinder innovation by pressuring management to deliver monetary return on investments, which in turn complicates targeting emerging markets. It is necessary to comprehend that radical innovation is always accompanied by high uncertainty, because it is impossible to predict the knowledge needed for work in novel areas. Moreover, successful development of radical ideas requires favorable risk prone environment. Though, risk averse climate is often created by top management’s lack of courage and control prone climate (Stringer, 2000). Another major problem under this category is avoiding investments into radical innovation due to the fear of cannibalization of successful projects. (Assink, 2006)
- The nascent barrier concerns about sub-optimal management of innovation process. According to Stringer (2000), mismanaging innovation process is the main reason hindering growth in large organizations. Oke (2004) points out that another reason is no effective innovation processes available. Moreover, another part of the nascent barrier is lack of creativity, which comes from the view that adopting historically proved solutions is less risky than untested novel one. Another issue is the shortage of market sensing and foresight. Traditional market research can have negative impact to radical ideas, because it is not capable to analyze non-existing markets. Similarly, devastating to radical innovation comes from a history of years of senior management turnover, which results in change of focus and commitment continuity. (Assink, 2006)
- The infrastructure barrier is characterized by lack of mandatory infrastructure and adequate follow-through, which prohibits easy integration of radical innovations. Problems under this

category are created due to upstream, downstream and midstream components of infrastructure (Assink, 2006). The upstream deals with technical novelty of radical innovation, whereas downstream handles the market side (Walsh and Linton, 2000). In addition, midstream component refers to the step from radical innovation to sustainable growth (Brown and Duguid, 2002).

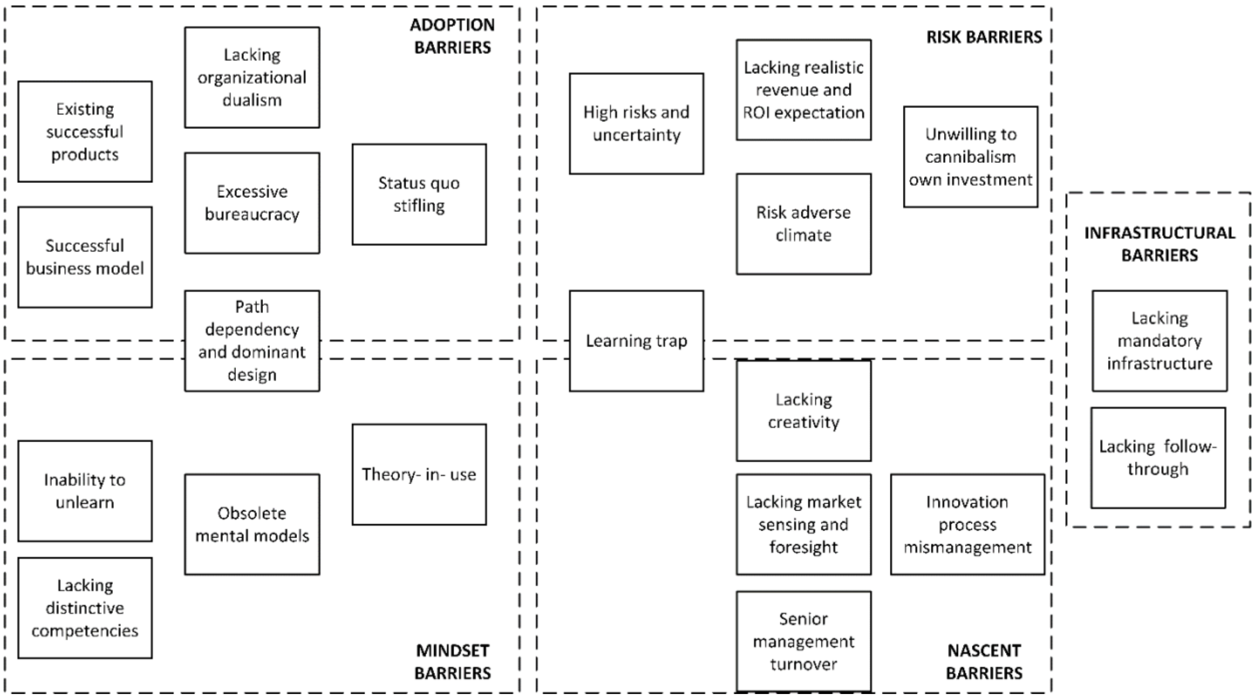

Figure 1. Radical innovation barriers and their causing factors (Adapted from Assink, 2006)

In addition, Braganza *et al*. (2009) point out seven innovation inhibitors to sustainable innovation, which to great extent overlap with Assink's (2006) five barriers. First inhibitor *pursuit of stability* is created by striving to have more effective processes, leading to a steady-state equilibrium which is incapable to cope with dynamic marketplace. Second inhibitor *risk avoidance* arises because organizations attempt to avoid risks that accompany radical innovations. Incremental innovation is preferred over radical innovation even when circumstances require radical innovation. Third inhibitor *constrained by experience* appears when companies hang on to current core competencies and strategies that are inappropriate for changed situation. Fourth inhibitor *lack of options* happens when companies get locked to resources they currently possess. *Legacy systems*, the fifth inhibitor occurs when information systems are developed and improved as an extension of past instead of designing them to support innovation. Sixth inhibitor *complex power structures* appear, because radical innovation changes power structure, which in turn is often resisted by people currently holding high power. *Myopic managers,* which is the last inhibitor, deals with the problem of managers having internal focus instead of external one. (Braganza *et al*., 2009) Furthermore, occurrence of one out these problems can have major negative impact on organization's innovativeness. Such problems are especially difficult to handle under unstable conditions such as economic crisis. Tidd *et al*. (2005) suggests that innovation management approaches that worked under stable conditions require re-thinking and continuous evolution, so that an organization can stay competitive also under unstable condition. Thus, it is important to understand the conditions the organization are acting in and evaluate the potential of the ongoing and upcoming innovation projects.

A part of innovation management is to overcome innovation barriers, which requires reinforced innovation capabilities. Lawson and Samson (2001 p. 384) define innovation capability as *"the ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the firm and its stakeholders."* Based on literature research, O'Connor (2008) proposes seven element management system to nurture radical innovation. First element *an identifiable organization structure* suggests that existence of dedicated teams or departments (with clear set of roles and responsibilities) in the organization help to boost radical innovation. *Internal and external interface mechanisms* as the second element advocates the importance of dedicated infrastructure between the teams and the organization. Third element called *exploratory processes* is needed to ensure quick learning and re-direction of old knowledge in high-uncertainty environments. Fourth element *requisite skills* suggest that creation of radical innovation needs a set of skills and talent management activities that support change and entrepreneurship inside the organization. Fifth element *appropriate governance and decision-making mechanisms* is needed to pursue double-loop learning that enables to question the objectives of current system. Sixth element *appropriate metrics* help to support radical innovation by ensuring high quality performance and activity based metrics for conscious decision making. Seventh and last element *an appropriate culture and leadership context* advocates the need of healthy and supportive environment that sees radical innovation as core of the organization. (O'Connor, 2008) Another literature research, conducted by Lawson and Samson (2001), also resulted in seven aspects of innovation capability. First aspect *vision and strategy* emphasizes the role of clearly communicating strategic direction and vision in effective innovation management. Second aspect *harnessing the competence base* requires organizations to effectively and efficiently allocate resources to critical innovation activities. The aspect suggests thinking through resource management, availability of funding sources, existence of innovation champions and their competences as well as e-business opportunities for the organization. Third aspect *organizational intelligence* has great impact to uncertainty reduction if the organizations utilizes internal knowledge and ideas in effective way to maximize the output of latest information of researched environment. In detail, it requires data collection and thorough analysis of customers and competitors. Fourth aspect *creativity and idea management* suggests that creativity is enabler for innovation and thus continuous presence of creative ideas must be ensured. Fifth aspect *structures and systems* draws attention to the importance of the necessity of optimal holistic business structure and innovation process. The attention should be drawn to the design of organizational structure, reward systems and slightly unreachable goals to enhance motivation. Sixth aspect *culture and climate* advocates the need of suitable organizational culture and climate to second innovation. The aspect presumes discussions around how to tolerate ambiguity and not take unnecessary risks, empower employees, enable creative time to employees and ensure effective communication inside the organization. Seventh and last aspect *management of technology* is crucial in nowadays fast changing environment to maximize the utilization of fast developing technology. (Lawson and Samson, 2001) Furthermore, the cure to innovation barriers can also be searched in open innovation. It means opening firm's boundaries to outside innovation to enable radical innovation. It is done, because innovation is likely to happen at interdisciplinary areas, which is enabled by acquiring a board ranges of external input. (Gasssmann *et al.*, 2006) In addition, Loewe and Dominiquini (2006) point out the necessity of diverse cross-functional teams, knowledge management, open and fear free environment to discuss ideas regardless of organizational level, availability of seed funds and mistake accepting mindset to effectively manage innovation. The view is shared by Collins (2012), who point out the importance of co-operation friendly organizational structure, which needs to be able to encourage people to share and create ideas and hence innovate.

As discussed above, there are multiple factors that inhibit innovation. Both Assink (2006) and Braganza *et al*. (2009) draw attention to harmful effects of fine-tuned effective processes, risk avoidance, absence of innovation process, top management with internal focus, weak leadership, not understanding the needs of changing situations, inability to unlearn and hang on core competences as well as focusing on current success story and believing that the way of working will enable innovation in the future. Possible countermeasures for eliminating individual or combined innovation inhibitors can be found in reinforcements to innovation capabilities. For example, O'Connor (2008) suggests having exploratory processes to have quick learning and acquirement of new knowledge in highly uncertain situations, which in turn is a remedy to Assink's (2006) mindset barrier, where the problem is in inability to unlearn and overcome outdated mental models. Similarly, nascent barrier (Assink, 2006) can be counteracted by Lawson and Samson's (2001) suggestion to have better vision and strategy to communicate strategic connection in the frame of effective innovation management. The same author points out the importance of ensuring creativity and idea management, having optimal holistic business structure and innovation process as well as thorough market and competitor analysis, which helps to put into focus the changing situations and necessary structures as well as resources to be innovative in uncertain and quickly changing situations.

2.1.2 Effectiveness vs Innovativeness

As previously stated, innovation is a problem-solving and learning process which turns opportunities into ideas and ultimately into implementation of a product, process, or method (Dosi, 1982; Dogson, 1991; Tidd *et al*., 2005; OECD and Eurostat, 2005). According to Oxford and Longman business dictionary (Anon, 2017), the transformed adjective form "innovative" describes the advance and originality of a product, process, methods, etc., while "effective" describes something succeeded in producing a desired result. As a result, a process that is both effective and innovative needs to be able to deliver new, original and desired results.

The paradox is often argued between standardization and creativity, formalization and innovation (Shalley and Gilson, 2017; Benner and Tushman, 2002). Creativity, originality, and innovation are synonyms and are often used interchangeably especially when referring to the capability of coming up with something new (Shalley and Gilson, 2017). To enable innovation, fuzzy front end allows divergence (Loewe and Dominiquini, 2006). Along the way to innovation, standardization restricts creativity with clear boarders. Hence, the process to innovate needs to be inclusive, adaptable and flexible. Since the success rate for carrying a raw idea all the way to make a real product is low, attempt to innovate does not always end up with desired results (Wheelwright and Clark, 1992). Whereas, installing a standardized process is an effective way to formalize a specific operation or a practice, (Shalley and Gilson, 2017). The results are more predictable due to the low noise factor using the standardized process and certain inputs. The success rate, as a result, is higher, just like outcomes are predictable when using one equation to process all data. Therefore, the two terms: innovativeness and effectiveness has contradictions while referring to a process. Effectiveness can be a trade-off for innovativeness and vice versa.

2.2 Innovation frameworks

Three frameworks were specifically researched for this thesis. Design thinking is to obtain innovative results in an effective way (Brown, 2008; Hassi and Laakso, 2011, Carlgren, 2013; Stanford d.school, 2016), Agile is to make the process effective but open to changes or iteration (Abbas *et al.*, 2008; Hunt, 2006; Beck *et al.*, 2001), and Stage-Gate® is to efficiently and effectively yield outputs stepwise with a roadmap (Cooper, 1990; Cooper, 2006; Cooper, 2016).

2.2.1 Design Thinking

The concept of design thinking originated in investigating the way designers think and was first specifically discussed by Simon (1969) in the book "The Sciences of the Artificial". The concept has evolved into a comprehensive way for creatively solving problems (Brown, 2008; Hassi and Laakso, 2011, Carlgren, 2013; Stanford d.school, 2016). According to Hassi and Laakso (2011), design thinking started to have practical discourses other than theoretical discourses from 2000s, where design thinking as a management concept is applied and investigated. Brown (2008) addresses the aim of design thinking as matching people's needs through transforming feasible technology and business into customer value and market opportunity. It indicates the user-centered characteristic of design thinking.

The guiding principles of design thinking were discussed in the article "Framing Design Thinking: The Concept in Idea and Enactment. Creativity and Innovation Management" by Carlgren, *et al*. (2016), adapted from Stanford d.school. Design thinking can frame problems with identified user group, needs and insights, besides the principle of user-centered. As a result, problems will be resolved in a structured way. Design thinking also requires diversities in a team that works with the process and the progress relies on taking actions, making prototypes and carrying out tests (Carlgren, *et al*., 2016).

The definition of design thinking varies between an approach, a discipline, a method, or a process, due to different perceptions to represent design thinking (Brown, 2008; Hassi and Laakso, 2011; Stanford d.school, 2016; Jahnke, 2013). There is not a common way to define and represent design thinking. One representation considers design thinking as a tangible process for implement in an organization (Carlgren, 2013; Brown, 2008; Stanford d.school, 2016). The design thinking process includes the application of sets of design practices to an innovation challenge (Carlgren, 2013).

In this thesis, the design thinking process is specifically in focus due to that the aim of the study is to develop, test and refine a process. There are many ways to classify the process into different phases, such as the 7-phase process by Simon (1969), 6-phase process by D.School Potsdam in Germany, the 3-phase circular process by Brown (2008). A typical design thinking process proposed by Stanford d.school consists of 5 phases: Empathize, Define, Ideate, Prototype, and Test. The purpose for the first phase Empathize is to reach a mutual understanding of user needs in order to explore the problem. With a better understanding, the problem needs to be redefined with a clear objective which happens in Define phase. Afterwards, many solutions are generated with ideation. To develop further, Prototype phase provides the opportunity to visualize several solutions. Test is to validate one or two solutions. This phase is dedicated for learning from the test results and iterate the last two phases. Therefore, design thinking process is not linear but with many circulations. In the occasion to address the iterative nature of the process, iterate is separated from test as an individual phase and demonstrated in the end (Kliever, 2015). The entire design thinking process consists of two diverging and converging stages. Empathize represents the first phase for diverging thinking, to enable an exploration front end (Loewe and Dominiquini, 2006), following with converging thinking throughout the define phase to reach a contraction. The latter phases bring in another round of divergence and convergence. Ideate diverges the problem into solutions. Divergence halts in prototype phase and the process turns to converging solutions till the end of test phase. Brown and Kätz (2009) illustrate the process as a double-diamond model (Figure 2) which visualizes the converging and diverging thinking of the process.

Design thinking facilitates the generation of creative solutions as a process, due to that it is immersive, integrative, and user focused (Pyla Pardha and Hartson, 2012). Starting from bulk and undefined problem, the front end is opened up for absorbing inputs through qualitative data collection from many groups including extreme users. The inputs, as in result, bring in diversified insights for shaping problem to a much clearer objective. Again, the defined problem together with ideation allows divergent thinking for generating solutions with different angles. The illustration of diamonds also represents the amount of ideas involved throughout the process. The amount of ideas reaches to a peak between empathize and define in the first diamond. Prototype is the phase when largest number of ideas are generated in the second diamond. Since the primary purpose for diverging phases is to avoid setting preliminaries to the scope of the problem, the process is open ended and not definite solution oriented. The opened up front end, two rounds of divergent and convergent thinking, as well as iterations involved make design thinking a process for coming up with creative solutions (Brown, 2008; Reid and De Brentani, 2004). In addition, design thinking is often referred as an innovation process (Jahnke, 2013).

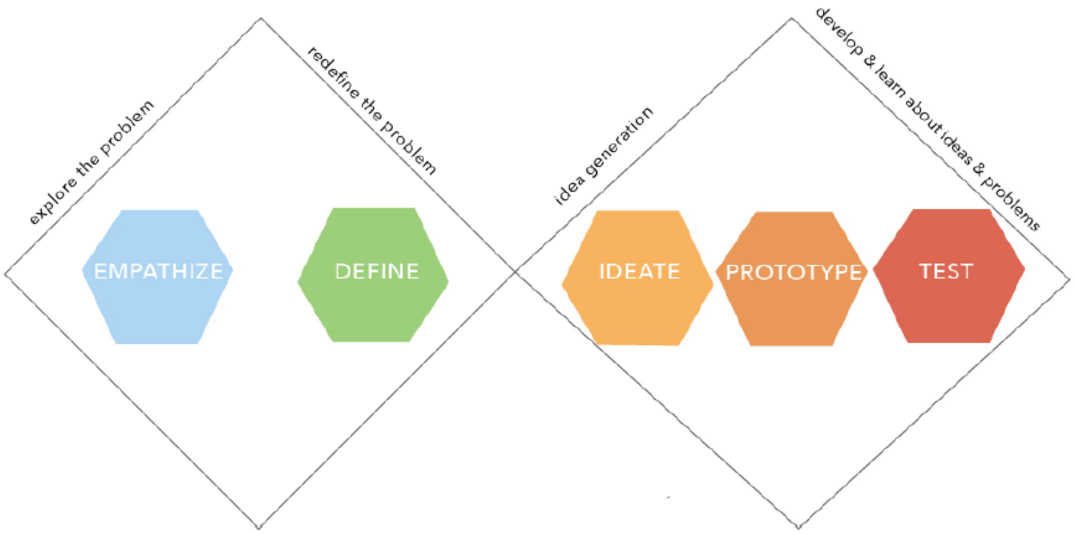

Figure 2. The Double-diamond Model of Design Thinking (adapted from Brown and Kätz, 2009)

As a process, design thinking does not only generate creative solutions, but also provide continuous learning opportunities. Demonstrated in a two-dimensional coordinate (see Figure 3), an innovation process model which includes observations, frameworks, imperatives, and solutions is evolved from Kolb's learning styles and Owen's theory of design (Kolb, 1984; Owen, 1997). The four stages move between abstract and concrete, analysis and synthesis (Beckman and Berry, 2007). Beckman and Berry (2007) emphasized the learning purpose of this innovation process model.

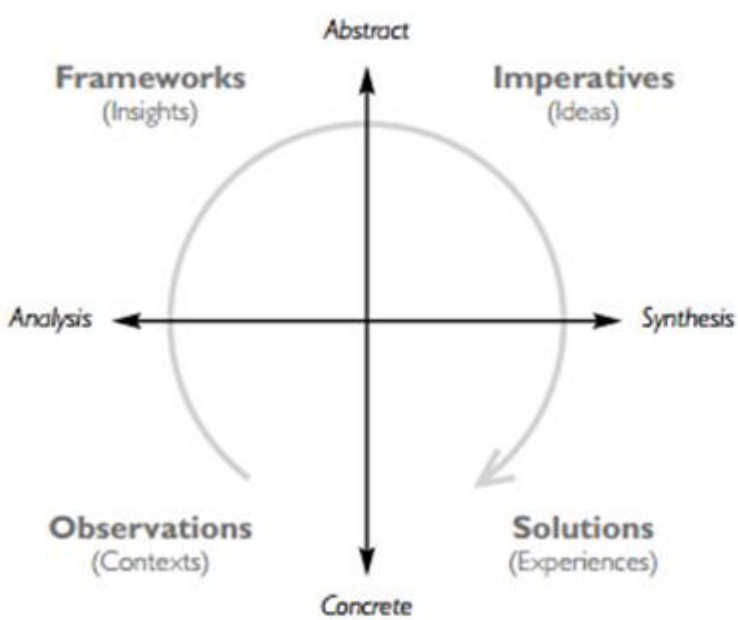

Figure 3. Innovation Process Model Inspired by the Learning Styles (Beckman and Berry, 2007)

Each design thinking phases fits in the coordinate from the third quadrate with empathize and continues clockwise. Empathize locates in the third quadrate, define in the second quadrate, ideate in the first quadrate, and prototype in the fourth quadrate, while test is on the concrete end of the vertical axis. People who uses design thinking as a process would experience continuous learning from problem defined, data collected, insights gathered as well as when moving between phases.

As mentioned in introduction, to sustain innovation is difficult for large firms, whereas adopting innovation process helps making changes or critical organizational transitions (Collins, 2012). According to Carlgren (2013), large firms in many industries have started to use design thinking through integration with their operations in various ways from the early 2000s. The industries covered are diverse, such as automotive, consumer goods, healthcare, electrics, telecom, and e-commerce, etc. As stated in previous paragraphs, design thinking is both an innovation process and a learning process. Firms adopt design thinking as an innovation and learning process for operations. Comparing to new product development process which involves all the way from idea generation to the first mass production, design thinking is often used for the front end of innovation (Martin, 2009; Lockwood, 2009; Carlgren, 2013; Stanford d.school 2016). In conclusion, design thinking not only brings effectiveness for problem solving with a 5-phase process but also induces solutions which inherit the innovativeness from the two rounds of divergent thinking.

The research process, which will be introduced in Section 3.2, includes dealing with creative ideas, products, concepts, operational processes and the final output is an innovation process for early phase of the product development in automotive industry. The challenge for the study is to involve people with distinct background, for example, product planners, engineers, business analysts, and commercial leaders. Nevertheless, to use a design thinking approach requires radical collaboration across disciplines turning the challenge mentioned above into an advantage and a cultivating ground for applying design thinking method. Besides the 5-phase guideline for design thinking, a couple procedures of synthesis and analysis are frequently and iteratively used between these stages. Tools such as Point of View (POV) and How Might We (HMW) questions will be further introduced in Section 3.4.3. Four principles are essential for implementation of design thinking, they are the human rule, the ambiguity rule, the re-design rule, and the tangibility rule (Meinel *et al.*, 2011). They respectively indicate that the activities in implementation should be human-centered, the people should be tolerant to ambiguity, the actions should be iteration friendly, and the concept should be tangible to communicate (Meinel *et al.*, 2011).

2.2.2 Agile

Some authors see agile as a philosophy (Boehm and Turner, 2003), others describe it as a set of methods (Larman, 2004; Hunt, 2006). Agile method is an umbrella term of a set of well-defined methods of iterative and incremental development that vary in practice (Abbas *et al.*, 2008). Agile methods are commonly used in software development, whereas application possibilities to hardware development are under research (Cooper and Sommer, 2016). It is said that agile ideas have been around since 1970s (Abbas *et al.*, 2008), though iterative and incremental development itself origins from Walter Shewart's "plan-do-study-act" iterative learning cycle developed in

1930s (Larman and Basili, 2003). In 2001, a group of experienced software development practitioners wrote “Agile Manifesto”, which stated core values and principles that are followed today (Dybå and Dingsøyr, 2008).

In “Agile Manifesto” Beck *et al.* (2001) state four core values of agile:

1. *Individuals and interactions over processes and tools*- People are the ones who develop software, not processes. Therefore, the focus should be on skills of individuals and interpersonal communication. (Blomkvist, 2005)

2. *Working software over comprehensive documentation*- Customers use working software not documentation and thus all kinds of documents should have supporting role. (Hunt, 2006)

3. *Customer collaboration over contract negotiation*- Systematic and frequent customer feedback is the key of a successful project, relying merely on specifications negotiated in contracts is not enough. (Blomkvist, 2005)

4. *Responding to change over following a plan*- Planning is crucial in agile, but instead of developing rigid and fixed plans for every possible situation, a plan should be adaptable to embrace changes. (Hunt, 2006)

To better follow and fulfil the core values, Beck *et al.* (2001) stated 12 principles of agile (see Figure 4).

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Business people and developers must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity--the art of maximizing the amount of work not done--is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Figure 4. Twelve principles of agile (Beck *et al.*, 2001)

The principles also function as a checklist for practitioners to evaluate the extent of following agile philosophy.

A development method is agile, if it is adaptive, iterative and incremental, people orientated (Abbas *et al.,* 2008), cooperative, straightforward (Hannola *et al*., 2013), self-organizing and emergent (Lindvall *et al.*, 2002). The commonality of all agile methods is that they focus on producing a working solution, while responding to changes in customer requirements (Hunt, 2006). Responsiveness to changes also include being open to feedback about used agile methods and being ready to change them according to the needs of the team and situation (Williams and Cockburn, 2003). Some examples of such methods include: Scrum, extreme programming, agile modelling, feature-driven development, dynamic systematic development method, crystal methodologies, lean software development, etc. (Dybå and Dingsøyr, 2008). The work is carried out in small co-located teams, which often means that the team sits in the customer's office and develops solution by carrying out short and frequent development iterations (Kettunen, 2009). Every iteration improves functionality of the product based on customer feedback, which also helps to keep the focus on fulfilling customer needs and expectations. Such way of working does not intend to eliminate rework, but to reduce the cost of making changes and assure the quality throughout the whole development process from planning to customer delivery (Highsmith and Cockburn, 2001). In addition, agile methods do not focus on formal communication and extensive documentation, instead it is concentrated on close face-to-face communication to enable fast exchange of information (Hannola *et al*., 2013). In all that, the agile methods have a purpose of providing general rules, which makes the solution of the problem dependent from the creativity of team members (Highsmith and Cockburn, 2001).

As every philosophy and method, agile also has its benefits and drawbacks. Agile have been given credit due to positive effect to project efficiency, improved delivery times, stakeholder satisfaction and perception of overall performance of the project (Serrador and Pinto, 2015). Furthermore, quick response to change (Boehm, 2002), short development cycles, people focus, improved creativity, employee satisfaction and communication between team members are also stated as strengths of agile philosophy (Mohhamad *et al*., 2013). Among other benefits, agile methods are found to be improving customer collaboration, defect handling in work processes, balancing high level of individual autonomy with high level of team autonomy as well as to be adoptable for use in various organizational settings (Dybå and Dingsøyr, 2008). On the other hand, criticism of agile include accusation that the method is nothing new and it merely collects many well-established practices (Hilkka *et al*., 2005). There is also a worry that employing agile methods may affect power structure in the organization due to decentralized decision making (Williams and Cockburn, 2003). Furthermore, it can be problematic to co-locate the development team and the customer due to global nature of nowadays business or to ensure that the customer has enough time to give feedback to the work (Mohhamad *et al*., 2013). In addition, it has been questioned if agile methods are able to provide improved product quality (Williams and Cockburn, 2003), coordinate between teams in large projects, ensues knowledge management due to weak documentation (Mohhamad *et al*., 2013), provide sufficient attention to product design and architecture (Dybå and Dingsøyr, 2008). Criticism of agile does not end here, it also includes expostulations about overresponding to change (Boehm, 2002), creating stress to customers, being a basis for ineffective decisions and creating an environment, where team members are not always interchangeable architecture (Dybå and Dingsøyr, 2008).

Agile focuses both on effectiveness and innovativeness. Effectiveness is ensured by focusing on producing working software that meets customers' requirements (Hunt, 2006). It is supported by direct face-to-face communication (Beck *et al.*, 2001), rapid adaption to change (Karlström and Runeson, 2006), early customer involvement as well as iterative prototype releases and feedback loops, which enable an organization to derive technical and market knowledge directly from users (Gassmann *et al.*, 2006). In addition, agile achieves innovativeness by providing freedom and autonomy to individuals in self-organizing teams, so team members can use their creativity to solve problems (Highsmith and Cockburn, 2001). Moreover, agile rather relies on team members' creativity than processes to handle challenges provided by unpredictable situations (Dybå and Dingsøyr, 2008).

2.2.3 Stage-Gate®

The Stage-Gate® (further just stage-gate) is a product innovation management model (Cooper, 1990), invented by Robert R. Cooper in 1985 (Stage-Gate International, 2007). The model covers all steps from idea generation to new product launch and provides a roadmap for effective and efficient process (Cooper, 1990). Furthermore, it is widely used to incorporate discipline into sometimes chaotic product innovation processes (Grönlund *et al.*, 2010). That derives from the design of the model, which enables to identify and drop ineffective product ideas (Sethi and Iqbal, 2008).

The stage-gate model consists of several sequential stages of project work (data gathering and analysis) that are separated from each other by go/kill decision gates (Grönlund *et al.*, 2010). The purpose of the gates is to evaluate completed work and make decision about the future of the project (Cooper, 2008). It is achieved by pre-defined deliverables (gate review inputs), must-meet and should-meet criteria as well as actual project outputs (Grönlund *et al.*, 2010). Once managers have made a go decision, resources will be committed to the next stage and thus resources are allocated only to projects with proven potential (Cooper, 2016). The model is designed in a way that every subsequent stage incorporates lower uncertainty and risk levels as well as higher costs than preceding stage. Therefore, the model provides risk management by preventing substantial investments into the project during the stages with high uncertainty. (Van Oorschot *et al.*, 2010)

Traditionally, the stage-model has consisted of five stages and gates (Cooper, 1990; Cooper, 2008; Cooper, 2014). Cooper (2007) describes the stages and the gates as follows: The model starts with Discovery, stage 0, in which the goal is to generate and capture new ideas by conducting technical research and competitive analysis, working with lead users, gathering and using voice of customer as well as opening innovation process to external ideas. The stage is followed by Idea Screen, gate 1, where the start of the project is decided by evaluating strategic fit, market attractiveness, project feasibility and product advantage. Following Scoping, stage 1, must determine the value of the product from technical and market perspective and put together preliminary business case by conducting low cost preliminary research. Thereafter, Second Screen, gate 2, reevaluates the project based on the accrued information from stage 1 and conducts brief financial evaluation. Build Business Case, stage 2, is dedicated to detailed investigation to define the product, carry out market studies and technical appraisal and build business case prior larger budget allocations. Go to Development, gate 3, concentrates to in depth financial analysis and evaluates further development, operations and marketing plans prior extensive budget allocation. Subsequent, Development, stage 3, is committed to physical product development, where technical work is done in iterative loops to integrate customer feedback to development. Go to Testing, gate 4, checks if the development work fulfils pre-set goals, if the product is continually attractive to market and revises financial analysis. Thereafter, Testing and Validation, stage 4, is carried out to confirm the viability of the project, including the product, its production, market acceptance and economic prospects. Go to Launch, gate 5, examines if the product is ready for commercialization by appraising test and validation results. Launch, stage 5, focuses on the implementation of market and operations plan, by getting everything ready for production, sorting out logistics and starting product sales. Final activity in the stage-gate model is Post-Launch Review. After product launch and new product development project is terminated, post-audit is carried out and reflections is used to learn about strengths and weaknesses of the project. (Cooper, 2007)

Throughout the years, the stage-gate model has undergone continual development process based on received criticism and best practices research. Currently available fourth generation model (see Figure 5 and 6) is made more flexible and adaptable to changing situations than previous ones were (Cooper, 2014). The model is not a rigid system, necessary amount of stages and gates as well as their detailed content should be adapted to the complexity and uncertainty of the project (Van Oorschot *et al*., 2010). Figure 5 visualizes adaptions of the full stage-gate model stages and gates to different contexts of projects. Cooper (2006; 2014) explains that full five stage process (see description in previous section and Figure 6) is used to handle large-scale and high-risk projects, light version of full model is used to medium scale and moderate risk projects and express version of the model is suitable for small-scale, low-risk projects. Furthermore, the author emphasizes that it is necessary to adapt, develop and utilize stage-gate model to the needs of a particular organization, so it would fulfil the needs of the organization in the optimum way.

Advantages of the stage-gate model has made it widely used for new product development. Even so, the model has received criticism that has been used to develop it throughout the years (Cooper, 2007). Advantages of the model are the employment of multifunctional teams, insurance of high work quality and provision of flexibility by enabling parallel activities as positive properties of the model (O'Connor, 1994). In addition, well implemented stage-gate process can lead organizations to faster new product development activities (Grönlund *et al.*, 2010), significantly reduce costs of making mistakes (Summers and Scherpereel, 2008) and costs in the whole development process (Abramov, 2014).

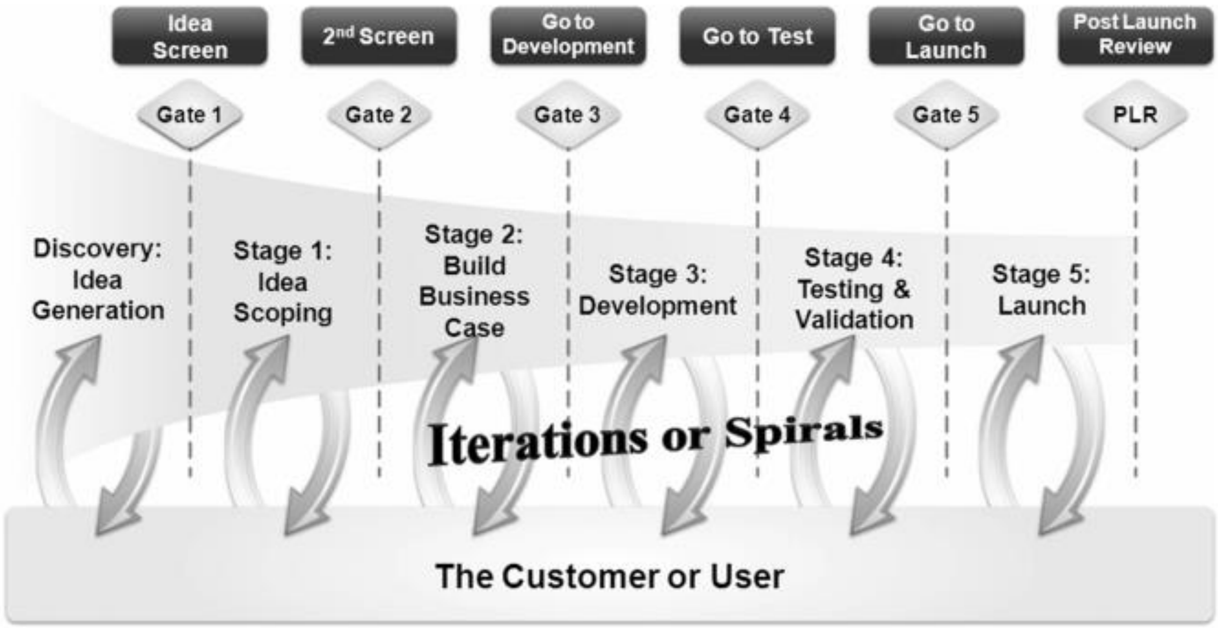

Figure 5. Stage-Gate model (Cooper, 2014)

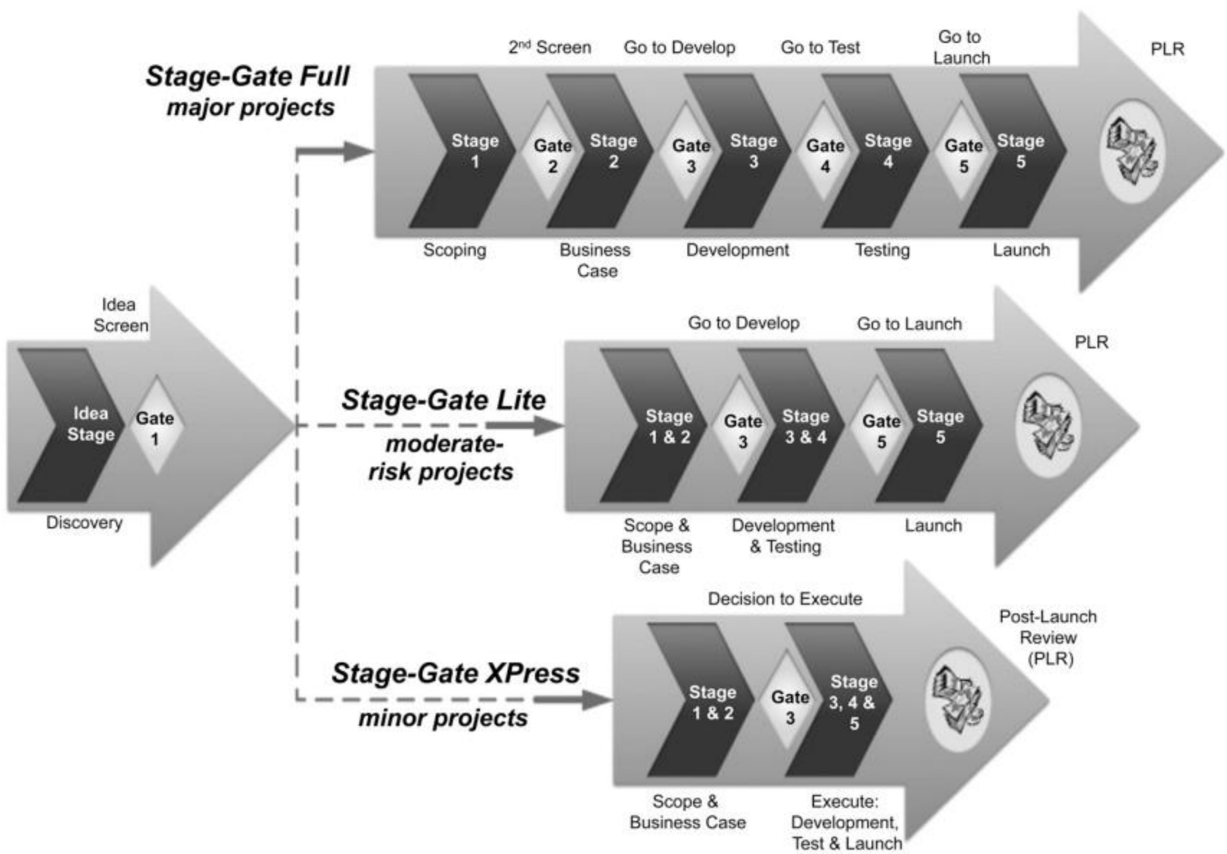

Figure 6. Suitability of Stage-gate model to projects with different scales (Cooper, 2014)

In turn, the stage-gate model has been criticized for being too inflexible (Summers and Scherpereel, 2008), linear and inadaptable as well as for lacking encouragement for experimentations (Cooper, 2014). It has also been found to be too structured and focused to financial figures (Lenfle and Loch, 2010) as well as too bureaucratic and time consuming by containing non-value-adding activities (Grönlund *et al.*, 2010). Moreover, criticism also includes accusations that the model is too planned for dynamic and innovative projects (Cooper, 2014) resulting in lower efficiency and delays in the project due to lack of tools for problem solving in such projects (Abramov, 2014). Carrying out innovative project may require incorporating external expertise, though the stage-gate model does not provide guidelines for involving open innovation activities to the process (Grönlund *et al.*, 2010).

Looking the stage-gate model in light of effectiveness and innovativeness shows that the model inclines towards effectiveness. The model is seen as an outline that ensure the effectiveness and efficiency of new product development process (Cooper, 1990; Cooper, 2006; Cooper, 2016). Though, the development of the model has not only sustained the effectiveness part of the model, but also increased speed, flexibility and adaptability of new product development process (Grönlund *et al.*, 2010). The model assures effectiveness by constraining monetary allocations in stages with high uncertainty and releasing investments as uncertainty is resolved (Summers and Scherpereel, 2008).

2.2.4 Comparison of frameworks

Comparison of frameworks (see Table 1) provides a summary of previously presented innovation frameworks. The aim is to compare the frameworks based on same characteristics to provide short and tangible overview of similarities and differences of the frameworks. Though, it is difficult to compare agile and stage-gate, because several available agile-stage-gate models that have been developed and applied during recent years, have removed some of the drawbacks and strengthened positive sides of individual models (Cooper, 2014; Cooper and Sommer, 2016). Furthermore, symbiotic combinations of agile and stage-gate model are the future (Dybå and Dingsøyr, 2008), because such combination enables both agility and discipline to the projects (Karlström and Runeson, 2006).

This comparison of frameworks helps the authors and readers to understand what the three frameworks can offer under the set of same characteristics: planning level, management involvement, scope, team type, customer focus/involvement, suitability to different industries, effectiveness vs innovativeness, change, uncertainty and complexity. For example, the research overview presented under innovation management (see section 2.1.1) brought out that radical innovation is accompanied by high uncertainty. The comparison of frameworks gives an overview how all three frameworks individually manage uncertainty. Thus, later in the design of the new innovation process, it is apparent that agile and design thinking should be strongly incorporated into the stages of the new innovation process with high uncertainty.

Table 1. Comparison of design thinking, stage-gate and agile

Characteristics	**Design Thinking**	**Stage-Gate®**	**Agile**
Planning level (micro- or macroplanning)	In between: it provides general guide-lines for the process and a set of specific tools for carrying out the process	Macroplanning: helps to define right activities, roles and responsibilities to carry out the project	Microplanning: involves specific tools to make functioning end-product
Management involvement	Solutions are generated by team members, very light involvement of management level	Heavy involvement of senior managers at decision making gates to decide the future of the project (go/kill)	Team members are trusted to make right decisions without heavy management involvement
Scope	Especially applicable for early phases of product development such as concept development, but also capable to apply for the entire PD	Whole product development from idea to product launch	Possible to use from idea to launch, though mostly used for front end development. Mainly covers development and testing
Team type	Enables cross-functional team	Small to large cross-functional teams	Small co-located self-managed technical teams
Customer focus/ involvement	Strong customer focus and the physical involvement of customer is encouraged	Customers are moderately involved in every stage	Extreme customer involvement, teams are often co-located with customers
Suitability to different industries	Have been applied in various industries	Suitable for hardware development, received criticism for software development (too slow, inflexible)	Most suitable for software development. Applied as agile- stage-gate hybrid model to hardware development
Effectiveness vs innovativeness	Both	Effectiveness	Both
Change	Always adapted to changes in design thinking process	Changes are simpler to handle in early stages of the development	Very flexible and change prone in every stage of the development
Uncertainty	Strongly emphasize on dealing with uncertainties	Handles, but is not as good as agile	Handles very well
Complexity	Suitable for high complexity projects due to the double diamond framework, which gives clear objectives of the projects	Suitable for complex projects (tears projects down to smaller activities and allocates majority of investments, when uncertainty has been reduced)	Reported to be good in complex environments. Have received criticism of working with large projects and large teams

3 METHODOLOGY

The methodology section gives an overview of employed research strategy, design and method as well as research process, ethics and quality.

3.1 Research strategy and design

This master's thesis research was designed to employ qualitative research strategy as general approach to the research. Qualitative research is utilized to understand the meaning individuals and teams give to a phenomenon or social problem (Creswell, 2014). The strategy produces descriptive data in a form of people's own words and observed behavior (Taylor *et al.*, 2016), which is used to develop new theories through an inductive process (Weathington *et al.*, 2012). Commonly, the choice of research strategy is derived from the aim and the research questions that are defined on the initial stage of the research (Sreejesh *et al.*, 2014). In this case, qualitative research strategy was suitable, because it enabled to learn organizational setting, identify criteria for the innovation process and modify the process to best fit to the organization. To do all that, research had to provide rich and deep descriptive data about the situation and point of views of relevant employees.

According to Bryman and Bell (2011), research design is a framework that is employed for data collection and analysis. This master's thesis research employs a single case study design in order to best answer established research questions and fulfil the aim. Saunders *et al.* (2012) define case study as follows: *"case study explores a research topic or phenomenon within its context or within a number of real life contexts"* (pp.129). The design is suitable for the thesis, due to the existence of clear research topic and real-life context. The research topic and real-life context are respectively "an innovation process" and SP&A department at "Volvo Car Group". The choice is verified by Dubois and Gadde (2002), who state that in-depth case study is the best way to understand the interaction between a phenomenon and its context. Moreover, Yin (2009) points out that case study design is suitable to be used in occasions, where explanations are sought to questions "how" and "why" some social phenomena works. It is also found to be appropriate to provide answers to "what" questions (Saunders *et al.*, 2012). Therefore, through employing multiple sources of evidence, the case study design is found suitable to collect valid data for answering all three established research questions.

Inductive approach, traditionally used in qualitative research, did not entirely fit to current research, because pre-study and the development of innovation process required inductive, whereas deductive approach suited better for iterative testing and improvement of the innovation process. Therefore, an abductive approach, where generation and evaluation of a hypothesis or theory are both involved in a study (Haig, 2005), was found more fitting to the research. It is achieved through using systematic combining, which according to Dubois and Gadde (2002) is suitable for single case study that aims for theory development. The authors define systematic combining as: *"a process where theoretical framework, empirical fieldwork, and case analysis evolve simultaneously"* (pp. 554). Systematic combining enables to continuously compare and match theory and empirical world as well as direct and redirect the study by confronting researched case and framework developed form it (Dubois and Gadde, 2002). Thus, the approach is well suited for researching non-static industrial situations (Bylund *et al.*, 2003) such as the one researched in this thesis. Moreover, deep structures are more likely discovered, if research method involves continuous movements back and forth between different research activities as well as between empirical world and theory (Dubois and Gadde, 2014).

3.2 Research process

The research process started with problem description that was originally provided by case company and further studied by the researchers. The problem description was the basis for deciding the scope of the study as well as establishing delimitations, which made it possible to develop research questions. Following steps included parallel conduction of literature study and empirical pre-study including semi-structured interviews, observations and document search. Iteratively going back and forth between these two steps and simultaneously analyzing incoming data created a basis for designing and conducting co-creation workshops. Removing emerged knowledge caps and improving the theoretical basis for workshop data analysis and interpretation led back from empirical research to literature research. All the workshops were connected to each other, meaning that every following workshop was designed based on the preceding workshop data analysis results. The innovation model was developed and improved through departmental collaborative co-creation in the workshops, which in turn got input from the researchers' continuous analysis and movement between the literature study, empirical pre-study and empirical research. Figure 7 visualizes the research process with different research steps and employed methodology. WS in the figure is the abbreviation of workshop.

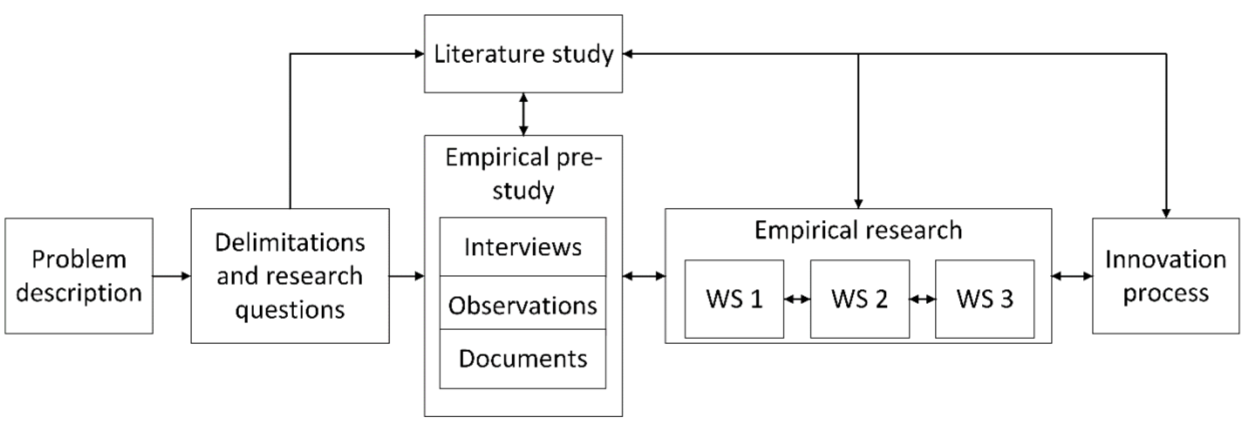

Figure 7. Research process

3.3 *Empirical pre-study*

Empirical pre-study was conducted to create initial understanding of the research problem and case company context. It included conduction of semi-structured interviews, observations and the company internal document search.

3.3.1 Interviews

Four qualitative semi-structured interviews (see Appendix 1) were conducted in the beginning of the research process, to quickly grasp current situation as well as different perspectives and expectations to the innovation process development. Bryman and Bell (2011) explain that the reason for having semi-structured interviews is to ask interviewees open questions and to allow involving additional questions to the predetermined questionnaire, although the theme is clearly defined and questionnaire is prepared before the interview. In such case, the questionnaire is not self-restricted and interviewees have large extent of freedom to elaborate on their professional areas (Cohen and Crabtree, 2006). The discussion freedom provided to the interviewers and interviewees, was the reason, why semi-structured interviews were employed for pre-study.

To capture different perspectives, the selected interviewees had different managerial or team member positions in product planning and engineering teams in SP&A department. The interviewees were found and selected based on recommendations from Volvo provided supervisor and interviewees from SP&A, to approach the innovation process stakeholders and quickly reach to the core of the problem. To ensure quality of the results, recording permission was requested in the beginning of the interview, which enabled later transcription and analysis of the data. Furthermore, the participation in the interviews was voluntary to all the interviewees, on top of which anonymity was provided if requested, in order to ensure comfortable and honesty enabling environment to participants.

3.3.2 Observations

Observations are used to find hidden and implicit insights (Bryman and Bell, 2011). In the process of innovation, it is hard to explicitly tell the opportunities and obstacles that users have experienced with innovation. As a result, observations are a supplementary method to interviews to create holistic view of current situation as well as deep understanding of inter- and intra-actions of the organization. This master's thesis research included both participant and non-participant observations to employ advantages from both methods. Scott (2014) explains that non-participant observations includes watching the subjects, but avoiding taking active part in the situation, whereas participant observations are conducted by researchers' intensive involvement with people in their common situations.

Non-participant observations were conducted during Global Innovation Generator (GIG) week, which included different innovation activities inside the organization. The aim of non-participant observations was to learn about the organization from the distance without interfering. Such observations were carried out during the introductory activities of GIG and Chalmers Case Night with students at first part of GIG. The method was employed to get the opportunity to learn how organization approached to the innovation topic as well as how employees and students acted during these events. Furthermore, non-participation gave a lot of time for the researchers to learn about the happenings, take notes, write situation descriptions and simultaneously discuss interesting findings with each other.

Participant observations were conducted during GIG moderation session and in three meetings with SP&A employees to improve the innovation process that the researchers had developed. GIG moderation session was selected, because it gave an insight to moderators work during the week to boost the ideas as well as pitch in some of own ideas to test electronical user interface and get the feeling of regular participant. Furthermore, three meetings with SP&A product planning leaders and operational development specialist were carried out to discuss and improve the innovation process developed by the researchers. The aim was to bring in more active interactions (Kawulich, 2005) for facilitating the development of the innovation process. Thus, it was a fruitful situation for open discussion and capturing improvement ideas for the innovation process for the department. To have data in reproducible form, both researchers took notes, pictures of drafts sketched on whiteboards and saved all physical materials.

3.3.3 Documents

Document research was chosen, because documents in the systems are heterogeneous, explicitly descriptive and mostly approved by management (Bryman and Bell, 2011). Additionally, the documents should be aligned with company strategies and specifically designed for people from the department. These documents help the researchers to get quick first-hand background information with a fresh but internal perspective (Bryman and Bell, 2011). In this study, document research covered working through documents from Volvo internal network and business management system including initial draft of innovation process, departmental role descriptions, advance engineering process and new product development process. The documents were found in the system through snowball sampling, which according to Biernachi and Waldorf (1981) is applicable when the study concerns sensitive issues and requires insiders' recommendations to find suitable research subjects. While exploring the massive database of Volvo internal system, snowball sampling helped to collect more relevant information in an organized way. For instance, the initial data collection in the system included all the connecting processes to the to-be-developed innovation process. Though, the studied documents suggested that description of roles in these connecting processes was critical for getting better interpretation of the processes. Therefore, role descriptions were studied right after studying the connecting processes.

3.3.4 Analysis

Data gathered from documents, interviews as well as from participant and non-participant observations were analyzed simultaneously and together if possible. Simultaneous analysis enabled validation of findings from different sources as well as highlighting peculiar findings. In addition, findings from one method suggested topics and questions to further research with the same or different method. Proceeding data collection had similar effect to literature research, where for example incoming data often needed additional literature research to verify or make sense of the data. Throughout the research empirical findings from documents, interviews observations and workshops had a great impact on the direction of the literature search and vice versa. For example, initial semi-structured interviews had strong focus to effective innovation, since that was the primarily emphasized by the organization, when establishing research topic for the researchers. Thus, to see if the organization's understanding of the effective innovation was aligned with the views of scholars, a thorough research on that topic was performed based on available literature sources.

Data analysis for observations and semi-structured interviews was somewhat similar. Transcripts from the interviews, notes, descriptions and pictures were read and commented multiple times by both researchers. Most important parts were highlighted and used as inputs to further discussions and workshops or as citations in the thesis report. Furthermore, there was no need to create a database for researched internal documents as suggested by Bryman and Bell (2011), because the Business Management System of the organization was well structured and therefore finding necessary documents was simple in every stage of the research. Even though, documents that were found to have high relevance to the research were saved to computer and stored in one common folder. Documents that were used most were also printed and important parts of them where highlighted and commented so that it would be easy to find them again in later parts of the research. Often used data coding (O'Gorman and MacIntosh, 2015), was skipped due to small amount of data, because interviews, observations and documents had merely supporting role in data collection. Thus, it was enough to take notes and highlight most important findings to find right direction for the study and have data triangulation to validate findings using different sources.

3.4 Workshops

Data collection is the primary purpose for designing a series of workshops in this research. Another purpose was to experience a complete innovation process with colleagues in SP&A department to find out advantages and disadvantages of the process. After two rounds of interviews in the department and many observations in meetings and activities, fundamental knowledge about pains and needs in the department was gained. Collecting massive data regarding elements of the innovation process in a relative shorter period of time was necessary for the second period of data collection which is specific for synthesizing solutions. The solutions will therefore be partially developed by employees to create higher sympathy, better acceptance, and greater motivation to implement. A series of workshops was designed for bringing insights to develop and test the innovation process.

Many reasons for adopting this method and design of the workshops are addressed in section 3.4.1, following with elaboration of conducting the series of workshops in section 3.4.2. In section 3.4.3, intermediate analysis between or after workshops is specified.

3.4.1 Design

There are four main advantages for conducting a series of workshops comparing to other methods such as interview. First of all, design thinking involves heavily of an ethnographic approach which is a way to identifying unarticulated customer needs (Carlgren, 2013; Koen *et al.*, 2002). Hence, the results of the workshops would be customer focus. Besides, it was convenient to design workshops with a process approach for people to experience and reflect in a progressive way. Additionally, workshops could involve many more people at the same time to interact. The number of employees invited and participated in each workshop ranged from 6 to 10. It was always an even number so for the convenience to form two teams during the workshops. After all, both explicit and implicit data were collected with divided roles among the two researchers. For instance, one led the process for obtaining explicit data on whiteboard and paper. The other one made observation and noted down interaction between participants which was very implicit to reveal during an interview.

A combination of non-participated and participated observation in workshops were adopted to collect data. Interference from the researchers' side was consciously avoided in the beginning. After the first workshop, the involvement of researchers increased. Especially by the third workshop, the knowledge for the innovation process had been comprehensively learned which allowed researchers to participate in discussion and contribute in conversation. Participated observation could bring in more active interactions to facilitate and develop hypotheses (Kawulich, 2005), hence to improve the process. Thus, the frequency of participated observation was increased in later workshops.

Design of the workshops started with selecting a suitable process approach. Design thinking is an approach to solve problems in an innovative way with user focus (Brown, 2008; Stanford d.school, 2016). Applied in workshops, design thinking approach was flexible to be divided into sessions with different lengths and learning purposes because of the individual but interrelated composing phases. During workshops, many handy tools in design thinking was introduced for participants to apply in routine. With the approach, people were encouraged to interact and corporate in workshops. One challenge was to reserve simultaneous time for a group of people. It was solved by early invitation and introducing attractive contents of the workshop. The researchers invited the supervisor of the thesis from Volvo side, to send out the workshop invitations in order to obtain a high reply rate.

The series of workshops consisted of three individual workshops. All the workshops had a common title: Innovation Experience Workshop, following with a sequence number of the workshop 1, 2 or 3 to differentiate between workshops. The first and second workshops were closely connected for carrying out a complete design thinking process from empathize to test and iterate. The first two phases of design thinking, empathize and define, were adopted for the first workshop, while the latter, ideate, prototype, test and iterate, were installed in the second workshop. As a result, each workshop evolves ideas through a round of diverging and converging thinking. The third workshop was aiming at testing the innovation process developed after the first two workshops. Afterwards, learnings and feedbacks from the workshop 3 were used for refining the innovation process. All the three workshops started with a warm up session for the purpose of bringing people from routine work to an active and interactive environment.

3.4.2 Conduction

It was decided to follow the principle of being extremely open in the beginning for design thinking process to avoid excluding any interesting insights from the starting point (Stanford d.school, 2016). This way conforms to one of the suggested way to make good innovation process: allow divergence at the front end (Loewe and Dominiquini, 2006). It also resembles the fuzzy front end before new product development processes (Koen *et. al.*, 2002).

Since time were restricted for having a group of people to participate in the workshop, time management was under extremely crucial consideration. A bad time management in the first workshop would bring doubts about the workshop and would create irreversible negative effect to the next ones. The time slot scheduled for the first workshop was two hours in total. To achieve an efficient cooperation between people, the optimum situation was to have two teams and each team were composed of different profiles in the department to obtain diverse ideas. Invitation email including the aim of the workshop and reasons for the researchers to conduct one was sent approximately two weeks ahead of the first workshop. Another email including objective, agenda and the brainstorming question was communicated one working day ahead for participants to prepare, so to save partial time for brainstorming.

<u>Workshop 1</u>

As mentioned previously, the brainstorming question for the first workshop did not directly ask what the main factors of an innovation process are in order to open up the front end. A wider range of ideas was expected through penetration of the brainstorming question. The question was about former experiences in SP&A and specifically the experience regarding innovation projects. To include extreme condition, the researchers decided to ask about the best or worst experience, due to that extreme condition has the strength of acquiring amplified behavior and feeling (Nyblom, 2016; Stanford d. school, 2016). As a result, the brainstorming question determined for initiation of the workshops was,

"*What have you suffered most from an innovation project?*"

This first workshop needed to reach to a result which can redefine the problem of having bad innovation experience in a clearer way. To be able to have certain degree of empathy, the backbone for the brainstorming question was to think in the standing point of selves being a product planning leader, engineer or operational process specialist. They will be the main user group of the ultimate innovation process. This was also the reason for inviting them as the participants of the workshops. The participants were divided into two teams, named team A and team B. The roadmap for the first workshop can be seen in Table 2.

Each idea was asked to respectively put on one piece of sticky note for convenience of rearranging later on a whiteboard or a paperboard. Besides, each person had his/her own color code which was very easy for the researchers to trace back data source after the workshop. A large amount of time (20 minutes) was arranged for communicating ideas clearly in teams, followed with a "Fika" break (15 minutes) for the purpose of leisure communication between teams. During the break, each team could duplicate at least three ideas from the other team using red color pen and put into their own board (see Figure 8 and 9, marked in black boxes). These ideas could either be ones that were missed out or inspiring for their own team. Through these 35 minutes, individuals and teams got information much more synchronized. Obtaining valuable insights from the other team was also a way to complement own ideas for better clustering later on.

Table 2. Innovation Experience Workshop 1 Roadmap

Phases	Empathy	Define
Tools	Brainstorming	Cluster and Grouping
Outputs	Ideas/Insights	Themes

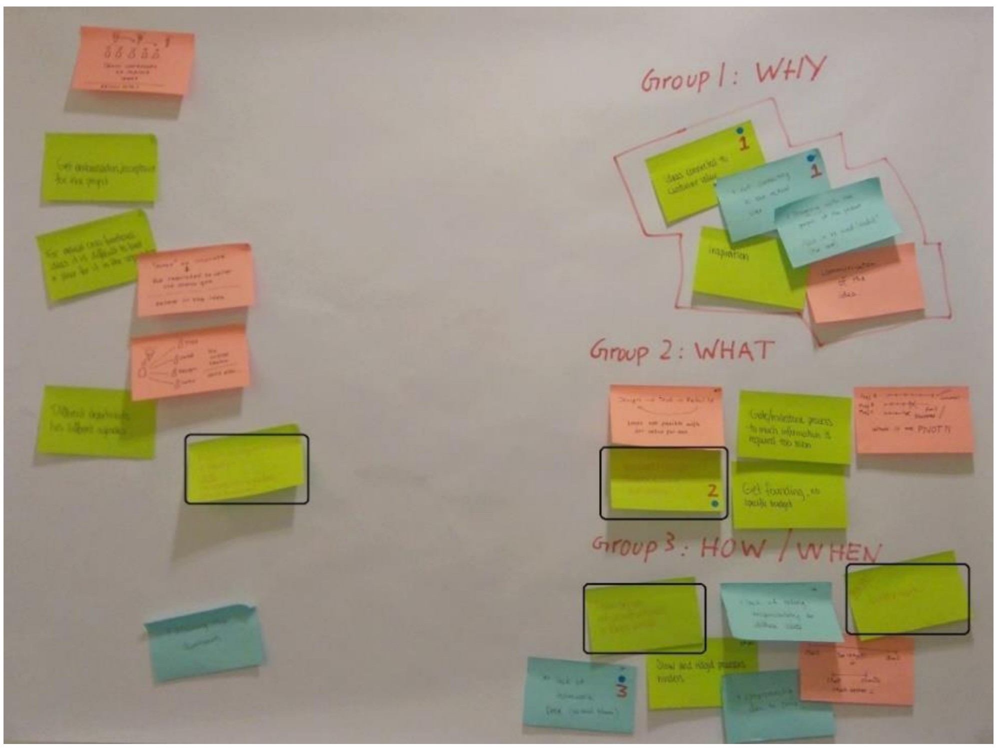

Figure 8. Clustered Themes by Team 1 in Workshop 1

Instead of putting very specific guideline for clustering, a common fictional case (see Figure 10) was designed to introduce to participants before clustering. The case was introduced through a video (Howcast, 2009) and the list shown in Figure 10 depicts the conditions that the team needed to consider. Introducing a case was for the purpose of being able to hand out freedom for different teams to form structures between data in their own ways but retain creativity at the same time. It is an ethnographic way to obtain empathy (Carlgren, 2013). The common case could loosely constrain the clustering meaning that empathy was again emphasized before entering converging process. After two teams characterize the clusters into themes, these themes and thinking behind was exchanged between teams.

Figure 9. Clustered Themes by Team 2 in Workshop 1

Figure 10. Fictional case 1 - A cooking car

At the end of first workshop, the theories were introduced, including principles of design thinking, and characters of using such an approach, as well as the two phases of design thinking. As a result, people were able to experience the first two phases with an exploring mind. Again, it was designed on purpose to open-up the front end. After the first workshop, a survey with multiple choice questions and open questions was sent to understand participants' satisfaction upon the first workshop (see Appendix 2).

Afterwards, define phase was completed by the researchers before the second workshop because completing this phase was time consuming. Another consideration for taking the phase as the intermediate between the two workshops was to bring in literature inputs and combine them with workshop data. Using the same way of clustering as in the first workshop, themes and HMW questions were derived before the second workshop (see Table 3).

Table 3. HMW Questions in Innovation Experience Workshop 2

Question #		**Need**	**User**	**Insight**
1	**How might we**	bring shared understanding early	for R&D engineers	through better teamwork/distributed responsibility?
2		be customer focused in innovation process	for product planning leaders	through quality/reliable ways to obtain direct voice of customer?
3		create learning cycles	for product planning leaders and R&D engineers	by properly maintaining/transferring knowledge gained?

<u>Workshop 2</u>

Again, an email including purpose, agenda, derived HMW questions and review of the previous workshop (Appendix 3) was sent one working day before the second workshop. The second workshop contains more phases than the first workshop. Meanwhile, it is more time consuming to arrive to a point where tremendous data could be collected, because the point came at later time comparing to the first workshop. Therefore, the length of time should be longer for the second workshop. Whereas with the confidence gained after the first workshop in terms of time management, the second workshop was scheduled up to 2.5 hours and the researcher was able to complete the second workshop within 2.25 hours. The roadmap for the second workshop is shown in Table 4.

Ideation was conducted for 20 minutes to generate and organize the solutions. Participants were again divided into two teams. Unlike the first workshop in which each team remained the diversity of R&D engineers and product planning leaders, participants in the second workshop was divided according to their profile. R&D engineers and an operations specialist were assigned in Team A and product planning leaders were assigned to Team B. As a result, Team A was specifically focusing on answering the HMW question 1 and 3, while Team B focused on question 2 and 3 (see Table 3). Ideation with brainstorming of HMW questions were applied for diverging problem scope in workshop 1. However, ideation in workshop 2 was to expand perspectives and generate solutions (Pyla Pardha and Hartson, 2012). Items of solutions to the HMW questions were written on stickers by each participant with the color code for researchers to trace back (see Figure 11 and 12). These stickers were then organized item by item to generate 2 to 3 comprehensive solutions each team. Not all items had to be adopted depending on the relativeness to HMW questions and compatibleness between items. In this workshop, the common Cooking Car case used in the first workshop was presented again after ideation in order to retain the empathy for the divergent thinking.

Table 4. Innovation Experience Workshop 2 Roadmap

Phases	Ideate	Prototype	Test and Iterate
Tools	Ideation with selection	Visualization	Presenting and reflecting
Outputs	3 customer-focused solutions	Prototype them	Re-prototype

Together with the “Fika” break, prototype phase was carried out in 30 minutes and the 15-minute “Fika” break within the prototyping timeslot was to promote communication between teams. The HMW questions were all related to soft aspects of innovation, such as shared understanding, customer focus, and learning cycle (see Table 3). The solutions were expected less likely to be physical objects. Considered that prototyping of such solutions was challenging, one question was that how to design these two phases in order to visualize solutions without limiting the willingness of being creative. In addition, according to Volvo employees, prototype specifically refers to the physical representation of the product for user to touch and experience the functions. However, the concept of prototype in design thinking was different that any tangible and experimental representation of design ideas (Stanford d.school, 2016; Fredrik, 2016). Therefore, the prototype phase, which requires the participants jumping out of the box and work in a different way, was introduced with a clear guidance. A variety of icons were selected, printed, and cut into pieces prior to the workshop. Different sizes of paper, color pens, highlighter, clips, tapes, glue, and staplers were provided. Any other material brought over such as paper cups, strings could be cut and used. Participants were trying to utilize all the materials available to make prototypes.

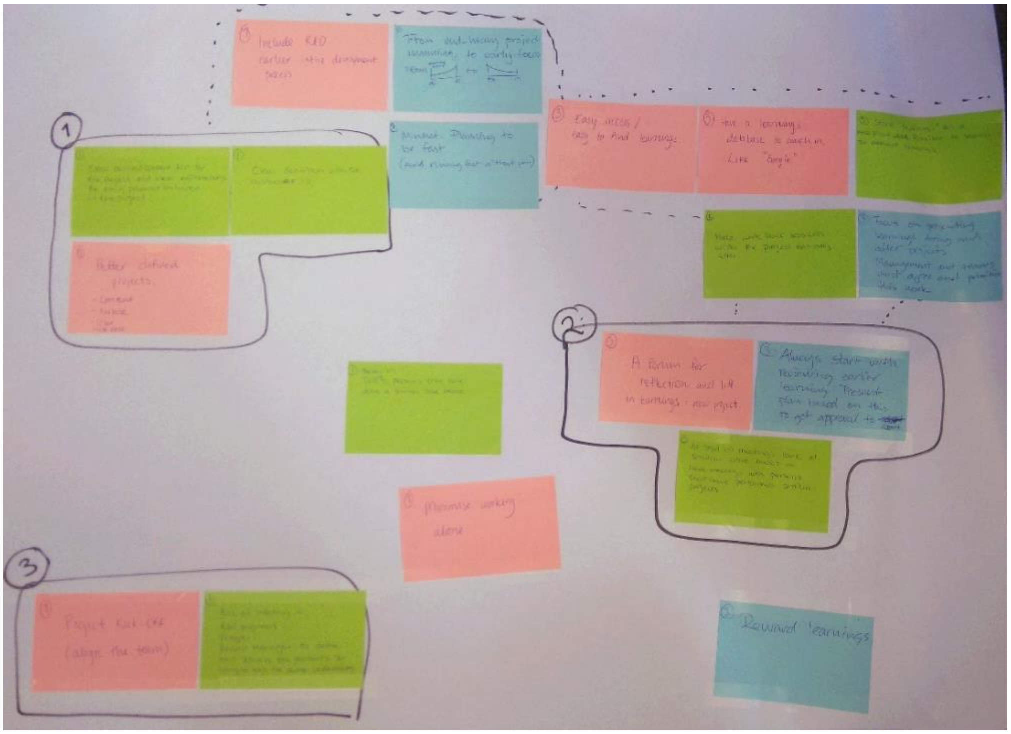

Figure 11. Organized ideation results from Team A

Figure 12. Organized ideation results from Team B

Test phase was composed of an introduction and a pilot trial of the prototypes. Different forms of testing that could be applied such as presentation, role play, and gamification (Fredrik, 2016) were introduced in the workshop. Both teams chose to do a presentation for 5 minutes each, followed with a 5-minute reflection. A 15-minute session of re-prototyping with reflection was also put into the agenda for participants to experience iteration in reality.

After the second workshop, processes designed by each team were digitalized retaining all their contents. These two documented processes were directly applied into the innovation process development. It composed of gathering all key elements in the innovation process, listing key factors for the process, mapping out the process with phases, estimating relative time span for phases, breaking down phases into steps, setting gates, identifying actions in each step and gate, as well as defining responsible personnel in each step and gate.

Workshop 3

Once the innovation process had been developed, the third workshop was conducted for testing and obtaining feedbacks to refine the process. In order to maximize the takeaway, the objective for the third workshop was to clearly present the innovation process and the goal was to allow many discussions while presenting. Creating a bi-directional communication was crucial for this workshop to avoid tedious distribution of information along each step of the innovation process. Main actions and benefits of each step were delivered to drift participants with the flow. An atmosphere for free interruption were created from the beginning of the presentation. Thus, instead of presenting the entire innovation process and waiting for feedback in the end, the process was presented step by step to simulate the creation of the process (see Figure 13). This way triggered more interaction and iteration. The feedback obtained was real-time reflections. The time for the third workshop was reserved for 1.5 hours. Invitations were also sent one week ahead of the time. It was not restricted to involve new participants to the third workshop since fresh views were welcome. Additionally, a new fictional case (see Figure 14) was used along the innovation process for creating empathy and dragging-in participants into a certain circumstance. The picture shown below is an illustration that depicts different functionalities and customer expectations to the customers composed of a number of small pictures.

The workshop was divided into three sessions (see Table 5). The entire process which involves gates will be introduced in detail in section 4.4. In the first session, the idea bank and before the first gate are covered. A proposal of SP&A idea bank was presented for the inputs two steps with a drawing proposal (Appendix 4) as a prototype in order to bring intuitive visualization. The first session lasted 30 minutes. The session 2 occupied another 30 minutes which ranges from the first gate and the third gate. It covered the main phase of the innovation process which is incubation. Incubation is the phase to grow ideas. Detailed information in each step was discussed during the workshop. In the following 30 minutes of the third session, participants were asked to decide which steam at the third gate to select using the fictional case and if there were any unarticulated issues that need another sub-process.

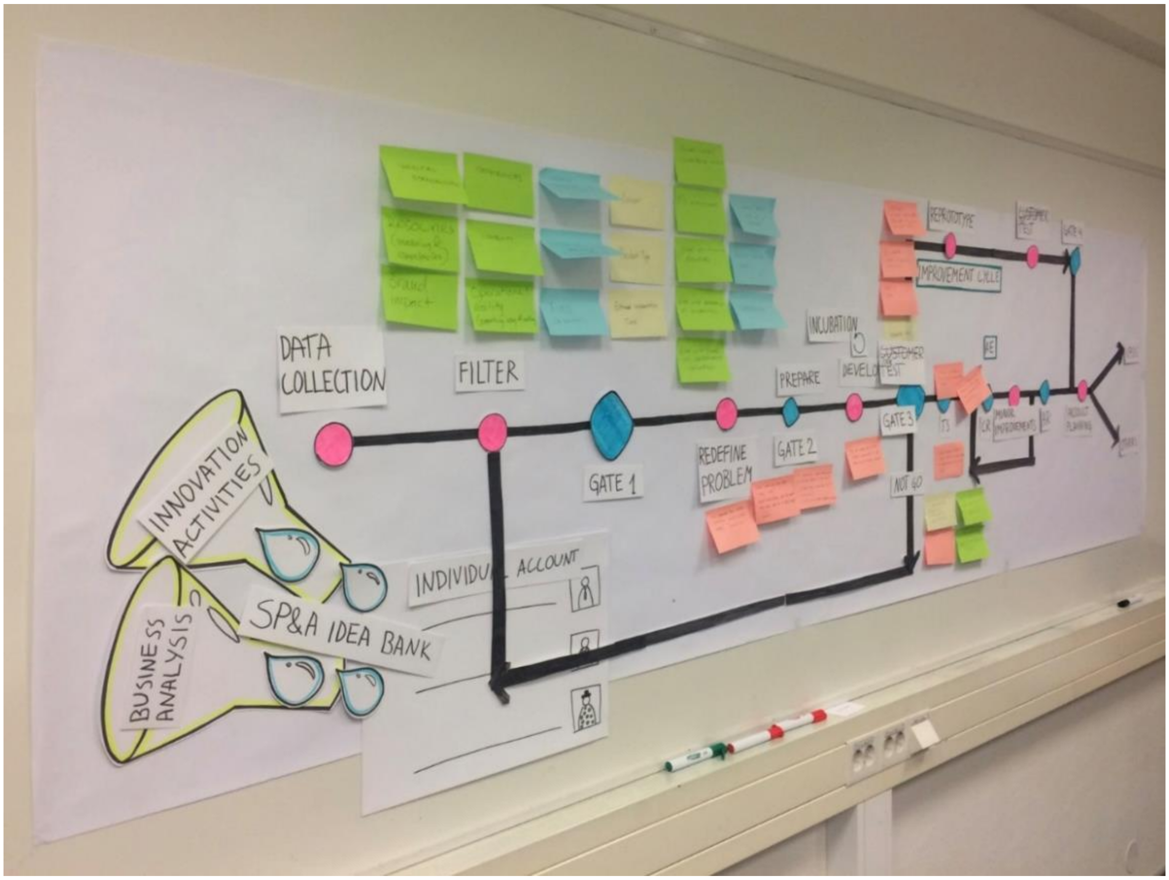

Figure 13. Process mapping during workshop 3

Figure 14. Fictional case 2 - A sleeping car

Table 5. Roadmap of Workshop 3

Session	1	2	3
Range	Before the first gate	From the first gate to the third gate	At and after the third gate
Content	Inputs to the process; Idea Prioritization Phase	Problem Redefinition; Incubation Phase	Advanced Development Phase

In each session, a brainstorming question was designed for all participants to discuss together (see Table 6). The purpose of brainstorming questions was to diverge thinking of participants to give inspiration in refining the process.

Table 6. Brainstorming Questions of Workshop 3

1	Which other categories than listed should be involved for filtering? Customer focus (VOC); Innovation level; Economy; Top management demand; Technology feasibility; How urgent/important is it
2	What are other preparation activities in incubation that should be fulfilled to pass the second Gate?
3	Come up with more problem to solve and decide which sub-stream to choose to GO?

Positive feedback was obtained by using this interactive way of presenting and having the fictional case for participants to relate to. The empathy created brought higher possibility to find potential areas to improve in the process for researchers. The third workshop ended with an overall review of the entire process and concluded with the frameworks that had been combined in the process while developing it.

3.4.3 Analysis and synthesis

Design thinking approach used in the workshops collects a large amount of qualitative data. Categorizing those qualitative data was a challenge, especially to organize data after a workshop. For capturing structured information, analysis and synthesis was used alternatively in and between each workshop. Unpacking data is a starting point of analysis process (see Figure 5) corresponding to the learning cycle introduced in Section 2.2.1.

During workshop 1 and 2, data was unpacked right after each brainstorming session on stickers and later posted on board. Similarly, unpacking data was through rearranging stickers and adding inputs from researchers between workshop 1 and 2. After data was unpacked, analysis continues through defining affiliation between stickers (Gumienny, *et. al*, 2014) or finding strongest relation between stickers and research questions (Alänge, 2009). After several rounds of grouping, stickers on board also revealed clear relation pattern which was characterized into themes. The massive amount of data was themed to form clues for synthesizing solutions.

When the memory was still fresh right after the workshop 1, data induced from the brainstorming question and the common case was documented as picture files which were collected in one folder. In order to add inputs of earlier literature review, all the stickers from participants in the workshop was duplicated word by word and literature inputs were added to repeat the synthesis process of grouping as in the workshop. Afterwards, new themes are proposed (Table 7). Figure 15 shows the work done only with all the duplicated data from workshop 1 while stickers with a red rectangle in Figure 16 were written with literature statements. Literature statement successfully closed most of the causality gaps between stickers.

Table 7. Themes concluded after workshop 1

Team 1	**Team 2**	**Researchers**
Reason	Prioritization	Interaction
Content	Content	Resource
Method	Process	Process

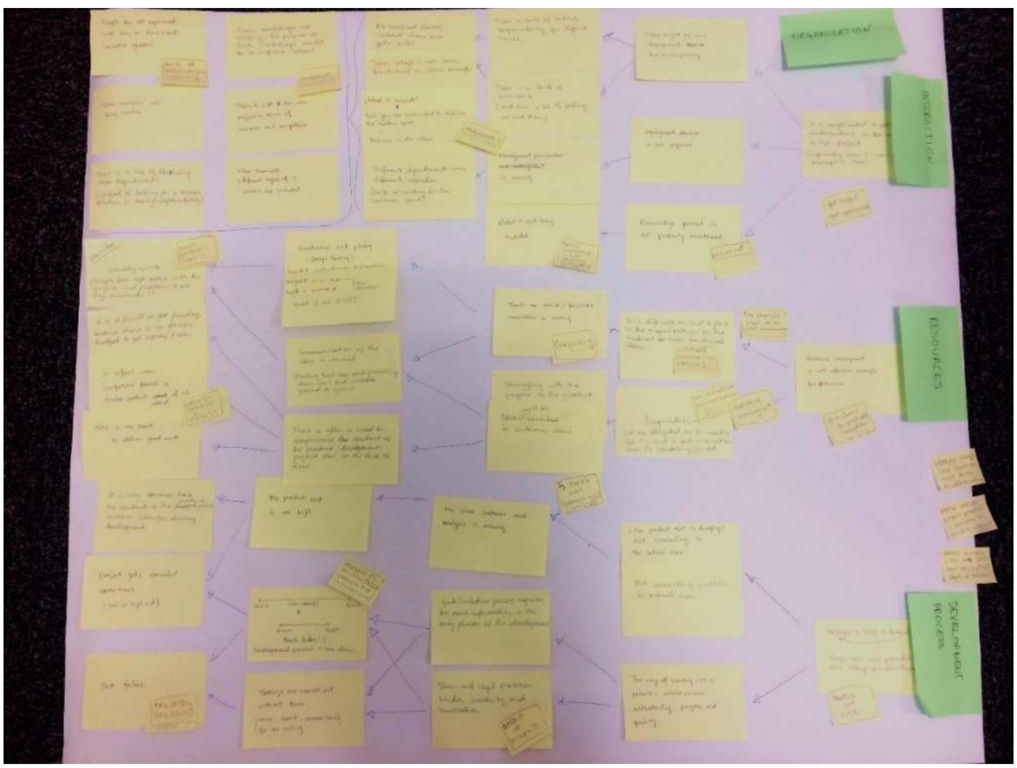

Figure 15. Clustered themes after workshop 1 before adding literature

How-might-we questions draws the converging point between the two diamonds of design thinking. It means that HMW questions generate the narrowest point for the entire design thinking process before reaching the end solution (Brown and Kätz, 2009). HMW questions are synthesized by another tool POV. It can be summarized with an equation: POV = User + Need + Insight

(Fredrik, 2016). The way to find insights was by two researchers discussing the reason for clustering. The discussion inspired the generation of interesting insights. Insights were noted on the tiny sticker besides the regular size stickers (see Figure 15 and 16).

Ideation was also used to facilitate analysis and synthesis to develop the innovation process after workshop 1 and 2. The processes proposed by Team A and Team B in workshop 2 were compared with the scale and main takeaways. Brainstorming questions in workshop 3 were generated for finding areas to improve in the innovation process which also enables the analysis and synthesis after the workshop 3.

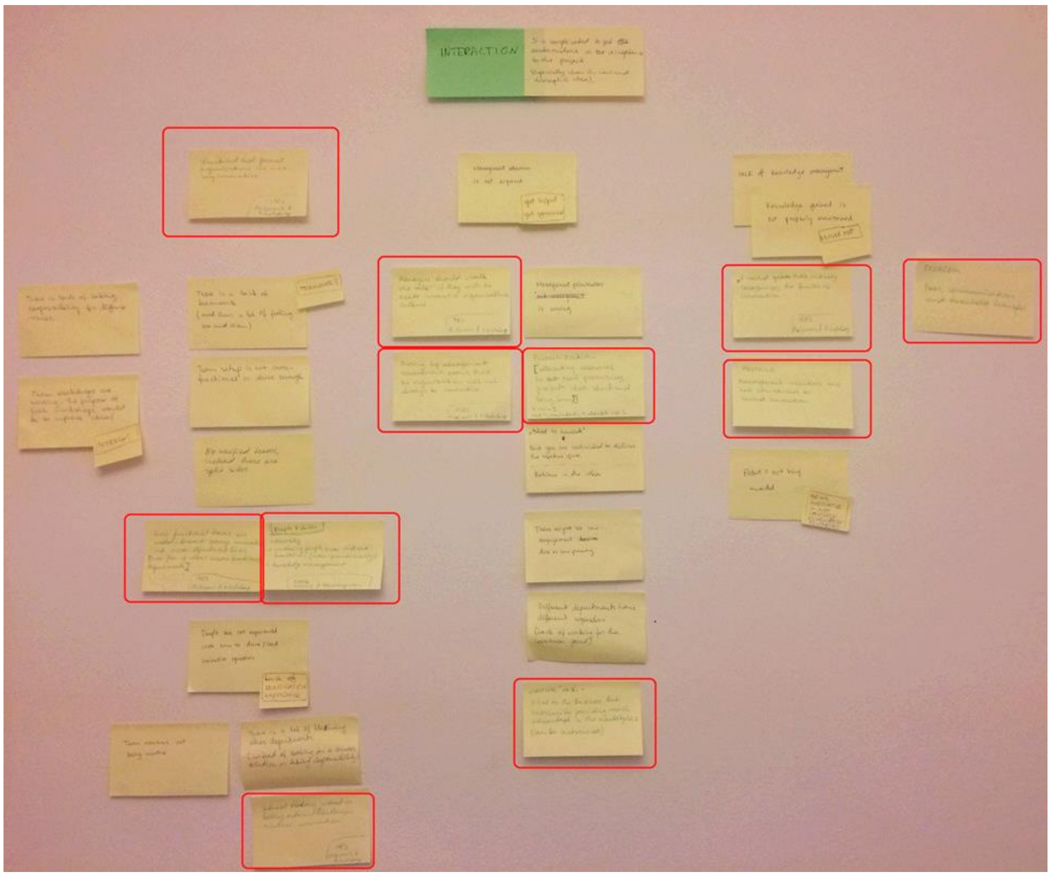

Figure 16. Clustered groups under the theme Interaction after adding literature inputs

3.5 *Research quality*

Trustworthiness, an alternative quality criterion for qualitative research (Bryman and Bell (2011), consists of four subcategories that have counterparts among traditional criteria. Internal validity is substituted by credibility, which concerns with believability of the findings based on gathered data and studied social world (Merriam, 2009). It is achieved by providing thick description of studied case, triangulation of data sources (Tracy, 2010) and usage of respondent validation (Mays and Pope, 2000, Bryman and Bell, 2011). External validity is replaced by transferability, which deals with applicability of research findings in different contexts (Merriam, 2009). Main aid for achieving transferability is by presenting thick case description in research report (Seale, 2002).

Reliability is displaced with dependability that deals with an issue of stability of the research results over time (Sinkovics *et al.*, 2008). In turn, objectivity is substituted by confirmability, which demands researchers to show that they have acted in good faith and have not been blinded by personal agendas (Sinkovics *et al.*, 2008). Dependability and objectivity are both ensured by auditing, meaning that the researchers should retain complete records of the research process (for example interview transcripts, research methods and decisions) that would be assessed and approved by peers (Seale, 2002; Bryman and Bell, 2011).

In this thesis, credibility was achieved by providing thick description of studied case and triangulation of data sources. The triangulation of data sources was attained by utilizing multiple data sources such as case company internal documentation, interviews, observations and workshops, which according to Eisenhardt (1989) strengthen generated understanding of phenomenon. Furthermore, triangulation was also achieved by using multiple researchers, which in this case means, that as much as possible, both researchers conducted data analysis first separately and then discussed to reach consensus. Eisenhardt (1989) points out that such arrangement enhances the creative potential of the research and improves trustworthiness of findings by increasing the chance of surprising findings. Furthermore, the researchers focused on avoiding manipulations with gathered data throughout the research process. For example, the stickers used for the analysis outside the workshops, were the same stickers in unchanged form that were written by workshop participants. Moreover, credibility of results was ensured by openly communicating findings in the organization and having regular discussions with both university and case company supervisors. Furthermore, transferability was ensured by presenting thick method and case description in the thesis report. Even so, it is found to be a responsibility of readers to decide whether the case and drawn results apply in another context or not, because it is impossible for case researcher to know in what situations the research could be tried to apply in the future (Lincoln and Guba, 1985). Thus, transferability is attained, when readers find major overlapping between own situation and the research case description and then intuitively transfer research findings to own situation (Tracy, 2010). Moreover, dependability and objectivity, which are commonly ensured by auditing had to be achieved with different methods in this thesis. Even though that the researchers preserved all gathered data in reproducible form and provided thorough description of methodology, it was not possible to audit it, because this research did not include resources for peers to go through and analyze the large number of transcripts, documents, records and notes that are generated in this research. Thus, in this thesis dependability and objectivity were ensured through discussing findings with respondents in workshops and closely co-operating with supervisors, who provided critical feedback on these topics.

3.6 Research ethics

To ensure that the research will be carried out in an ethical way, the researchers considered four ethical principles of business research: harm to participants, informed consent, invasion of privacy and deception (Diener and Crandall, 1978; Mertens and Ginsberg, 2008; Bryman and Bell, 2011) throughout the conduction of the thesis.

In practice, following the ethical principles during the conduction of the research means that the research and aim of the interviews, as well as used methods for conduction, usage and analysis of the interviews should be presented to the participants beforehand. In addition, permission for using recording devices and referring to participants with their name was asked before the start of interviews. After becoming aquatinted with the information, the participants could make a conscious choice to voluntarily participate in the interviews, participant observations or workshops, which according to Israel and Hay (2006) increases informed consent. The detail agenda and review material sent before conducting a workshop was to spread the objectives to the participants to avoid deception and enforce informed consent. However, participants still had the right to refuse answering any questions or to leave during the activity (for example a workshop) if they found questions/tasks were harming or otherwise inappropriate. During workshops, open topics were used without presetting standing point for the result, which enabled participants to choose exactly what they want to share under that topic. All participants invited were within the same administrative level to minimize the invasion of privacy and harm to participants. Moreover, as suggested by Wiles (2012), to protect participants' privacy and avoid any kind of harm, all the records of gathered data were kept to the authors and were not handed out to other parties. In addition, all the stated interviewees were kept fully anonyms in the thesis report due to the risk of revealing identities even by referring to them by work positions, because of small number of participants and SP&A department size.

4 RESULTS

The chapter presents the empirical findings that were gathered through observations, interviews, documents search and workshops. Attention is given to initial state of work with innovation at SP&A, identified challenges, improvement possibilities and presentation of newly developed innovation process.

4.1 Initial state of work with innovation at SP&A department

Initial state of work with innovation at SP&A department in VCG was the state captured during the first half of 2017. According to an interviewee, at that time the only way to develop ideas into products was conducting Advanced Engineering studies. The process was used, because there was no officially approved innovation process. Tough, the unsuitability of AE studies to early stages of product development was known to the SP&A department. Another interviewee pointed out that the studies were found to be too slow and complicated due to insufficient definition of the ideas entering to AE studies. An interviewee also criticized AE due to inflexibility and high resource consumption in cases, where the wish was to merely evaluate if the idea is possible or not. Though, the interviewees suggested that the solution of the problems is performing more effective and efficient work prior AE studies. On that purpose, the department had internally developed a partly finished draft for idea generation process and idea evaluation process. Despite the existence of drafts, there was no official approval of the documented processes and thus in reality, the drafts were never tested or used.

4.1.1 Advanced Engineering at SP&A

"Advanced Engineering is the company's way of turning innovative ideas, from science to technical solutions, into viable, marketable products or manufacturing processes." (Special Products & Accessories, 2016). The AE involves development activities that are carried out before product development projects can start. The purpose of AE is to search, evaluate and develop new functions and technologies that would be applicable in product development projects.

According to an interviewee, carrying out an AE study takes around 4-12 months. It requires a study leader and sometimes involves more diverse team, which consists of advanced engineering leader, design engineer, financial controller, technical line manager, product planning leaders, system responsible and technical development leader. AE studies are driven and followed-up based on Global Technology Development System, which consists of various stages and gates. Similarly, to stage-gate process, the project can be stopped in any of the gates. AE studies are normally carried out according to the annual product planning activities, but can also be initiated during the early stages of Volvo Product Development System. Carrying out an AE study as a part of annual product planning activities, means that a need for new technology has been detected and approved technology for a generic VPDS program is expected. On the other hand, if an AE study is performed in connection to VPDS, then the technology was not ready for VPDS program and expected result after AE is the technology that is approved for a specific program. The GTDS consist of four gates. First, Technology Kick Off (TKO) executes the project and requires a brief project description (info about the team, budget, timeframe). Second, Technology Strategy (TS) checks the identification of business and technical targets (for example, voice of major customers) as well as evaluates different technological alternatives. Third, Concept Readiness (CR) requires demonstrated proof that at least one of the technological concepts is able to generate the primary stated purpose. Fourth and last gate, Application Readiness (AR) examines if the technology works in a generic vehicle environment and is robust to principal noise factors. (Special Products and Accessories, 2016)

4.1.2 Idea evaluation and idea generation drafts

The aim of creating an idea evaluation process (see Figure 17) was to leave only technical development to AE studies and carry out fast and flexible front-end study prior to AE. Thus, the idea evaluation process should start with ideation, selection of investigated idea, investigation plan creation, 2-4 weeks pre-study (identify questions to resolve, form a team) and 8-12 weeks desk study (resolve questions, suggestions for future) to check the feasibility of the idea prior entering to AE and/or VPDS. (Special Products & Accessories, 2017a) According to an interviewee, such change was desired on two purposes: first, to study if there is a business behind the idea and second, to better prepare for development processes. Another interviewee added that the department had witnessed several long-lasting (could be up to a one year) AE projects that resulted in decisions, that market is not ready yet for the product or there is already existing technology for the product. Furthermore, the idea evaluation process was intended to employ more diverse team than AE studies, bringing more focus on market and business by forming a team from product planning leaders, system responsible, principal engineer, business analyst, finance controller, commercial project leader and technical development leader.

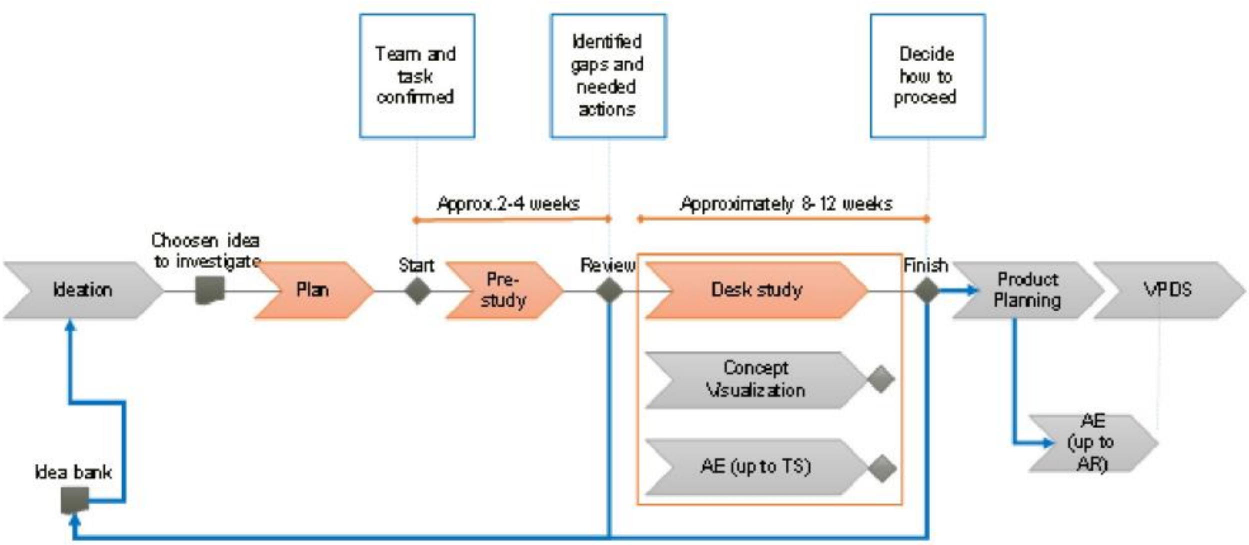

Figure 17. Idea evaluation process draft at SP&A (Special Products & Accessories, 2017a).

The SP&A department had also developed an idea generation activities draft, which covered the ideation and idea bank activities in idea evaluation process (see Figure 17). The purpose of it was to define through which activities ideas of features and products will be created at SP&A. It first required creation of idea bank, where all gathered ideas would be stored, sorted, prioritized and extracted. So far, each product planners have their own excel sheets for storing new ideas, which cannot enable sharing, collaborating, discussion and co-development with colleagues prior to official meetings. Defined idea generation activities, include annual activities to discuss existing ideas at SP&A and annual activities to find new ideas. Discussion of ideas is proposed to be achieved through internal events such as internal award giving at SP&A director's town hall meeting, open door events and management level annual activity planning. Furthermore, SP&A planned to find new ideas through various co-operation events with universities, sending employees to technology shows, participating at Global Innovation Generator events, visiting supplier events and technology companies, regularly analyzing competitor products, etc. (Special Products & Accessories, 2017b)

4.2 Innovation challenges at Volvo SP&A

As discussed in previous section, conducted interviews revealed that AE studies were found to be too slow, complicated, inflexible and requiring large amount of resources. Furthermore, interviewees pointed out that an effective innovation process is expected to deliver results, deploy ways to control and manage deliverables and be flexible in conjunction to other already existing processes in the organization. SP&A is a unique unit at VCG since the products are complimentary comparing to other units in the Group. Thus, the competency for developing various products is highly needed in the department. Even so, according to an interviewee, the department struggles with lack of some competences like development team's ability to work with early product development stages or management team's ability to foresee market changes. Another challenging aspect brought out by an interviewee, is the way customers fit into new product development process. The department has no direct connection to customers and end users nor a way to incorporate them into the development process. Another interviewee pointed out that it results in missing direct feedback and having poor understanding about what is happening on customers' sites. In addition, it was brought out that customers are not always able to give feedback that could result in something innovative and tend to give negative feedback on products that they do not understand. Thus, according to an interviewee, it is necessary, that SP&A conducts thorough business studies to promising ideas inside the department and acknowledges that customers might understand radical ideas.

Workshop 1 revealed a diverse set of innovation challenges (see Table 8) that have been encountered by SP&A employees, while carrying out different new product development projects. The challenges that were pointed out covered different phases and aspects of the development process from idea generation to product launch. The challenges in Table 8 have been categorized under eight topics: development process, resources, organizations and teams, customer focus, management, practices and tools, projects and products as well as other. The category development process concerns with the issues about product development process, which is found to be unsuitable to innovation due to too long development cycles, slowness, rigidity and too early information demand. In addition, current process is criticized, because it does not provide sufficient structural support and does not contain any iterative development loops of build-test-rebuild. All that is problematic, because the development process is the backbone of the whole development work. The category resources include all issues connected to monetary, time and human resources, out of which lack of time, absence of allocated budget and deficiency of right competences were highlighted by participants. The category organization and teams concerned with diversity of team setup, responsibilities, relationships within and outside teams. It was also brought up that it is complicated to find a right place in the current organization to radically new ideas that require cross-functional team, which in the long run can have severe negative impact to innovation capability of the organization. The category customer focus consolidates issues about knowing who are the customers of developed products, collecting, analyzing and using voice of the customer in ideation and development. The category management deals with diverse set of problems starting from getting management acceptance to the projects, management prioritization and analysis, measurement of success and ends with lack of knowledge and resource management. Furthermore, under the category arose an interesting issue, which said that one is expected to innovate, but when one is doing that, then management expects just sticking with and deliver according to status quo. The category practices and tools draws together issues with existing practices and tools and points out missing ones. For example, attention is drawn to absence of visualization, which is connected to problems with tests that also work as boundary objects for explaining product idea and functions to other parties. Moreover, lack of tools that boost creativity has been emphasized and one of such tools, team workshops, are mentioned to be missing. The category projects and products includes negative experiences with cancellation and changing content of the project in the middle of product development process as well as finding out that a competitor has already launched a similar product. In turn, inability to change with changes in the situation that leads back to above mentioned rigidity of the process. The last category other contains a set of various discrete issues like lack of rewarding for well performed job, problems with finding inspiration, feeling left alone in the process and poor communication of product ideas.

Furthermore, criticality of some of the challenges came out when both teams in workshop 1 used a possibility to copy 3-4 problems that the other team had put up and add them to their own. Thus, the problems were chosen based on discussion with the other team and consensus inside own team, which emphasizes the acknowledgement of severity of the problems to all the participants. These highlighted challenges were absence of iterative development loops of build-test-rebuild, slow and rigid development process that hinders innovation, lack of teamwork, lack of cross-functionality and diversity in team setup, not connecting the product to the actual user, missing management prioritization and analysis, missing visualization and piloting and increased/changed content during the development. To provide some examples, one participant brought out that failing to connect the product to the actual user has multiple times resulted in failing to understand why the product is developed at all, which in turn has diminished engineers' motivation to do a good work. Another example provided by a participant explained the losses due to the absence of iterative development loops of build-test-rebuild. The participant pointed out that currently, without such process the ideas entering to the development process are unrefined.

Table 8. Categorized innovation challenges revealed in workshop 1

Development process	Resources	Organization and teams	Customer focus	Management	Practices and tools	Projects and products	Other
-Current organizational setup does not allow to use iterative design → test → rebuild loops -Gate process requires too much information too early in the process -Lack of supporting structure to ensure understanding, progress and quality of the work -Slow and rigid process hinders innovation -Development cycles are too long	-Lack of time, low priority and engagement -Compromising due to time -It is hard to get funding, because there is no specific budget for it -Lack of time makes it impossible to make a good work -Not finding right resources/ competences are the risk for the project	-Lack of taking responsibility for diffused issues -There are no unified teams, instead people are split into silos -Lack of teamwork -Team setup is not cross-functional or diverse enough -Team members are not creative -Blaming other departments -Different departments have different agendas -It is difficult to find place in the organization for radical cross-functional ideas	-Not connecting the product to the actual user -Missing clear customer need analysis -Ideas must be connected to customer value	-Get ambassadors acceptance to the project -Low experience and understanding of how to drive/ lead innovation operations -Missing management prioritization and analysis -Lack of knowledge management, knowledge gained is not properly maintained -Ineffective resource management and prioritization -How the success of the project is measured -One is "asked to innovate", but restricted to deliver the status quo	-Test failures -Testing is not a focus, because it needs time, reports, booking cars, etc.) -Missing visualization and piloting -Missing tools to help up the creativity -Team workshops are missing to improve ideas	-Product cost is too high -Increased/ changed content during development -Project is cancelled -Struggling to understand the purpose of the product - Finding out that a competitor has already launched similar product	-Not being awarded a patent -Finding inspiration -Development work is lonely - Poor communication of the idea

4.3 *Ideas for developing and improving the innovation process*

In the beginning of workshop 2, three HMW questions were used for ideating solutions towards having early shared understanding, always being customer focused, and creating a learning cycle (for complete questions see Table 3). Solutions were generated from both teams. Figure 18 shows one example of clustered solutions from Team B and Table 9 lists all the solutions answering to one or more HMW questions.

Figure 18. Team B clustered groups for solution to HMW questions

To conclude, the project should start with a very clear objective, clear content, defined user and user case. A kickoff meeting should be hosted at the beginning of the project. The objective, content, designated user and user case should be spread and communicated among the cross functional team during the kickoff meeting, so to bring shared understanding early. In order to ensure that the project is always customer focused along the process, real customers should be involved in the innovation process and market trends should be analyzed for understanding real customer needs. The market trends should also be communicated for early shared understanding. Additionally, it is believed that learning cycle is formed when learnings are documented during the project and reviewed for upcoming related new projects. Therefore, a sharing and learning basis database is needed to create and store and these documents.

Table 9. Solutions drawn for HMW questions in workshop 2

Team	Shortened Questions	Corresponding Solutions
A	Q1: HMW bring shared understanding early?	Projects should start with clear defined objective, content, user and user case
	Q1: HMW bring shared understanding early?	To have a kick off meeting to align the team for the new project
	Q3: HMW create learning cycles?	Include in the process to enable learning for the new project from previous projects or studies, provide incentives to people working with innovative projects
B	Q2: HMW be customer focused in the innovation process?	Agile working process where real customers are involved in the innovation process
	Q1 and Q2: HMW bring shared understanding early and be customer focused in the innovation process?	Use all available methods/reports to analyze market trends even outside of the automotive industry—translate trends into actual customer need. The research should be presented when every program/project starts.
	Q3: HMW create learning cycles?	Knowledge sharing database plus lessons learned reports

The process proposed by Team A (Figure 19) at the end of workshop 2 contains two major ideas corresponding to HMW question 1 and 3. First, R&D engineers of the department give inputs before and after an early study which initiating a program. Second, an integral learning mechanism is installed in the process by the proposed Volvopedia. Worth to notice that customer focus is also reflected in the early study phase where user/customer, purpose and user case should be very clear and focus groups is one way of early study.

Team B was solving issues regarding customer focus and learning cycle for HMW questions 2 and 3. The graph started with an intensive study including consultancy company reports, trend reports, technology trends, culture impact, etc. The prominent cycle from idea development to create concept & prototype to real customer test distinguishes an iterative learning process (Figure 20). The process prototype built by Team B also illustrates early R&D engineer involvement at the idea development phase.

Comparing the two proposals, similarities and differentiations are interesting to investigate. All the three major needs from the HMW questions were comprehensively considered and designed in their processes, even though each group was focusing on two of the three questions to solve. This indicates that all the three needs are concerning both Team A and Team B. Team A integrates the mechanism such as early involvement of R&D and learning cycle in VPDS for cars, while Team B built a process that was separated but able to link with VPDS. This implies that the need of the process to be flex enough to freely decouple or connect with other processes.

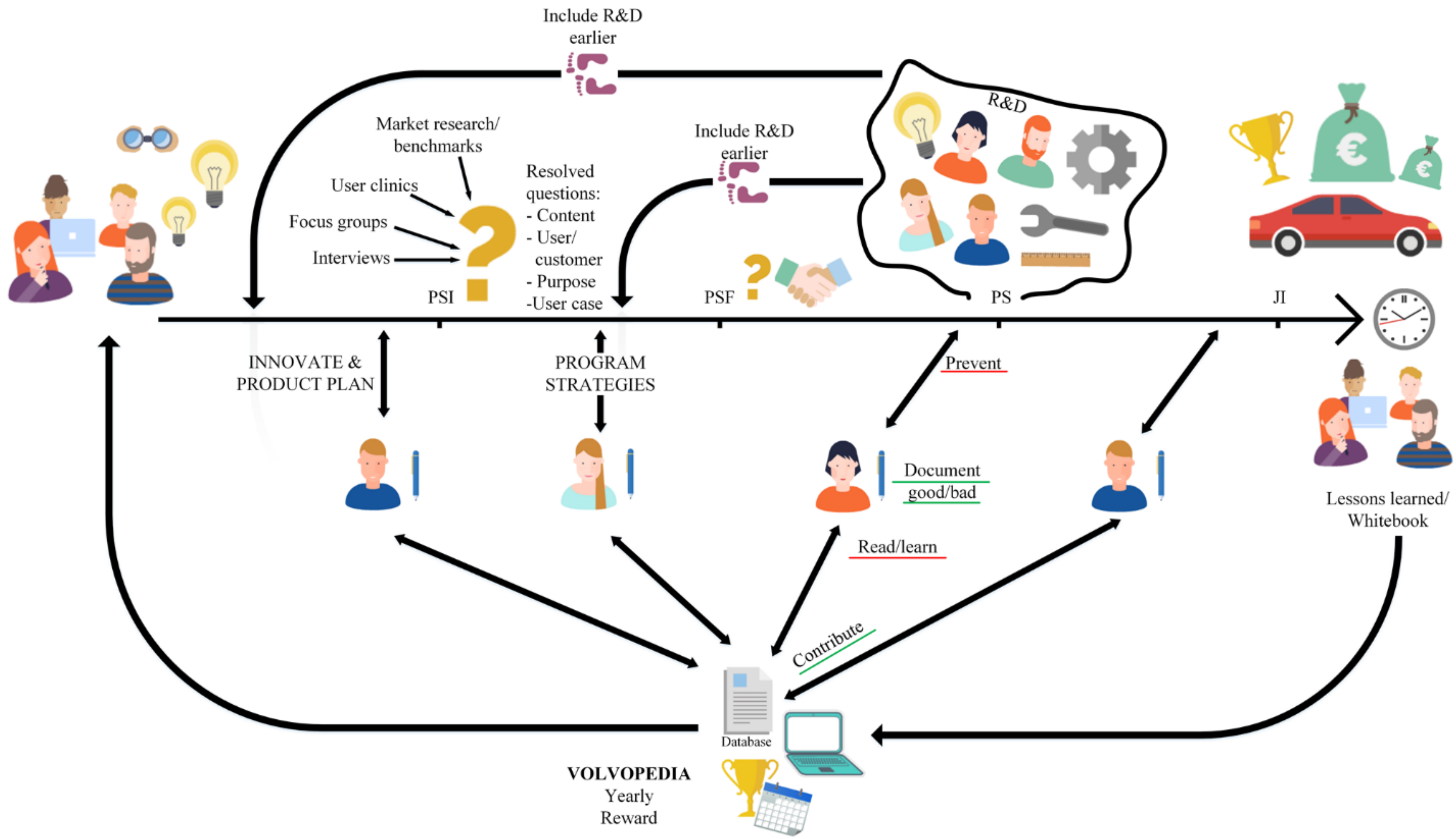

Figure 19. Team A proposed process in workshop 2

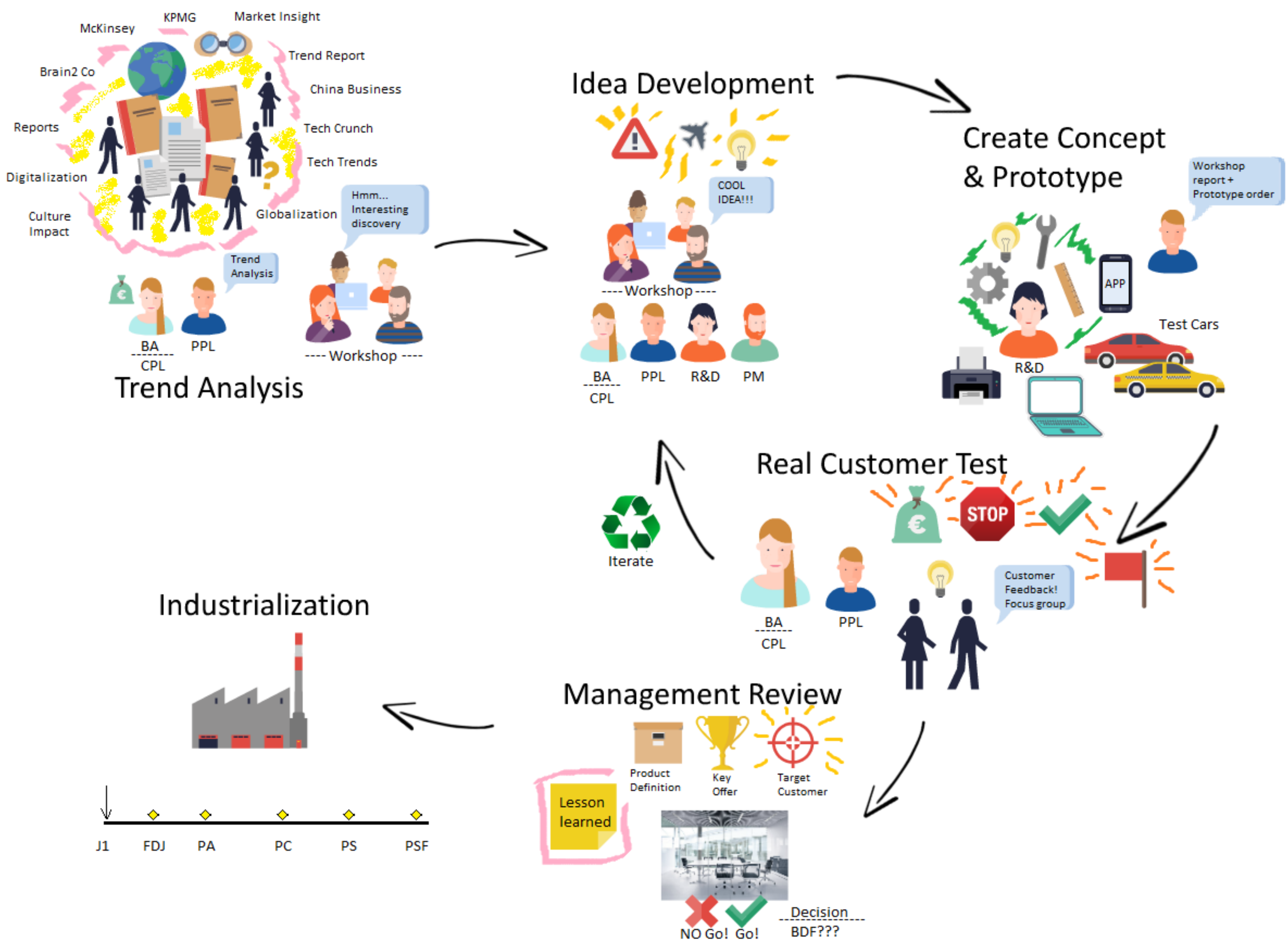

Figure 20. Team B proposed process in workshop 2

4.4 The new innovation process

A complete innovation process (see Figure 21) was developed upon the drafts and the takeaways from the workshops. The process was built with the learning from the three frameworks: design thinking, stage-gate and agile under the SP&A department environment to grow ideas. For either special products or accessories, the ideas need to be grown mature enough as a finalized concept before inserting into VPDS.

While identifying a starting point of the innovation process, characterization of all inputs to the process was the first consideration. The first phase of the process is idea prioritization (see Table 10). Inputs are categorized into annual activities and business analysis inspired from interview and workshop 2 results. They are ideas from activities conducted with both internal and external sources as well as analysis of competitors and market trends. A system, which play the key role to select ideas, is needed to interrelate ideas and provide sufficient analysis. An idea bank is proposed to absorb large amount of information throughout a year. The idea bank continuously supplies ideas into the innovation process. It not only acts as an idea storage space but also as a preliminary processor for ideas.

Annual activities include having product planning leaders participate in automotive shows and technology shows. It is a chance for getting inspired with new ideas presented in the shows. VCG also collect feedback from different market segments and suppliers. The department host product days with sales where customer feedback is received. Commercial product leader make analysis upon companies in a regular basis. If ideas generated from annual activities are seeds, business analysis provides water for the ideas to survive. Business analysis, for example on feature of competitors, external market trends report and special editions report, is critical for later selecting ideas. On the other hand, data out of business analysis can effectively support those ideas aligning with business strategies and vision of the department. Besides analyzing competitor action and consultancy reports, tools like Kano model[2], House of Quality[3] can be used for identifying customer attributes. Other ways are leading workshops with end users to study voice of customer or using sales company summit to collect more direct customer feedback. In the system, product planning leaders and business analyst will have individual accounts to carry out screening and ranking steps.

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[2] Kano model is a theory that classifies customer preferences into must-be quality, one dimensional quality and attractive quality. They can be presented in a two-dimensional coordinate. This model is widely used in product development or identify attributes of customer demands.

[3] House of quality is the first house in Quality Function Deployment which is applied when transforming voice of customer into product engineering characteristics. House of quality firstly identify customer desires and correlates to engineering characteristics, then it is weighted in order to prioritize system requirements.

In Table 10, the first two rows represent the annual activities and the following two rows represent seasonally incidents. Therefore, the color code of light orange indicates the frequency which is annually, while the light blue color indicates that the screening and ranking happens seasonally.

The step screening is to find interlinks between ideas. Meanwhile, ideas are screened to match with strategy, vision and mission, market trends and voice of customer. It is done through combining ideas by product planning leader to form groups of ideas which can be shared to business analysts. Then, business analysts provide supporting evidences of how well the group of ideas are aligning with strategy, vision and mission, market trends and voice of customer. Ranking is the step when ideas or groups of ideas are prioritized according to urgency and importance. Eisenhower's Urgent/Important Matrix[4] is a tool to use at this point. Urgency contains considerations of top management demand and car program demand, while importance contains, for instance, strategic alignment, customer focus, innovation level, economy of development, technology feasibility, etc.

A gate is placed after ranking to determine if certain ideas should be developed into a project. It is the end point of the idea prioritization phase and the starting point of a new phase called incubation (see Table 11). The grey colored rows are steps to go through per project, while all gates are colored in green. Decisions at this gate are made together with the presence of the director of product planning and management, after product planning leaders and the business analysts presenting the list and discussing the cycle plan of the department in a meeting. The first gate is also the point where system responsible from the R&D side of the organization should start to get involved. Instead of passively accepting and distributing tasks in R&D, engineers should be able to participate in decision making and express engineering side of opinion upon Go or Not Go of a project. In the meeting, cycle plan is reviewed to foresee if a new project would influence any of other projects in the cycle plan. Cycle plan gives a holistic view about product portfolio of the year. If an idea is rejected, it will remain in the idea bank for future references. Those ideas that are not selected to continue as a project at the moment would stay in the system and product planning leader can choose level of visibility of their grouped ideas to others in the department for sharing and learning purpose.

The following step is concept definition which is to redefine the problem to ensure that the problem is the right one to solve. This step imitates the define phase in design thinking to continue keeping customer in center and focusing on the need and point of innovation just like defining user, needs, and insights while generating HMW questions. A workshop using design thinking approach as the process did by the researchers between workshop 1 and 2 is the suggesting way to clearly define the problem. The workshop should involve product planning leader, business analyst and system responsible. User of the final product or service can also be invited to the workshop.

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[4] Eisenhower's Urgent/Important Matrix has the principle to identify tasks into 1) important and urgent; 2) important but NOT urgent; 3) NOT important but urgent; 4) not important and not urgent. The tasks should be dealt with the declining priority from 1 to 4.

Table 10. Idea Prioritization Phase Description

Steps	Objective	Input	Action	Enabler	Participants (Responsible in Bold)	Output
Annual Activities	Enriching idea bank with inspired ideas that are aligned with strategy and customer needs	Strategy and Vision; Voice of Customer	● Participate in auto and tech shows ● Closer connection with supplier and customer ● Maximize the use of both internal and external resources ● Join networks (e.g. innovation network forum)	● To have a pilot system which is handy, NOT complicated to manipulate ● product planning leaders have personal authorization and account to edit towards their focus (luxury, limited offer, commercial, accessories)	**Product Planning Leader; Commercial Product Leader**	● SP&A idea bank with individual account for product planning leaders ● Ideas inspired from annual events ● Understanding of up-to-date market trends and customer needs
Business Analysis	Fully considering market trends and competitors movement in the early phases	Market Trend Report; Special Edition Report; Competitors Analysis	● Use analysis tools: Kano, House of Quality to identify customer attributes ● Use sales company summit to get more structured direct customer feedback	● These should also be able to put into the same system ● Get connect with academic institutes for up-to-date study outcomes	**Business Analyst**	
Screening	Ideas in the system are screened and found with interlinks	Strategy and Vision; Voice of Customer; Market Trends; Ideas in the system	● Regularly meet with Business Analysts to match up needs/trends with interesting ideas found in system ● Answer to the question "Is there common issue behind a series of ideas?" and such ideas are grouped	● The system can filter, extract, combine, decouple relevant ideas ● Should be able to use the individual account to link ideas	**Product Planning Leader;** Business Analyst	● Valuable data found with strong customer focus ● Sorted information in the idea bank ● Grouped ideas
Ranking	To prioritize and rank ideas in the account	Grouped ideas; Understanding of up-to-date market trends and customer needs	● Rate to prioritize with criteria like: Strategic alignment, customer focus, innovation level, economy, top management demand, technology feasibility, as well as in terms of urgent/important ● Tools: Pugh, Eisenhower's Urgent/Important Matrix	● An established criterion, could refer to the one used for Corporate Innovation Office	**Product Planning Leader**	● Ranked ideas

Once having a redefined problem, the major period of incubation starts. Incubation is initiated with preparing all resources for the incubation phase, making sure that all resources are available or capable to be allocated. First, it needs a cross functional team for the incubation and it is a merit if all team members are self-motivated with the project. Second, it is essential to free-up time for people in the team of incubation. After all, a request form is filled for officially launch the incubation. A gate following preparation is called Incubation Kickoff (IKO). It determines if the redefined problem has a clear scope and if the concept has definite user and descriptive user case. The following steps named develop, visualization and user test are generally dependent on people, money and time resources, imitating the second divergent and convergent part of design thinking.

When all resources are ready, the step of develop in incubation starts. The purpose to have an incubation is to “fail fast and fail often” before the intensive technological development in advance engineering. The step consists of ideating solutions, generating time/cost/quality/resources breakdowns of these solutions, and researching the applicability of available technologies. Cross functional cooperation for the ultimate goal in this develop step is to make a prototype that sounds. Afterwards, visualization is the next step to primarily communicate the concept for easily reaching a mutual understanding in the team and the department before fully developing a product concept. It composes of presentation of user case and prototype. Unlike prototype in advance engineering and new product development, the purpose for prototyping. Therefore, the output is usually one or more rapid prototypes for illustrating the appearance and major features. Small scale of iteration might be involved after testing the prototype in order to achieve a finalized incubation concept. With prototypes for people to touch and feel, user test is necessary for early identification of problems in concept. The learning from the incubation is extremely important to continue to advance concept development. Therefore, the learning in incubation includes the found gaps in knowledge, technology or other areas.

The incubation concept is finalized when rapid prototypes are tested to meet the user requirements and they reveal a good match with the user case. Advantages and disadvantages of each prototypes are also analyzed. All the test description and results are ready for entering the Gate Incubation Concept Finalized (ICF). At this gate, decision is made to specify which sub-process to develop advanced concept. There are five possible decisions at this gate (see Table 12). If the technology gap is obvious, the sub-process to proceed is advance engineering. If the technology already existed in market or had been developed or studied previously in other projects to the extend for direct application, the sub-process advanced concept development is chosen. It is important to address that these two sub-processes can apply simultaneously meaning that if part of the technology just need to be integrated and partial needs to be developed, two sub-process are used in parallel. If the concept can be adopted directly by the generic car program to VPDS, the following phase of advanced development is skipped.

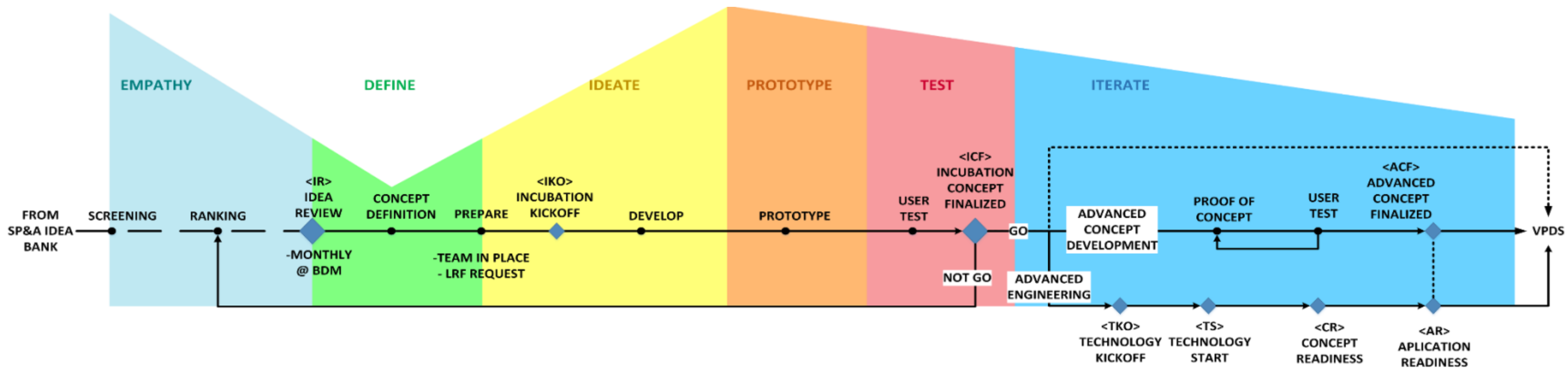

Figure 21. The final version of the new innovation process

Table 11. The Incubation Phase Description

Steps	Objective	Input	Action	Enabler	Participants (Responsible in Bold)	Output
Gate: Idea Review (IR)	Determine if certain items should become a project	Ranked ideas; Cycle plan; Strategy and Vision; Voice of Customer; Market Trends	● Determine which of them can continue developing into projects through a meeting ● Determine whether the ideas are still aligned with strategy and vision or customer focused ● Discuss cycle plan upon any changes to have a holistic view of product portfolio	● A rank of ideas supported with analyzed data ● Present the rank list in a meeting ● Start to involve engineering side of the department for opinions ● Not selected ones stay in the system	**Director of Product Planning and Management;** Product Planning; Business Analyst; System Responsible	● Ideas passed the gate become individual projects
Concept Definition	Define or redefine problem to have the right problems to solve	The selected idea	● Have a brainstorming session for the idea following with a workshop to find needs, user and insights ● Go through the process of defining problem using tool of POV ● Transform POV into HMW questions	● Workshop using design thinking approach which should be similar to the design in WS1 and after WS1	**Product Planning** System Responsible Business Analyst	● Defined objective and scope of the project ● Target user ● Clear user case

Table 11. Incubation Phase Description (Continues)

Steps	Objective	Input	Action	Enabler	Participants (Responsible in Bold)	Output
Prepare	Prepare the growth of the idea in terms of resources allocation for incubation	Defined project	● To have a team for incubation on-board ● Time/quality/resource breakdown ● Cost estimation of incubation	● Filling in LRF which is the checklist document for kickoff	**Product Planning Leader;** System Responsible; Business Analyst	● Team formed ● Breakdowns ● Cost estimation
Gate: Incubation Kickoff (IKO)	Official launch of the project and get every team member clear with tasks	A business case with defined problem(s) to solve	● Determine if all recourses are in place ● Tasks for incubation agreed ● Incubation time agreed ● Budget in place	● A meeting	**Product Planning Leader;** System Responsible; Business Analyst	● Team ready ● Free-up time for dedication during incubation
Develop	To fail fast and fail often; Research upon technology to realize the concept;	Project Objective; Target User; Clear User Case	● Conduct a workshop to ideate solutions and come up with ideas for prototyping ● Technology compatibility/integration study	● Using design thinking approach of ideation phase which is similar to WS2	**Product Planning Leader;** System Responsible; Business Analyst	● A ready concept for prototyping ● Applicable technologies identified
Visualization	Make prototypes that users can touch and feel	A ready concept for prototyping	● Present concept and point of sale ● Make rapid prototypes	● Cooperation with other departments, universities, science park for rapid prototyping	**Product Planning Leader;** System Responsible; Business Analyst	● Rapid prototype
User Test	Test with user and find improvement points	Prototypes	● Test prototype with user and make test analysis ● Document test description and results ● Select the best solution	● Facilities for carry out the tests	**Product Planning Leader;** System Responsible; Business Analyst	● Test results ● The gaps to industrialized product
Gate: Incubation Concept Finalized (ICF)	Determine which sub-process to go forward with and what are the gaps till industrialization	Rapid Prototype(s); Test results; Gaps till industrialization	● To decide upon different situations: 1) Advanced Concept Development 2) Advance Engineering 3) Directly insert into VPDS (rarely happens) 4) Not Go (also rarely at this point) Note: 1) and 2) are not exclusive to each other	● A meeting	**Director of Product Planning and Management;** Product Planning Leader; Business Analyst; System Responsible	● Decision to continue with sub-process ● Plan for the upcoming advanced development phase

One exception is to drop the project when sever deviation of test results from user needs, or the user case is no longer valid due to rapid change of the market, or it is believed that the product will be introduced to the market at a wrong time according to the current plan. However, all the documents should be preserved in the system for learning purpose of later review.

Table 12. Possible decisions at Gate ICF

1) If technology is existed in market, go to Advanced Concept Development (ACD)
2) If there is tech gap, go to AE
3) If both gaps described above exist, go for ACD and AE in parallel
4) If the concept is ready to directly insert into VPDS, the following phase could be skipped (very rarely happens)
5) If business model is no longer applicable, e.g. trend change, choose Not Go and the idea gets back to rank list with notation

As for tasks applying the advanced concept development, two steps before Gate Advanced Concept Finalized (ACF) are proof of concept and user test. Proof of concept is not simply an extended step of prototyping from incubation phase making continuous improvement. Instead, in advanced concept development, proof of concept needs to solve problem regarding integration and the prototype here must reveal all the features to demonstrate functionality. The user test is the real opportunities for obtaining customer inputs (Veryzer, 1998). Therefore, a user test is necessary to retain customer focus in the solution. Gate ACF decides if the test results show sufficient evidences for industrialization and insert into VPDS. This gate is comparable to the function of Gate AR in AE.

In general, the innovation process is composed of annual, periodical and project-wise activities. Annual events outputs combining with business analysis are the inputs to SP&A idea bank in which individual accounts can be created for processing ideas in the system. In the idea bank, ideas are grouped, selected and prioritized to be ready to insert into the first gate. After the first gate, the activities are periodical for concept consolidation and problem redefinition. Here, the product portfolio is still possible to be controlled with a holistic overview. After the right problem is clearly defined, the second gate leads to a major sub-process of incubation where the concept is developed with a small amount of money while the potential of the concept can be fully explored. Passing through the Gate ICF, three pathways differentiate the non-technical development which extends the incubation process from the technical development which deploys the existed advance engineering process, and it gives the possibility to lay aside or drop the project. The end of the innovation process is the end of product planning. Thus, there is a conjunction between the innovation process with the new product development process VPDS. After that, the completely developed concept can be injected into VPDS.

In order to be specifically viable for VCG to implement the process, certain parts of the innovation process were improved with colleagues from the SP&A department after the third workshop. The improvements after the third workshop are 1) modification of abbreviations, 2) having more refined steps after Gate IKO, and 3) better demonstration in advanced development phase (see Appendix 5 and Figure 21). As for the abbreviation, the modification was made because that certain rules needs to be followed for documentation in VCG. Therefore, abbreviation modification will not be elaborated in the text.

Incubation is expanded for clearer explanation on objectives and actions of steps. Originally, the incubation phase is only composed of two gates and two steps in between. Because the sub-process is the critical portion which determines the success of concept development in the entire innovation process. It was suggested to have finer breakdown in this sub-process and clearer description. Three steps visualization, prototype and user test are added into the sub-process as routine steps. The concept is presented to the management team with verbal and illustrations in visualization step while physical prototype should be used for the step prototype. A user test should be conducted for detecting major system conflicts and integration issues.

The third phase *advanced development* was improved for better demonstration. The former way of drawing after Gate ICF was advance engineering as the main stream at middle while the advance concept development as the alternative (see Figure 21). However, it is equivalently likely to enter either of the process after the Gate ICF, therefore the illustration is improved that these two processes are two equivalent tributary streams derived from the main stream.

5 DISCUSSION

The aim of this thesis was to develop, test and refine an innovation process for automotive industry in a way that combines effectiveness and innovativeness. This was done by answering three research questions which will be discussed here in light of academic literature.

First research question asked, what is the current state of the innovation process at SP&A in VCG? Early stages of the thesis research revealed that there was no official innovation process in SP&A department. Although, Lawson and Samson (2001), draw attention to the importance of creating optimal holistic business structure and innovation process to nurture innovation in the organization. Instead the department used AE studies for all the research and development activities from idea generation to product launch. It was done even though the definition of AE studies limits its use to technological solutions development. The imperfect fit of AE to the needs of SP&A department, forced them to give more effort to front-end parts of NPD and therefore develop own idea evaluation and idea generation process drafts.

The AE studies that are conducted used Global Technology Development System, which have no resemblance to design thinking or agile methodologies. Thus, the possible positive outcomes provided by the methodologies (like flexibility, creativity, fast and rapid change even in later phases of product development, thorough front-end work, etc.) are missed out. Even so, GTDS is a stage-gate model, not the exact copy of Cooper's (2014) stage-gate model, but adapted version of it. Thus, the names and content of stages and gates are defined by the organization and the resemblance to the Cooper's (2014) model is the logic of having various working stages and decision-making gates for the process. On a contrary to most recent stage-gate model (Cooper, 2014), the GTDS is not scalable to fit the needs of different innovation novelty levels (incremental, radical). Therefore, all the ideas and concepts go through the same stages and gates, despite the needs of them. The whole process of AE studies is highly standardized and document dependent, which makes is simple to communicate to employees and evaluate for managers. Though, it often takes more time to conduct an AE study than the organization believes is acceptable in rapidly changing world. Therefore, getting an evaluation of new idea takes considerable amount of resources (worktime, money, etc.) and often delivers unsatisfying results. It does not mean that making decisions to pause or kill the project is unsatisfying. Though, it is preferable to reach into such conclusions as quickly as possible to use least amount of resources and maximize learnings. GTDS process allows pausing and termination of projects in every gate, which is common property and success factor of stage-gate (Cooper, 2008), but according to interviewees, fails to do it quickly. Furthermore, when it comes to capturing and managing learnings from the AE studies, the process itself gives no attention or guidelines for sustainably doing it.

Second research question asked, what are the challenges in the innovation process at SP&A in VCG? The list of challenges that were revealed in interviews and workshop 1 is extensive. Unsurprisingly most of the identified challenges are also discussed in literature about innovation barriers. Two out of four key reasons of product innovation management problems (Cormican and O'Sullivan, 2004): lack of customer focus and poor communication and knowledge transfer, repeatedly pointed out in interviews by interviewees and participants in workshops one and two. Other two reasons, lack of shared understanding and poor portfolio management were informally discussed in the organization, but not brought out in interviews or workshops. Furthermore, four out of five Assink's (2006) innovation barriers were identified in SP&A department. The adoption barrier was represented with organizational dualism, where stable and successful business models with fine-tuned effective processes have proven to be unsuitable ground for radical innovation. It is exemplified by highly standardized AE, GTDS and VPDS processes. The barrier includes also excessive bureaucracy, which according to the first workshop hinders innovation by requiring too much information in too early development stages. The mindset barrier appeared in lack of distinctive competencies, which were noted in workshop 1 as missing the knowledge of visualization, testing, prioritization and creativity. The risk barrier occurs in the department as the need to create revenue (at least from accessories side), which makes it difficult to acquire management's acceptance for ideas and projects. In addition, employees admitted in workshop 1 that one major risk is inability to find right resources and/or competences to the project. According to Assink (2006), it is a common problem, because it is impossible to predict the knowledge needed for work in novel areas due to the high uncertainty that accompanies radical innovation. The nascent barrier is present due to sub-optimal innovation process management, which is exemplified by expressed concern over low experience and understanding of how to lead innovation processes. Another sever cause of nascent barrier, lack of creativity, was also pointed out in workshop 1, where a participant said that team members lack creativity. One more issue under that category is lack of market sensing and foresight, which according to an interviewee is that the management of SP&A lacks ability to foresee market changes. Moreover, some of the inhibitors of sustainable innovation (Braganza *et al.*, 2009), were also apparent in SP&A. For example, first and second categories, pursuit of stability and risk avoidance both have been already covered by Assink's (2006) barriers. Though, inhibitor constrained by experience and lack of options, occur in using same set of moderately diverse teams for AE studies, who based on an interviewee's example, are not able to develop solutions based on android, even if the organization suddenly sees great potential in it. Furthermore, some of the innovation inhibitors discussed in literature were not confirmed to be present at SP&A. These were Assink's (2006) infrastructure barrier and Braganza *et al.*'s (2009) inhibitors: legacy systems, complex power structures and myopic managers. Some of these were again informally discussed in the organization, but none of them where given great importance.

In addition to merely defining innovation barriers, researchers have also researched the ways of nurturing organizations' innovation capabilities. Related to innovation challenges, this thesis research revealed, which of innovation capability enablers were not fulfilled in SP&A. O'Connor (2008) proposes seven element management system to nurture radical innovation. According to workshop 1, more than half of them were not fulfilled at SP&A and thus seen as innovation inhibitors. The author suggests the need of an identifiable organization structure, which can be counted missing due to the pointed-out difficulties in finding the right place in the organization for the radical cross-functional ideas. Furthermore, the lack of innovation enablers internal and external interface mechanisms and an appropriate culture context, is considered to be missing due to numerous complaints: lack of taking responsibility for diffused issues, poor teamwork, presence of silo organization and lack of cross-functionality, different departments having different agendas and blaming other departments. Another, innovation enabler proposed by O'Connor (2008), is exploratory processes, which is missed due to lack of supporting structure to ensure understanding, progress and quality of the work. The author also points out the need of appropriate metrics to support performance and decision making, though in SP&A it came out that employees are not satisfied with the way success is measured, finding current way ambiguous. Moreover, some innovation capability support aspects (Lawson and Samson, 2001) were also absent in SP&A. First, the aspect vision and strategy, was found to be lacking due to the struggles of employees to sometimes understand the purpose of the developed product. Second, harnessing the competence base, was found missing, because of ineffective resource management and prioritization and difficulties in finding seed funding for discovering novel ideas. Third, the aspect structures and systems, is missing, because SP&A has no reward system, which does not need to be monetary, but could also be in a form of patent. Lastly, the aspect culture and climate, suggests providing creative time to employees. Though, employees at SP&A pointed out lack of time and difficulties in finding inspiration, which could be cured by little dedicated time to creativity. Furthermore, two of the problems pointed out in the workshop 1 found no appropriate place in previous categories and thus are brought out separately. First problem was that current organizational setup does not allow to use iterative design-test-rebuild loops, which would allow more agile and faster development work. Second concern was that employees are asked to innovate, but when they do so, they find to be restricted to deliver the status quo, which is diminishing creativity and motivation among employees.

Third research question asked, what does an effective and innovative innovation process look like in automotive industry? In SP&A at Volvo, the product planning for concept development is directly connected with the process of AE. Once a concept is defined, the project is passed to R&D of the department to study technology aspects in order to develop the product. For all projects, AE was universally adopted for solving all issues before industrialization. Many other aspects had been neglected. The time span for carrying out a complete AE project ranges up to years according to interviews to employees in the department, while the Special Products and Accessories (2016) indicated the time for an AE project should be 8 to 12 weeks. The process was rigid and very ineffective.

The process was seldom cross-functional, especially in the early phases before AE starts. In this case, engineers have very limited communication with product planning before rush into AE. Therefore, the output of the AE might be undesired results in the product planning perspective, although the tasks are clearly divided depending on the function. In addition, the support engineers can receive from other parts of the group is limited because the department was trapped in the dilemma between being more dependent or independent. Decoupling from the group brings more flexibility to the department in self-controlling the time and resources. The department can be very independent in product development and take initiative on what to develop. On the other hand, the department can obtain more support and resources while being collaborative and dependent on other sectors of the group. Therefore, employees were anticipating a process that can give a balance between dependence and independence to the department.

The new process is composed of three phases: idea prioritization, incubation, and advanced development. Incubation occupies relatively longer time span comparing to advanced development. Advanced development is compacted due to the emphasis shift towards the earlier phase- incubation. Thus, the workload of product planning leaders is distributed along the process. The workload of engineers is moved towards the front, leaving higher flexibility in the end of the innovation process. As a result, the process becomes much more agile due to the cross functional way of working created and flexibility induced. Besides, the initial investment for the project in incubation would be lower than directly entering AE. The smaller amount of cost in the early two phases of innovation process allow the project to fail early before greater investment. The five options after incubation also ensures that there is always a suitable sub-track of the process to continue develop concept. AE is no longer the universal process to deal with all gaps found after incubation. The new process provides engineers to get involved in the project early from the beginning of the incubation at Gate Idea Review (IR). Engineers can therefore contribute their profession on technical aspect from the very beginning. The early involvement would also encourage the engineers to dedicate in their interested projects.

The process, having agile as the philosophy to effectively deliver, uses Stage-gates as the backbone to control and manage on-time deliverables. Meanwhile, it applies design thinking, the human centered method as the framework of the process for keeping innovativeness in the deliverables. The first two phases idea prioritization and Incubation together represent a complete process of design thinking. The project owns high ambiguity in these two phases. The reason to deploy design thinking as the framework is that it can handle ambiguity in the project and uncertainty feeling in the team very well in the early phases and guide directions to continue the process. The advanced development is an iteration of prototyping and which gives a conjunction point to other processes such as VPDS. The conjunction point is the readiness of the concept for industrialization.

The implementation of a process in design thinking framework needs to rely on the four principles (Meinel et al., 2011) of having human centered activities, preserving ambiguity, allowing re-design, and making ideas tangible stated in section 2.1.1. Human centered activities are heavily contained in the first phase of the innovation process, and ambiguity is preserved for the first two phases. Re-design happens both at visualization and proof of concept in which prototypes are developed. Since both steps are followed with a user test step, there is a need to iterate and continuously improve in between. Tangibility is reflected in presenting the concept and prototyping in visualization as well as re-prototyping in proof of concept.

6 METHOD DISCUSSION

Like all research methods, single case study that has been employed in this research, has also its own limitations. Main criticism that single case study research design has received is that it does not provide adequate basis for statistical generalization of research results (Yin, 2009). In turn, Flyvbjerg (2006) argues that it is possible to generalize based on one case study. The author adds, that ability to generalize depends on the case that is discussed and the method used for choosing it. Furthermore, Gummesson (2007 p 230) approaches generalizability topic from a different angle and asks instead: *"Is it not better to understand a phenomenon in depth than to know how often the not understood phenomenon occurs?"*. In this master's thesis research, the focus was on creating understanding and learning about innovation processes in a certain context instead of trying to generalize results to other industries or contexts and thus the authors view of creating relevant and true knowledge coincides Gummersson's (2007) view.

Qualitative workshops were the main research method in this thesis research. The workshops were designed and conducted in collaborative co-creation fashion to gain insights from the group of people that would later use the innovation process developed based on the gathered data. The workshops enabled to gather different stakeholders of the new innovation process into the same room and commonly discuss the same questions, which was convenient for the participants due to the creative and playful design (warm-up games, gluing pictures and drawing, etc.) of the workshop. In turn, having series of workshops with almost the same participants, allowed the researchers to dig a lot deeper into collective understanding than observations, interviews and documents would have allowed. Though, without creating initial understanding of the situation in the organization by conducting pre-study consisting of observations, interviews and documents search, the design, conduction and analysis of workshops would have been more complicated and maybe even impossible. Another perk of using workshop as method, was creation of traceable written data such as stickers and process maps, which enabled to later approach and discuss with the authors of the data. One another point worth to address is that all data is in a form which has high degree of visualization. Visualized data facilitates the development of process in a great extent, since the process should be visualized for reaching a mutual understanding among the future users of the process. Lastly, conducting qualitative workshops allowed the authors to test the innovation process they developed. Within a tight timeframe of master's thesis conduction, it is often the case that processes are developed, but not tested and improved. Though, in this case, workshop 3 was dedicated to presentation and feedback acquisition for the newly developed innovation process. Such mental prototyping or pre-run with future users allowed to discover weak parts and refine the process. As seen in the thesis research, there were significant improvement possibilities and using these before real implementation enabled to launch more mature process. Launching process with initial weak parts would have created a lot of confusion as well as loss of belief into the process. Even though such verification is not replacing the real pilot run, it still prepares the process better for real run.

Furthermore, using workshops as research method has its own limitations. Firstly, designing and preparing workshops as well as organizing suitable timeslots (2-3h) for all participants, recording findings and conducting analysis was time consuming and challenging. These issues arose partly due to the large volume of gathered qualitative data and limited availability of research examples on using workshops as research method. Secondly, conduction of workshops allows small number of participants to be involved, which means that the research is built upon more limited data sources than using some other method. In addition, conducting series of workshops with small number of participants leads to close participant- workshop organizer relationship, which could either create more comfortable and open environment or affect participants' responses as well as influence participants by researchers' personal biases. All these delimitations were kept in mind throughout the research process and were opposed as much as possible. For example, due to the time-consuming preparation, design and analysis activities, the researchers had to review initial research timeline and postpone it to have enough time to deliver trustworthy results.

Moreover, despite the limitations, the workshop design enabled to use design thinking in two more ways in this thesis research. The new innovation process has been built up based on design thinking (among to stage-gate and agile) and future users had a possibility to try out and become familiar with the thinking behind the model that has major part in the new innovation process. Thus, the workshops were not only for data collection, but served a major role in starting organizational change, which implementation of new innovation process certainly will be. The reception to using design thinking model in workshops, was generally positive, with some initial hesitations and confusions that were eliminated by continuous discussions about the model.

7 FUTURE RESEARCH

This thesis research has multiple future research possibilities. First, the thesis developed, tested and refined an innovation process for SP&A department in VCG. Thus, the next step would be implementation of the process, which can be a basis of new research. The focus areas could be further evaluation and adaption of the process to the customer needs as well as open innovation. Second, the thesis researched three innovation frameworks: design thinking, agile and design thinking, which all were combined into one innovation process. Though, no literature sources were found that would discuss these three models as a hybrid model. Agile-stage-gate models are discussed by multiple authors (Cooper, 2014; Cooper and Sommer, 2016; Karlström and Runeson, 2006), which implies that other combinations of independent innovation frameworks could be interest for researchers as well. Third, the thesis employed a series of qualitative workshops to gather data, which is not extensively used method. Based on the conclusions, it came out that the employment of the method was successful and thus in the future, the usage of qualitative workshops could be more common. Furthermore, it would be also beneficial to research how qualitative workshops would be best conducted, since available method descriptions for this type of workshops were limited.

8 RECOMMENDATIONS

Since the innovation process has been developed, one or two real project pilot runs are necessary in addition to the test done in workshop 3 to depict all the deliverables of each step and any difficulty in making decisions at each gate. For instance, the sequence of the step *Prepare* and the Gate IKO caused a debate. Whether preparations such as team building and task breakdown should be done before kickoff. There are benefits and drawbacks for placing *Prepare* in front of Gate IKO or the other way around. The best way to draw a conclusion on this sequence is to try both way in the pilot runs and compare. Other unarticulated issues would rise during the pilot run and incremental improvement should be done afterwards. Having the pilot run will take the innovation process one step further towards finalization of the process and implementation in the department.

It is also recommended to utilize both internal and external resources for innovation in SP&A. Earlier-mentioned annual activities, including GIG, case night with Chalmers students, etc., are the main source to enrich the SP&A idea bank. In terms of GIG, employees of the SP&A department can seize the chance to become a problem owner among the collection of problems (GIG 2017 brought up 7 problems corresponding 7 problem owners). The problem owner can raise a specific issue for all employees at VCG to solve. The problems are the core of the later challenges, because all the ideas need to respond to one of the problems. More active participation in GIG can benefit by bringing more relative ideas into the department for the subsequent innovation process. SP&A can also consider maximizing the cooperation with tertiary education institutions which is a win-win for both parties. Besides internal resources, getting involved in external networks (e.g. innovation network forum) is a way for the employees in the department to detect opportunities to get inspired and to make interdisciplinary innovation.

Deploying an idea bank for the department will allow employees of the department to organize data on a common platform and establish a database for learning. As mentioned earlier in section 3.4.1, a proposal of SP&A idea bank presents features of the system in a more intuitive and visualized way (see Appendix 4). Starting with a pilot system which is 1) handy and easy to manipulate with capability to insert, extract, combine, and decouple ideas as well as 2) able to match ideas with analysis reports. As later developed to be more intelligent, the system would become an integral department learning platform, where stores all documented reports of each processed project along the innovation process. The SP&A idea bank also facilitates the preparation of the presentation for product planning leader and business analyst at Gate IR, because the material from both sides are integrated in the system. The system can ensure that each presentation has all the necessary data for Gate IR and avoid submitting incomplete material to Gate IR meeting. Therefore, a SP&A idea bank is recommended in addition to implementation of the innovation process on a project.

In the step of concept definition, workshop is recommended for systematically and efficiently reframing the objective and scope of the project. In a workshop, diversifying the profile of participants helps generating more insights for the product planning leaders to build a concept. It also creates an opportunity for engineers to discuss technical aspects of the concept for the first time in the process, before they are officially involved from Gate IKO. In this case, early shared understanding as one primary need is fulfilled. Furthermore, mutual understanding between product planning and engineering is shifted more in front. This early involvement brings cross functional collaboration and makes agile way of working possible. It will benefit the innovation work profoundly. Throughout the incubation phase, it is equally important to keep agile in collaboration, so that the team can easily adapt to any changes that has occured in the process.

While implementing the process, it is crucial to take advantages of the incubation phase in order to maximize the outputs with lowest costs. Since the investment in incubation phase is small, it is encouraged to try out different solutions. Also, it gives greater allowance to fail and tolerance of failure in incubation. As discussed previously in chapter 5, tangibility is one of principles in implementation of design thinking. Visualizing ideas or concepts is the way to achieve tangibility and it is emphasized in the process. Therefore, in the incubation process, the visualization step is the focus and the target is to make prototypes that can reveal the major features. In advanced concept development, prototypes are improved to reveal all the features in order to get approved after proof of concept and user test.

To other firms in automotive industry, the steps of the innovation process can be modified according to the needs and desires of the firm. Therefore, needs and desires of the firm should be studied and summarized first. However, it is recommended to keep the three major phases of the process which are prioritization of ideas, incubation and advanced concept development along with Gates 1 to 4, because three phases grow ideas and concepts in a different extent. The phases in combination of gates were designed for effectively delivering innovative results. It is necessary to have pilot-runs using the process before implementation for the same reason explained above. In addition, an idea bank or a similar system is needed as an enabler for sustaining the effective innovation work through storing documents of each project carried out with the innovation process.

9 CONCLUSION

The aim of this thesis was to develop, test and refine an innovation process for automotive industry in a way that combines effectiveness and innovativeness. The process covers from preliminary idea generation to advanced concept finalized before industrialization. The thesis had a design of single case study with an abductive approach. The case study was conducted in SP&A department to specifically fit into VCG's operational environment.

The thesis was carried out with the guideline of three research questions: 1) What is the current state of the innovation process at SP&A in VCG? 2) What are the challenges in the innovation process at SP&A in VCG? And 3) What does an effective and innovative innovation process look like in automotive industry? Answering to the questions through interviewing VCG employees, observing meetings and activities, reviewing documents, and conducting workshops, a new innovation process was developed, tested and refined. This new process ranges from idea generation in SP&A idea bank to advanced concept finalization which is much wider than the original AE process. In addition, the process gives an alternative pathway additional to AE for advanced concept development. Overall, thirteen steps are included in the process and four of which are gates, called idea review, incubation kickoff, incubation concept finalized, and advanced concept finalized respectively. The process consists of three phases: idea prioritization, incubation and advanced concept development. Referred to the draft of idea evaluation process in SP&A, the innovation process developed has design thinking structure with agile philosophy and stage-gate backbone.

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APPENDICES

Appendix 1. Questionnaire for semi-structured interviews

General

1. What is the correct name of the company? Group or Corporation???
2. How do you define/differentiate "effective" and "efficient"? Why effective?
3. (What is innovation for you?) What is innovation process for you?

Organization

4. What is the vision of the department/unit/group? (What is leading the department?)
5. What is the mission of the department/unit/group?
6. How do you define “brand building”?
7. How do you view the dynamics of the team you are working in? (creative team, fact based team, initiative taking, …)- is it fulfilling your/department’s expectations?
8. What is the unique value that the team is adding?

Innovation process

9. Through which mechanisms/processes the ideas are coming in today? (CUSTOMERS, from employees, …. -how can they contribute?)
10. Who are the stakeholders of the innovation process?
11. How do you measure the performance of the department/ innovation process?
12. How "advance engineering" evaluate if a concept is feasible enough but still innovative??
13. When creating the process, how to manage to keep the process motivating people to innovate but also making it manageable/controllable?
14. Collaboration mechanism between functions (in a light of innovation process)

Appendix 2. Survey after workshop 1

Innovation Experience Workshop

Thank you very much for participating the workshop, it meant a lot for us! We received a large amount of brilliant insights. Hope you enjoyed the try out of design thinking.

Estimated time to complete the questionnaire: 5 min

Heleri and Yuxi

* Required

Are you satisfied with the workshop? *

	1	2	3	4	5	
Not satisfied at all	◯	◯	◯	◯	◯	Very satisfied

What did you like about the workshop? (You wish these things to be kept for the next one) *

Your answer

What do you like us to improve? *

Your answer

To what extent design thinking could be relevant to your work? *

	1	2	3	4	5	
Not relevant at all	◯	◯	◯	◯	◯	Very relevant

Have you had previous experience of design thinking before the workshop? *

◯ Yes, I have used it

◯ I have heard of it but not used

◯ No, I have not heard of it

If you have any other commons, please put them down here :)

Your answer

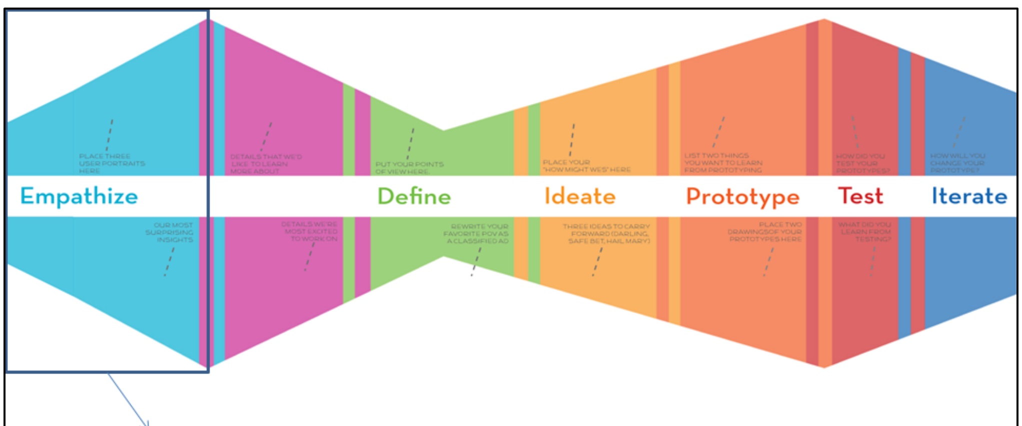
Appendix 3. Innovation Experience Workshop 2 - review material

INTRODUCTION TO
Innovation Experience Workshop 2

Last week, we carried out a workshop to look into a problem through design thinking approach. It is an approach to solve problems in an innovative way with a strong customer focus.

As a nature of innovation project: full of uncertainty throughout the way, we also wanted to use the workshop to give a overall feeling which is "ambiguity" about an innovation project.

Yuxi and Heleri 2017.03.30



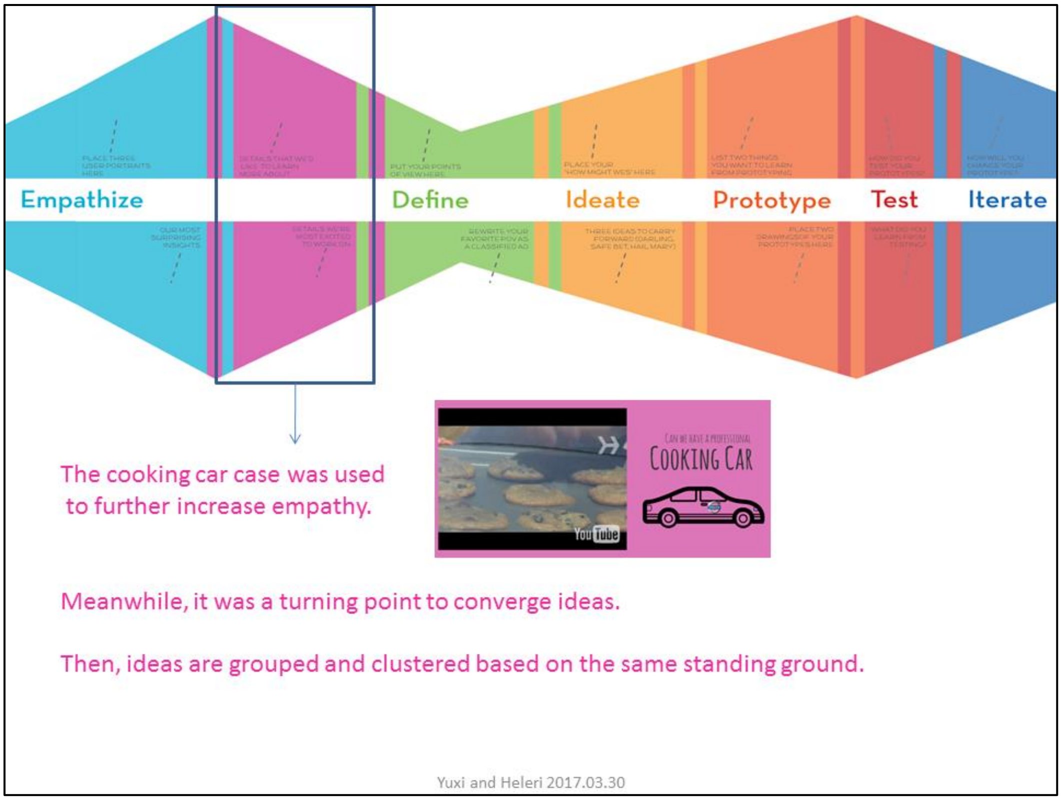
We started with a brainstorming question:

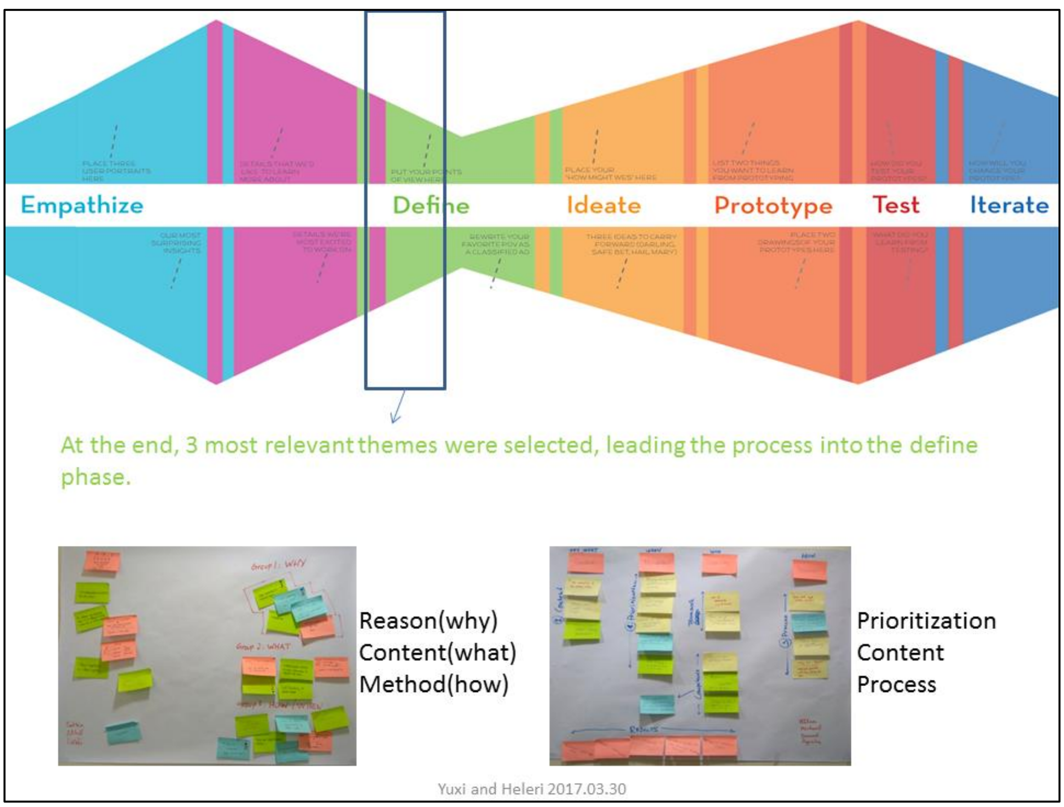
What have you **Suffered** most from an innovation project?

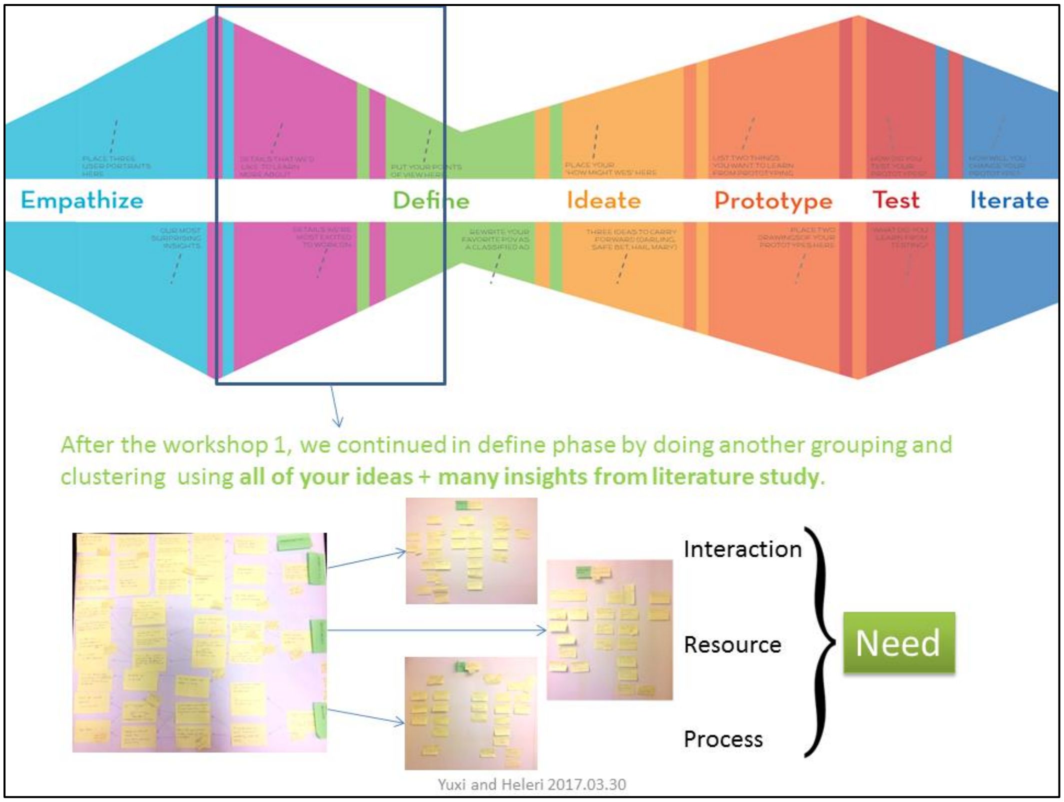
Magnificent ideas were collected from your own experience.

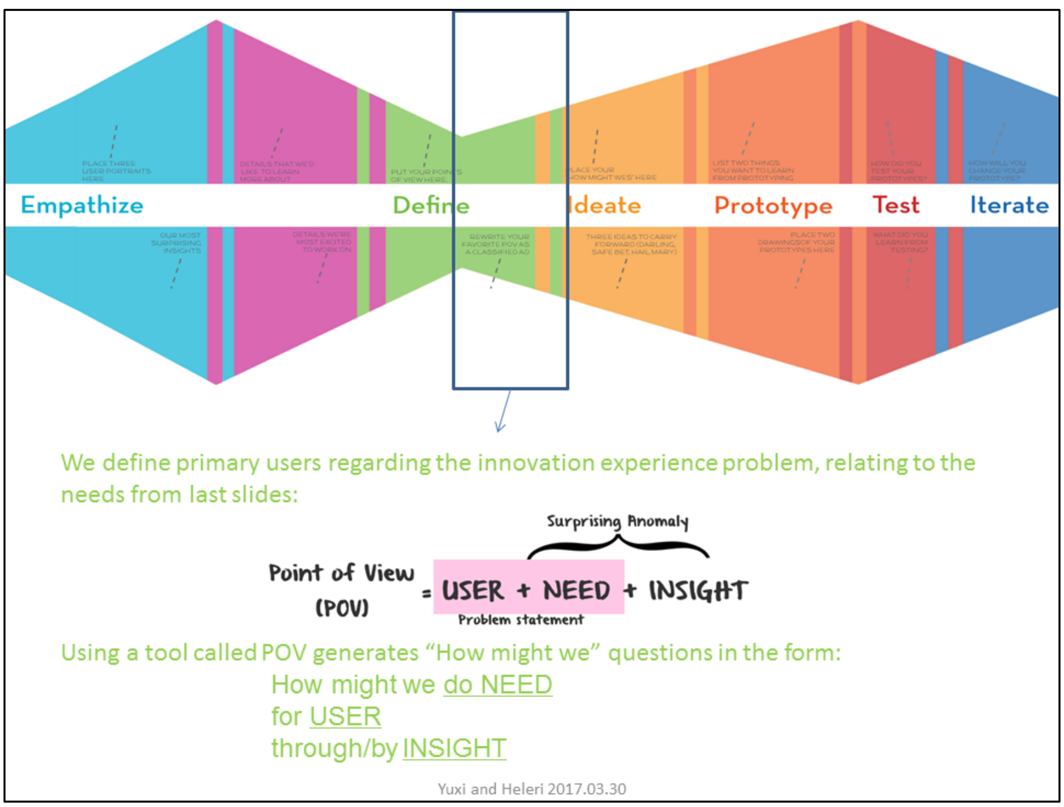
Taking ideas from another team was designed into the workshop to absorb some more input.

Yuxi and Heleri 2017.03.30


Empathize
Define
Ideate
Prototype
Test
Iterate
The cooking car case was used
to further increase empathy.
COOKING CAR
Meanwhile, it was a turning point to converge ideas.
Then, ideas are grouped and clustered based on the same standing ground.
Yuxi and Heleri 2017.03.30

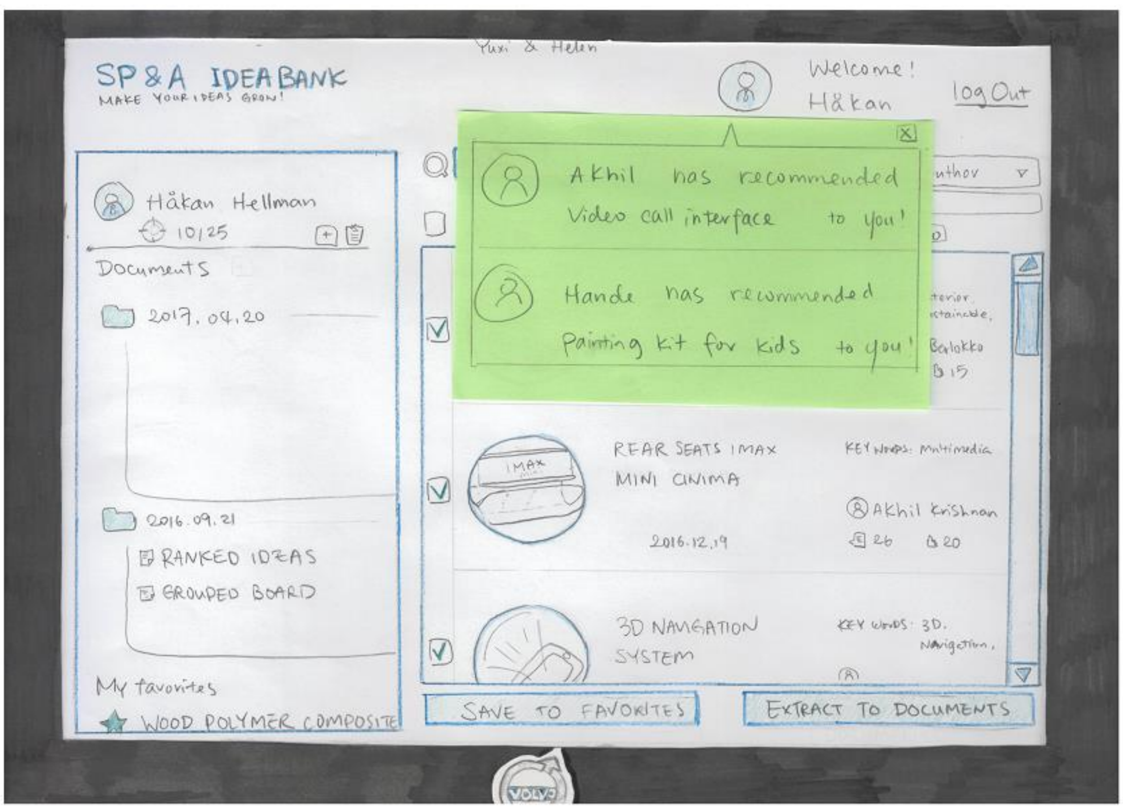

Empathize
Define
Ideate
Prototype
Test
Iterate
At the end, 3 most relevant themes were selected, leading the process into the define phase.
Reason(why)
Content(what)
Method(how)
Prioritization
Content
Process
Yuxi and Heleri 2017.03.30

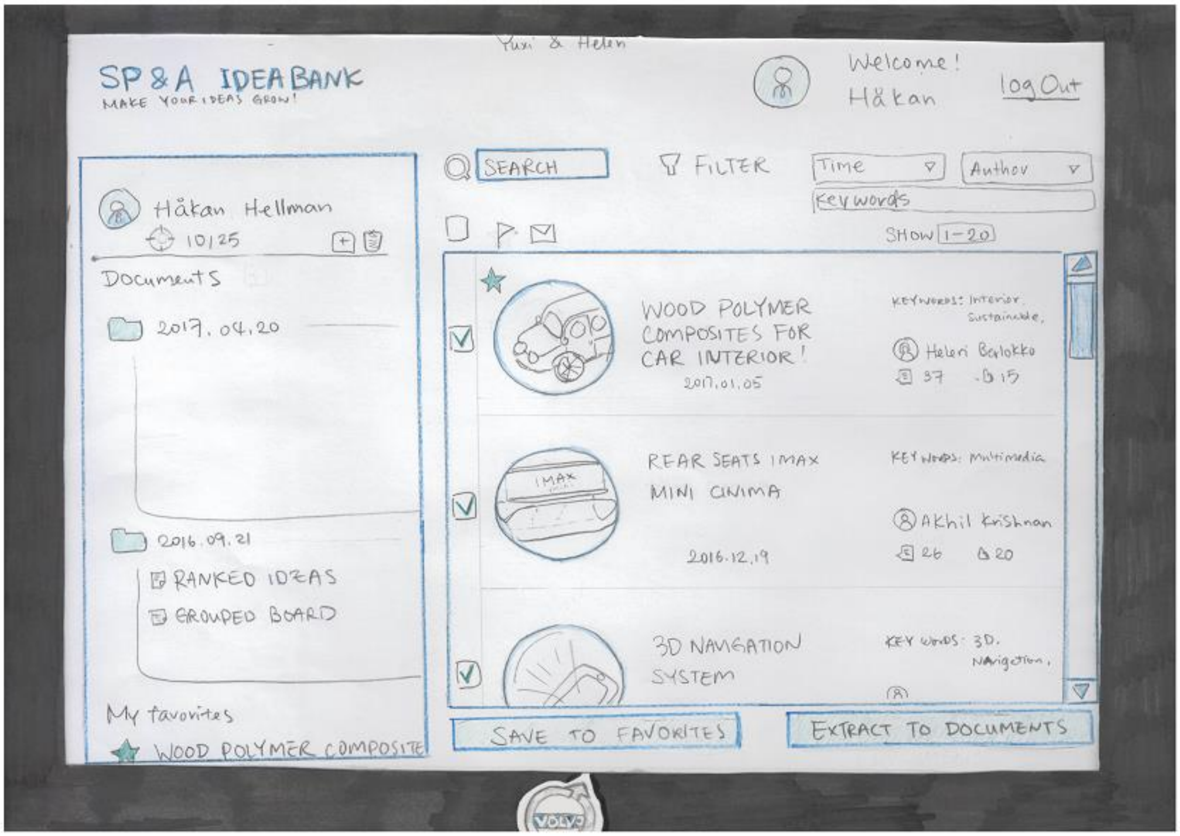

Empathize
Define
Ideate
Prototype
Test
Iterate
After the workshop 1, we continued in define phase by doing another grouping and clustering using **all of your ideas + many insights from literature study**.
Interaction
Resource
Process
Need
Yuxi and Heleri 2017.03.30

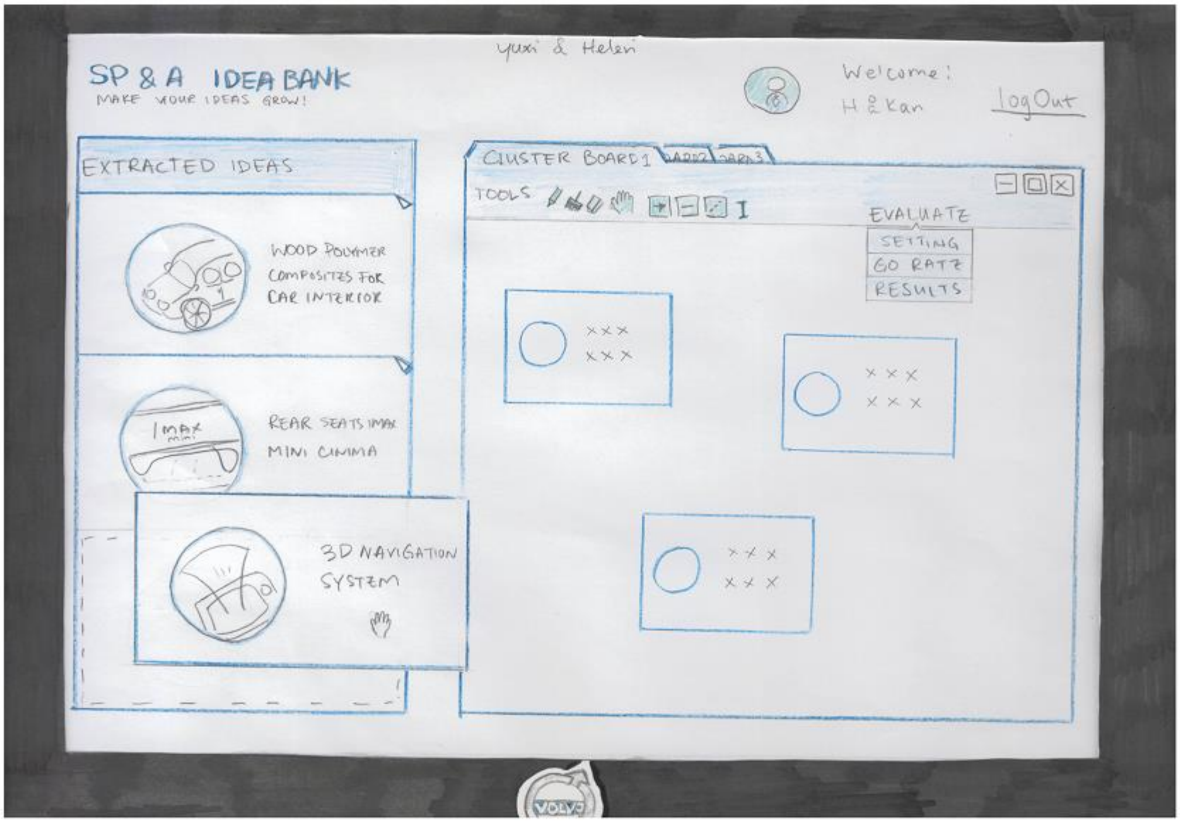

Empathize
Define
Ideate
Prototype
Test
Iterate
We define primary users regarding the innovation experience problem, relating to the needs from last slides:
Surprising Anomaly
Point of View (POV) = USER + NEED + INSIGHT
Problem statement
Using a tool called POV generates "How might we" questions in the form:
How might we do NEED
for USER
through/by INSIGHT
Yuxi and Heleri 2017.03.30

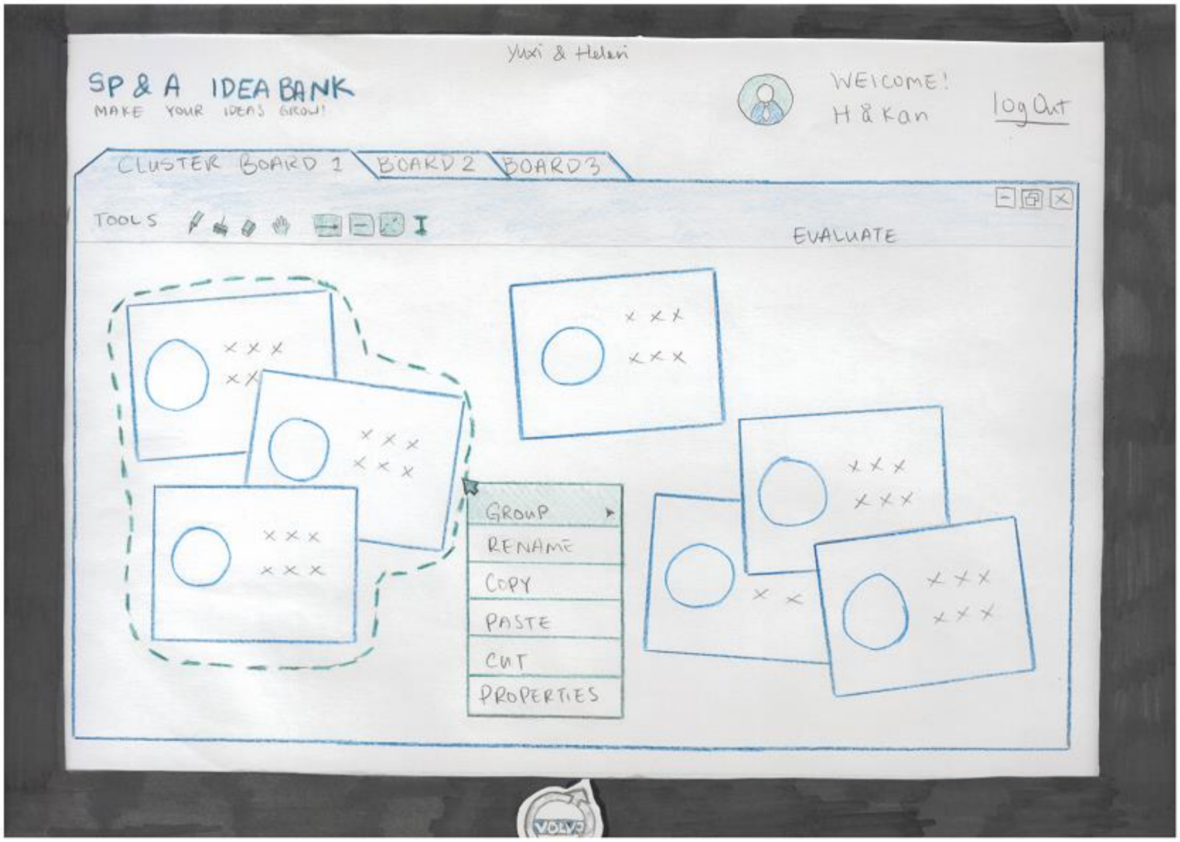

"How might we" questions will be the starting point for the upcoming workshop.
Please take a bit time to think about these questions, see you tomorrow!
1
HMW bring shared understanding early
for R&D engineers
through better teamwork and better distributed responsibility?
2
HMW be customer focused in innovation process
for product managers
through quality/reliable ways to obtain direct voice of customer?
3
HMW create learning cycles
for product managers and R&D engineers
by properly maintaining/transferring knowledge gained?
Yuxi and Heleri 2017.03.30
"How Might We" questions

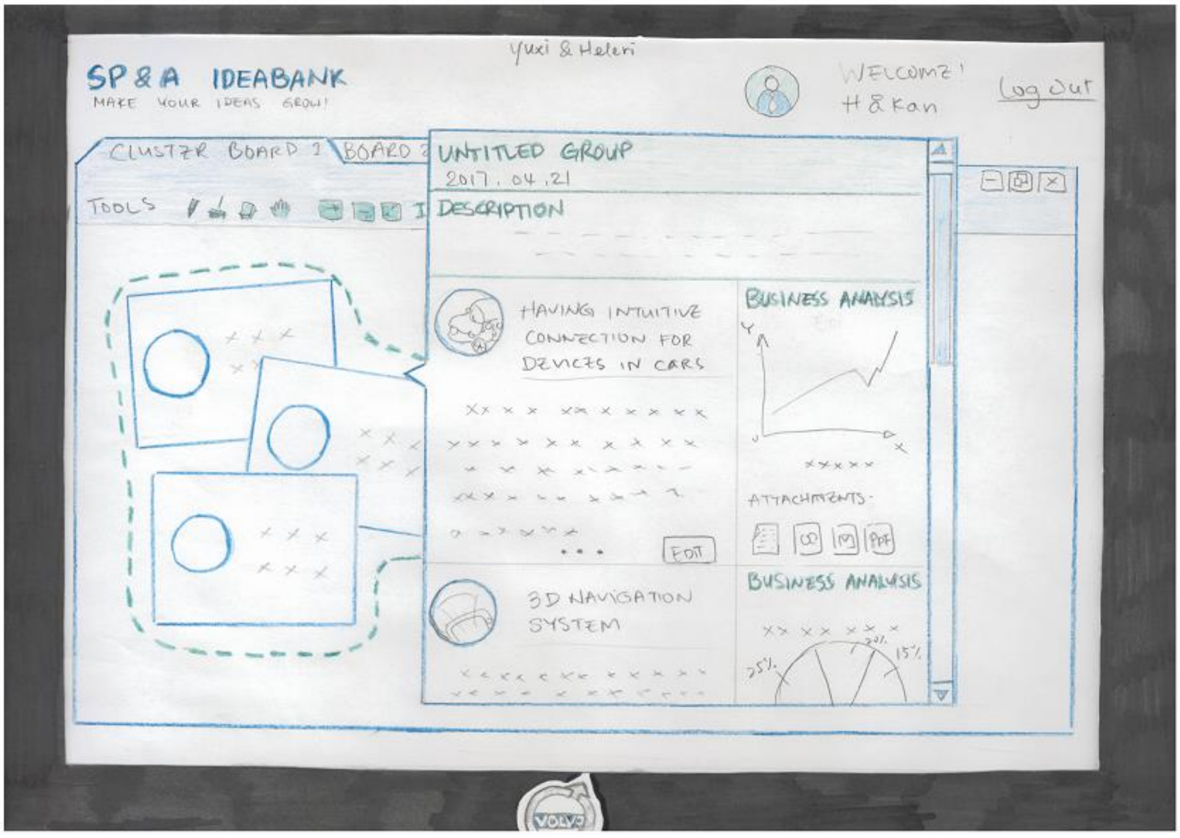
Appendix 4. Volvo SP&A idea bank proposal

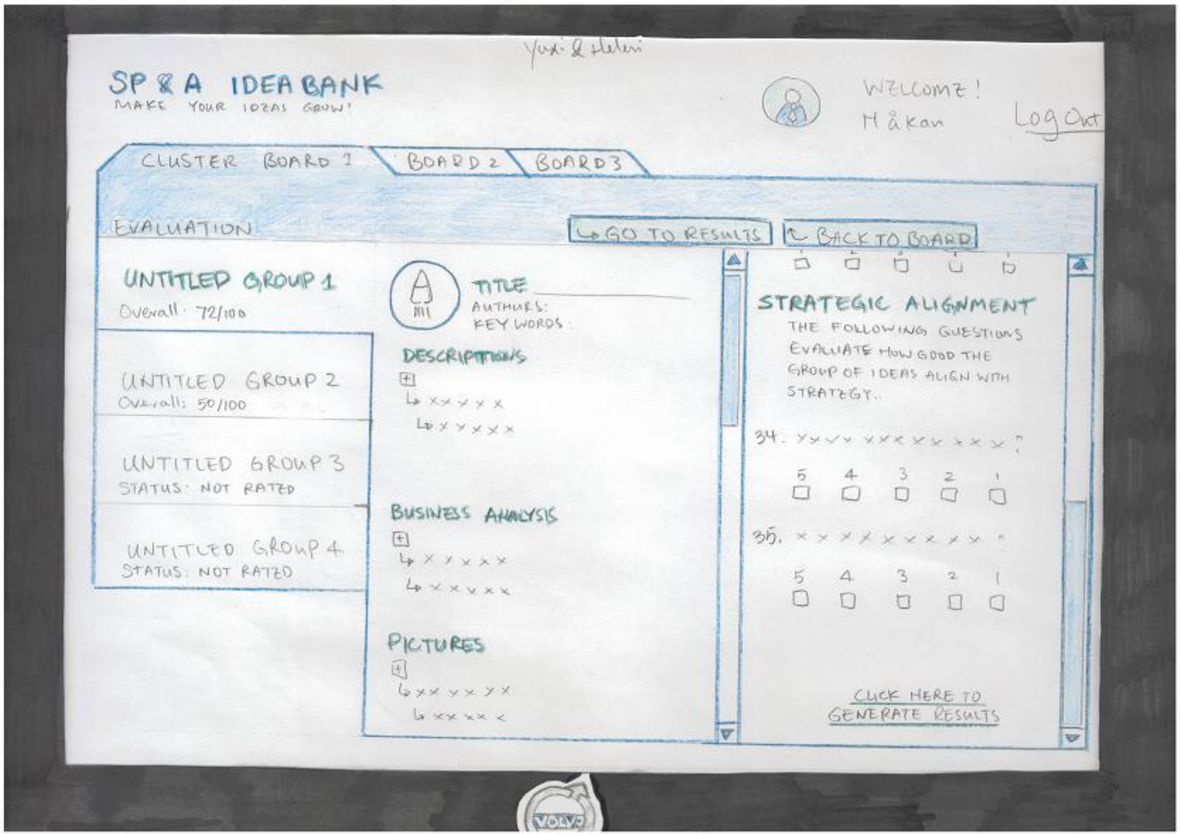


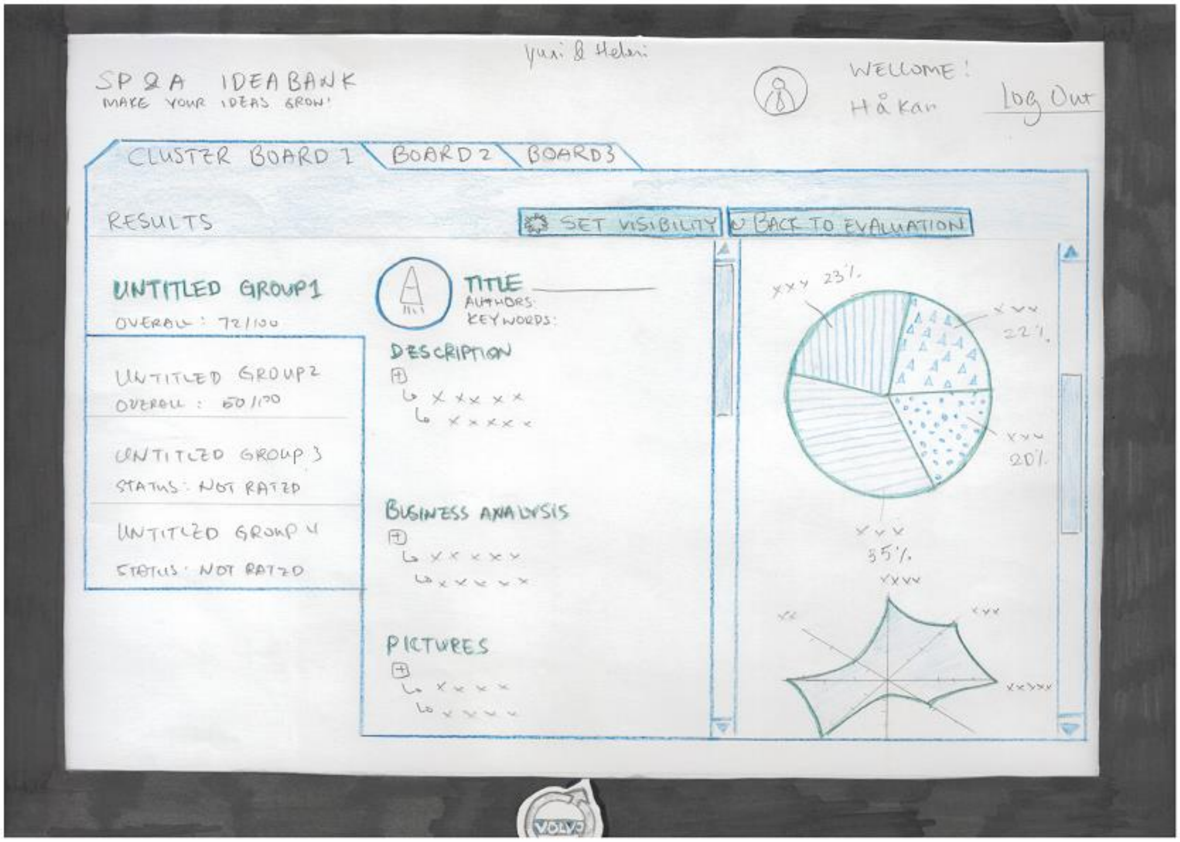

Yuxi & Helen
SP & A IDEA BANK
MAKE YOUR IDEAS GROW!
Welcome!
Håkan
Log Out
SEARCH
FILTER
Time
Author
Key words
SHOW 1–20
Håkan Hellman
10/25
Documents
2017.04.20
2016.09.21
RANKED IDEAS
GROUPED BOARD
My favorites
WOOD POLYMER COMPOSITE
WOOD POLYMER COMPOSITES FOR CAR INTERIOR!
2017.01.05
KEYWORDS: Interior, Sustainable,
Heleri Barlokko
37
15
REAR SEATS IMAX MINI CINIMA
2016.12.19
KEYWORDS: Multimedia
Akhil Krishnan
26
20
3D NAVIGATION SYSTEM
KEY WORDS: 3D, Navigation,
SAVE TO FAVORITES
EXTRACT TO DOCUMENTS

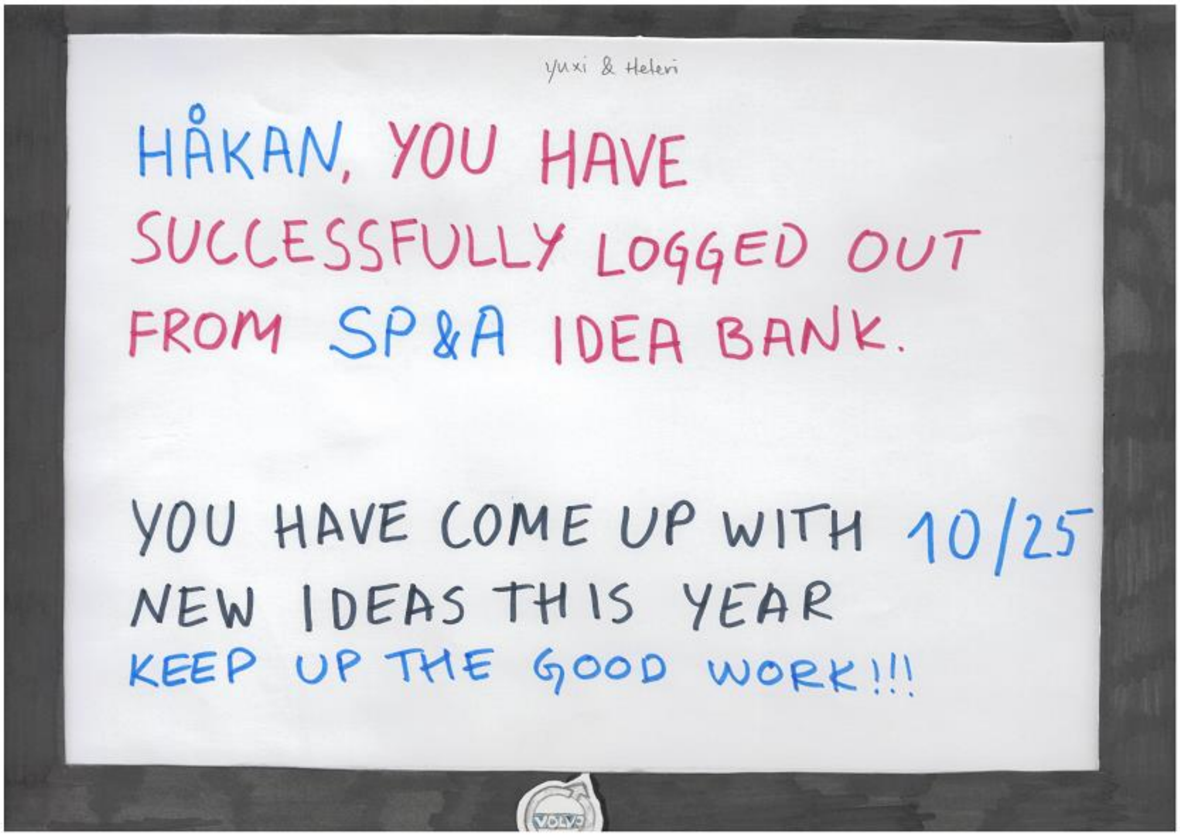

Yuxi & Helen
SP & A IDEA BANK
MAKE YOUR IDEAS GROW!
Welcome!
Håkan
Log Out
EXTRACTED IDEAS
WOOD POLYMER COMPOSITES FOR CAR INTERIOR
REAR SEATS IMAX MINI CINIMA
3D NAVIGATION SYSTEM
CLUSTER BOARD1
TOOLS
EVALUATE
SETTING
GO RATE
RESULTS


Yuxi & Heleri
SP & A IDEA BANK
MAKE YOUR IDEAS GROW!
WELCOME!
H & Kan
Log Out
CLUSTER BOARD 1
BOARD 2
BOARD 3
TOOLS
EVALUATE
GROUP
RENAME
COPY
PASTE
CUT
PROPERTIES


Yuxi & Heleri
SP & A IDEABANK
MAKE YOUR IDEAS GROW!
WELCOME!
H & Kan
Log Out
CLUSTER BOARD 1
TOOLS
UNTITLED GROUP
2017.04.21
DESCRIPTION
HAVING INTUITIVE CONNECTION FOR DEVICES IN CARS
EDIT
BUSINESS ANALYSIS
ATTACHMENTS
3D NAVIGATION SYSTEM
BUSINESS ANALYSIS
25%
20%
15%


SP & A IDEA BANK
MAKE YOUR IDEAS GROW!
WELCOME!
Håkan
Log Out
CLUSTER BOARD 1
BOARD 2
BOARD 3
EVALUATION
GO TO RESULTS
BACK TO BOARD
UNTITLED GROUP 1
Overall: 72/100
UNTITLED GROUP 2
Overall: 50/100
UNTITLED GROUP 3
STATUS: NOT RATED
UNTITLED GROUP 4
STATUS: NOT RATED
TITLE
AUTHORS:
KEY WORDS:
DESCRIPTIONS
BUSINESS ANALYSIS
PICTURES
STRATEGIC ALIGNMENT
THE FOLLOWING QUESTIONS EVALUATE HOW GOOD THE GROUP OF IDEAS ALIGN WITH STRATEGY.
5 4 3 2 1
CLICK HERE TO GENERATE RESULTS


SP & A IDEA BANK
MAKE YOUR IDEAS GROW!
WELCOME!
Håkan
Log Out
CLUSTER BOARD 1
BOARD 2
BOARD 3
RESULTS
SET VISIBILITY
BACK TO EVALUATION
UNTITLED GROUP 1
OVERALL: 72/100
UNTITLED GROUP 2
OVERALL: 50/100
UNTITLED GROUP 3
STATUS: NOT RATED
UNTITLED GROUP 4
STATUS: NOT RATED
TITLE
AUTHORS:
KEY WORDS:
DESCRIPTION
BUSINESS ANALYSIS
PICTURES
23%
22%
20%
35%


Yuxi & Heleri
HÅKAN, YOU HAVE
SUCCESSFULLY LOGGED OUT
FROM SP&A IDEA BANK.
YOU HAVE COME UP WITH 10/25
NEW IDEAS THIS YEAR
KEEP UP THE GOOD WORK!!!

Appendix 5. First version of the new innovation process