CHALMERS
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A Business Approach to Advanced Engineering Portfolio Selection

A study of how Volvo Cars can improve their selection process for environmental advanced engineering projects to ensure alignment with business goals

Master of Science Thesis
In Supply Chain Management & Quality and Operations Management Programme

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Gothenburg, Sweden 2017
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ABSTRACT

The environmental situation is becoming more severe and a sustainable approach is therefore crucial in order to maximize a firm's value. The automotive industry represents one of the main manufacturing sectors in the world and the increasing vehicle usage worldwide is straining the environment. Therefore, it is of great importance that automotive companies work to reduce their environmental impact. One automotive manufacturer, aiming to be more sustainable, is Volvo Cars. The company is improving their cars from a sustainability perspective through various efforts within the R&D departments. However, it is not possible to execute an extensive number of projects, thus a strategic selection process is required.

The purpose of this study was to investigate how the process of selecting environmental advanced engineering projects at Volvo Cars can be improved in order to create more alignment with business goals and maximize the value of the projects.

The study was performed using a qualitative method. The purpose was achieved by performing a literature review where theories connected to selection of technology projects were studied. Furthermore, several qualitative semi-structured interviews have been conducted with employees related to the studied process. Triangulation has been done to ensure credibility and confirmability of the results obtained. Based on analysis of the theoretical and empirical findings, conclusions were drawn.

The result of the study was that more cross-functional collaborations are needed throughout the process. Furthermore, an establishment of two defined screenings which serve different purposes can be beneficial to ensure that the right projects are selected. To ensure that the portfolio of projects is strategically aligned, maximized in value and has a good balance some tools can be applied to the activities in the process to facilitate decision making. Additionally, it was found that a software tool used for idea generation in other contexts within the organization could possibly be applicable to the process of selecting environmental advance engineering projects at Volvo Cars to enhance communication and information distribution.

Keywords: project portfolio management, project selection, development funnel

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Gothenburg, January 2017

Sofie Carlsson

Sofia Sjöberg

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NEEDS	-	Developed by the Attribute Areas based on the strategy for future technology development
MEANS	-	Project ideas that meet the needs and potentially become advanced engineering technology development projects if financed
ENGINEERING UNIT	-	Constructing units responsible for developing means
ATTRIBUTE AREA	-	Departments responsible for identifying needs based on the strategy
ENVIRONMENTAL COUNCIL	-	Meeting place where environmental attribute area and engineering unit representatives discuss the status of the environmental part of the needs/means process
GOVERNANCE BOARD	-	Meeting place where all council leaders and engineering unit representatives discuss the status of the overall needs/means process

ABBREVIATIONS

AE	-	Advanced Engineering
R&D	-	Research and Development
PPM	-	Project Portfolio Management
ECV	-	Expected Commercial Value
NPV	-	Net Present Value
GTDS	-	Global Technology Development System

1 INTRODUCTION

This chapter introduces the background and the objective of this thesis, which is followed by three research questions to support the course of the study. Lastly, the delimitations for the study are stated.

1.1 BACKGROUND

Sustainability within businesses is getting increasingly important today when the environmental situation is becoming more severe and gaining considerable attention from stakeholders (Rezaee, 2016). Therefore, a sustainable approach considering all stakeholders' interest by integrating governance, economic, social, ethical and environmental dimensions of sustainability performance is crucial in order to maximize a firm's value. Weidinger et al. (2014) emphasize that companies which develop business solutions solving urgent challenges regarding social and ecological issues are leading organizations of tomorrow. According to Kiron et al. (2013) consumers, especially in Europe, are increasingly aware of the sustainability situation and are willing to pay a premium for green products and services. In addition, Klassen and Whybark (1999) emphasize that customer demand is changing and regulations are sharpened which result in an increasing importance for environmental management.

The automotive industry represents one of the main manufacturing sectors in the world (Liu et al., 2015). According to Mayyas et al. (2012) there is a global growth of vehicles worldwide, which contributes to an increasing demand of fuel, material requirements as well as more air emissions. Also, Orsato and Wells (2007) argue that the products from the automotive industry create challenges in terms of global warming, worsening air quality in urban areas and treatment of scrapped vehicles. This growth results in that sustainability continues to be a crucial issue in the automotive industry, as vehicles' environmental impact worldwide needs to be reduced to ensure cars are a sustainable product in the future (Mayyas, 2012).

One automotive manufacturer is Volvo Cars, a company who emphasizes a will and aim to be sustainable. Therefore, much effort is put on decreasing the environmental impact through several technical solutions, for instance to reduce fossil fuel emissions from cars and increased usage of sustainable materials. Volvo Cars is working actively to improve their cars from a sustainability perspective (Volvo Cars, 2016a). There are efforts made within all sustainability aspects in various research and development (R&D) departments. One R&D department focuses on the environmental sustainability by managing a number of environmental improvement projects. The purpose of the department is "*to work out the technical concept, balancing legal requirements and verify the final product with good competitiveness in the different attributes areas; environment, weight, fuel consumption, thermodynamics, aerodynamics and contamination, both physically and virtually*" (Volvo Cars, 2016a). In order to decide which improvement projects to realize and implement, Volvo Cars has a project selection process. According to Dickinson et al. (2001) companies constantly need to invest in technology projects in order to stay competitive, but due to limited resources they have to be strategically allocated among possible projects. Cooper et al. (2000) state two main reasons for business success for new products, namely to execute

projects in the right way and to invest in the right projects. This study is focusing on the second route, to invest in the right projects.

1.2 PROBLEM DISCUSSION

According to Wheelwright and Clark (1992), the reality for several firms in the process of identifying, screening, selecting projects and focusing resources, is that this is done inefficiently, fuzzy and disjointed. Therefore, there are a lot of improvement opportunities within this area for several companies, since creating a successful product development process has great power. Furthermore, having a well-reasoned selection process is essential to prevent waste of resources on the "wrong" projects that in a later stage are terminated and never finished (Thamhain, 2014). Except for economic downturn, investing in these projects also results in missed other opportunities. Thamhain (2014) states that the R&D projects are critical to a company's overall success and growth. However, there is substantial difficulty and unreliability in predicting the success of a project at an early proposal stage (Thamhain, 2014). Furthermore, the author describes that the process of selecting the most suitable projects is influenced by both human and organizational factors.

With an increasing demand for sustainable products in society in general and high pressure on the automotive industry from environmental regulations in particular, it is essential to invest in the right technology development projects. It is especially important to undertake projects within advanced engineering (AE) that will create technology to the cars of tomorrow. AE projects are needed to create cars that satisfy customer demand, secure that the company is moving in the right direction strategically and to ensure that future regulations are met. A prerequisite for this is to have a well-defined and functioning selection process to select the projects most suitable for Volvo Cars. It is essential that all people involved in the process have the same understanding of the process and that the activities are performed in similar ways, regardless of where in the organization they are performed. Currently this is not the reality at Volvo Cars.

1.3 OBJECTIVE

This master thesis aims to investigate how the process of selecting environmental advanced engineering projects at Volvo Cars can be improved in order to create more alignment with business goals and maximize the value of the projects.

1.4 RESEARCH QUESTIONS

In order to obtain the objective of the thesis, the following research questions will be used. These questions function as guidance as to what possible improvement that could be implemented based on theory and empirical findings.

***Research Question 1**: What activities should be performed, and with which actors, in the project selection process to ensure investments in the right projects?*

***Research Question 2**: What kind of tools can be used in the project selection process at Volvo Cars to enable good investment decisions regarding environmental advanced engineering projects?*

***Research Question 3**: What information is required, and when, to streamline the project selection process?*

1.5 DELIMITATIONS

This report is restricted to only include AE projects related to environmental improvements at Volvo Cars' R&D department focusing on the final product. This includes projects meeting the needs of attribute areas such as environment, aerodynamics, weight, emission and fuel economy. The interviews supporting this research have been conducted with representatives involved in the specific selection process, however due to time constraints only a collection of representatives has been interviewed. The representatives participating have been chosen in collaboration with the supervisor from Volvo Cars.

2 METHODOLOGY

In this chapter the proposed research strategy, research method and research process will be presented. The chapter aims to give an idea of how the authors plan to conduct the research and explains how the research questions will be answered.

2.1 RESEARCH STRATEGY

Research strategy is the orientation in which business research is conducted, which can be either qualitative or quantitative (Bryman and Bell, 2015). In qualitative research, data collection and analysis of data is based on words rather than numbers. In contrast, quantitative research focuses on quantification in collecting and analyzing data. This research will be of a qualitative nature, namely including more detailed and focused data rather than collecting massive amounts of data. The reason for this choice is that collecting quantitative data was not desirable and the understanding of the process was gained by conducting qualitative interviews.

In qualitative studies, the approach of the relationship between theory and research is predominantly inductive (Bryman and Bell, 2015). This refers to theory being generated as the outcome of research, hence generalizing the observations made. In quantitative studies the relationship between theory and research is the opposite; theory forms the basis to a hypothesis which research serves to test. However, the distinction between inductive and deductive is not strict, both approaches can contain elements from each other. One approach to research that has evolved to overcome the limitations of inductive and deductive is a combination of the two called abductive. In this approach, an occurrence is studied and, using imagination, theory that might account for the occurrence is studied (Mingers, 2012). In this approach the researcher provides several explanations of the data and selects the most suitable explanation, being aware that more explanations exist (Mantere and Ketoviki, 2013). The thesis will use the latter approach, namely abductive.

Within qualitative research there are a number of approaches in which the research subject actively take part of designing the research and influence the outcome of the process (Bryman and Bell, 2015). One such approach is action research where the researchers and a client collaborate in the definition of the problem and the creation of a solution. Eden and Huxham (1996) describe action research as involving participants from an organization in an issue that is of concern to them. They state that to develop good action research there need to be some implications also for other situations than merely the studied one, hence to be generalizable, as well as be related to theory. Furthermore, they discuss that theory building based on action research will be incremental, thus by small steps move from a particular situation to the general. This thesis will be performed by conducting an action research, where the authors will spend time at the office of the collaboration partner and by the input of the employees create a solution to their problems as well as provide general insight.

2.2 RESEARCH METHOD

A research method is a technique for collecting data (Bryman and Bell, 2015). In order to answer the research questions stipulated, a literature review have been performed and interviews have been conducted to gather qualitative data.

2.2.1 LITERATURE REVIEW

This study was initiated with an extensive literature review, which was essential for the early stage of this study. In the literature review, theory regarding technology development and development funnels was studied. In addition, project portfolio management was reviewed in order to gain insight in best practices of selecting projects in a good way. Furthermore, also theory about goal setting have been reviewed. All theory has further been applied to Volvo Cars' early stage of selecting environmental AE projects in order to find improvements areas. The literature review has been functioning as a base for the continuation of the research, however the literature review has been iterative, and thus more literature studies have been performed during the data collection process as well.

In the literature review some theory has been briefly studied but not included in the scope of this study. For instance, the applicability of business case and business models has been investigated and decision about exclusion has been made in collaboration with academic expertise at Chalmers. The reason for the exclusion is that business models and business case are related to new product or service development, however the character of the projects studied are primarily technology development to be implemented in new products at a later stage. Furthermore, multiple criteria decision making, which is frequently used within this research area, has also been excluded from the scope of this study. Multiple criteria decision making requires advanced modelling and simulation, however the researchers do not possess the competence needed in order to apply the theory to this study.

When doing the literature review, literature searches were made in databases called Summon provided by Chalmers Library, Scopus and Google Scholar. In order to find the most trustworthy articles the number of citations of each article have been taken into consideration as well as who the original founder of the theory is. In these searches a number of search words have been used. For the technology development chapter these were: research and development, technology development, R&D management, development funnel. In the chapter presenting Project Portfolio Management, the search words were: project portfolio management, project portfolio selection, project portfolio prioritization, project portfolio management tools, project portfolio evaluation, portfolio management, challenges with portfolio management, scoring model, strategic buckets, and bubble diagram. For the chapter introducing S.M.A.R.T goals the following search words were used: SMART goals, SMART criteria and goal setting theory. In addition to the online searches made, books were also studied after recommendations from an expert at Chalmers.

2.2.2 INTERVIEWS

In addition to the literature review, primary data was collected by conducting interviews. Since the study is of qualitative nature the interviews were also qualitative which in comparison to quantitative interviews provide more flexibility (Bryman and Bell, 2015). When performing qualitative interviews, the interviewers can conduct more than one

interview with the same interviewee, change the order or the wording of questions and focus on the interviewee's point of view rather than the interviewer. Within qualitative interviewing there are different approaches to use; unstructured and semi-structured. In this study the semi-structured approach has been used. Semi-structured interviews are performed with predefined questions with space for additional question as well as possibilities to change the sequence of the question along the interview (Bryman and Bell, 2015). Furthermore, the interviewee might ask counter-questions and provide additional insight that is not stipulated in the initial question template as well. This way it was ensured that all the interviewees with similar roles in the selection process could be asked the same questions to be comparable, however with room to obtain extra information when the interviewee can provide it.

The purpose of the interviews is to understand the selection process for environmental projects by interviewing the actors currently involved. These actors are primarily employees from Volvo Cars' R&D department, where the three different types of actors in the selection process have been interviewed, thus there are three interview templates created (see appendix A). The interview templates were discussed with the supervisor at Volvo Cars before the interviews were held, in order to make sure that all questions asked were relevant. According to Bryman and Bell (2015), having templates strengthen the dependability of the research. The interviews were audio recorded, under the permission of the interviewee, to ensure that all information is captured and available since taking detailed notes can distract the interviewer from the actual conversation and the possibility to ask follow-up questions. However, some notes were taken throughout the interview to capture the main points that can be backed up with the recording afterwards. To assure that the interviewee agrees with the interviewers' interpretation of the interview, summary notes were provided to the interviewees in order for them to evaluate the accuracy.

In addition to the industry interviews, people with expertise and knowledge from the academic world were contacted. Axel Edh, Senior Strategic Advisor Environment at Volvo Cars, was the main provider of contact information to the employees at Volvo Cars and the academic experts were found by the authors' own network as well as with the help of Chalmers supervisor Magnus Blinge.

2.3 RESEARCH PROCESS

In order to obtain the objective of this study there are three supportive research questions. The first research question, referring to which activities that should be performed in a selection process, was answered by reviewing literature about project portfolio management as well as theory about development funnels. In addition to that, the interviews with the actors involved in the process at Volvo Cars served as a base for understanding which activities that are currently included in the process. In order to answer the second research question, what kind of tools that could be used for investment decision making about AE projects, further literature about project portfolio management was studied. In addition, an interview was held with a representative from the innovation office at Volvo Cars to understand the applicability of a tool they today are using for innovation generation, on the project selection process of AE projects. This was also linked to the first research question, by combining the activities with the tools suggested. Lastly, the third research question, about what information is required and when in the process, was assessed primarily by the data gathered at the interviews with the actors within the process. In addition, literature about goal

setting, development funnel phases and project portfolio management selection processes were reviewed to understand what theory states as important information at different stages. The aforementioned activities have been done in the sequence shown in figure 1.

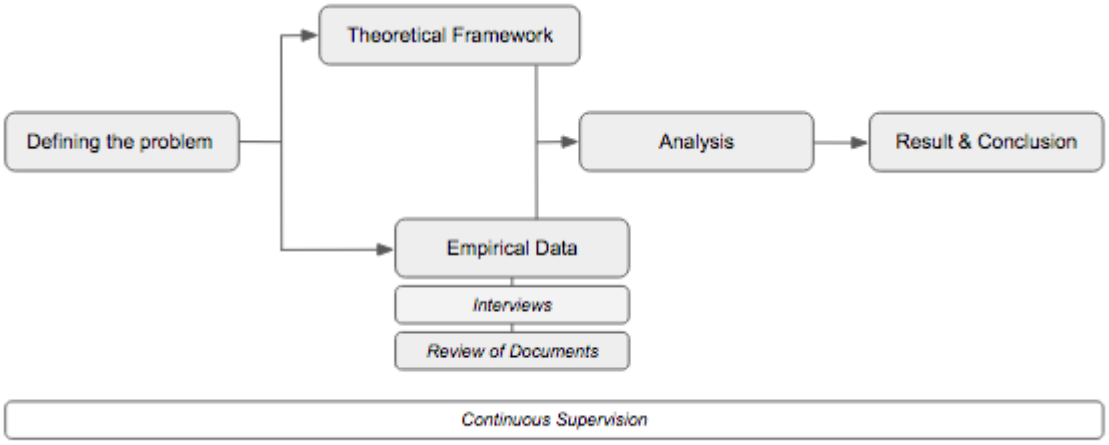

Figure 1. The research process

2.4 RESEARCH QUALITY

According to Bryman and Bell (2015), several authors have suggested that qualitative studies should be evaluated from different criteria than the ones used for quantitative studies to ensure the quality of a research. Shenton (2004) and Bryman and Bell (2015) describe the alternative criteria that were first established by Lincoln and Guba in 1985 to create a trustworthy study. These criteria are trustworthiness and authenticity, where the former is further divided into four criteria: credibility, transferability, dependability and confirmability. These four criteria will be discussed further in this chapter.

Credibility

Credibility is the alternative for the quantitative measure for internal validity (Bryman and Bell, 2015). This criterion concerns how well the findings are matching the reality (Merriam, 2009). It is the extent to which the results from the study is credible from the research participant's perspective and about ensuring that the findings are submitted to the participants for confirmation that the researcher has understood the situation correctly (Bryman and Bell, 2015). Shenton (2004) states that according to Lincoln and Guba (1985), to create trustworthiness, credibility is one of the main important factors. To ensure credibility Bryman and Bell (2015) suggest the use of respondent validation and triangulation. Respondent validation is when the researcher provides material of the findings to the people involved, by for instance interviews. In this study the researchers have allowed the interviewee the possibility to read the interview notes in hindsight to check that the stated comments are valid and could be used in the research paper. The latter technique, triangulation, indicates that more than one source or method of data collection has been used. This method has been used in this master thesis study as interviews have been held with several interviewees with the same role in the Environmental Council but belonging to different departments. Additionally, apart from the interviews, observations of people involved in the process have been

performed by participation at the Environmental Council meetings. Also, a literature review has ensured that information has been collected outside the studied organization as well.

Transferability

Transferability is the qualitative alternative proposed for external validity (Bryman and Bell, 2015) and this criterion refers to how well the findings from the study can be applied to other situations, hence how generalizable the results are (Merriam, 2009). Since the character of qualitative studies is more detailed and specific to a certain situation it can be hard to demonstrate that the findings could be applicable elsewhere (Shenton, 2004). To facilitate for other researchers to see if the findings could be applied to a new situation, the researcher should provide a thick description, that is, rich contextual information about the settings and the culture (Bryman and Bell, 2015; Shenton, 2004; Merriam, 2009). Within this master thesis project, the intention is to make the results generalizable across both other parallel project selection processes within the organization as well as outside.

Dependability

Dependability is the qualitative version of reliability (Bryman and Bell, 2015). This criterion is referring to repeatability of the study; if the study was to be made again, in the same context and with the same participants if the results would be similar to the initial results (Shenton, 2004). Bryman and Bell (2015) suggest that an auditing approach could be useful which requires that records are kept for each phase of the project, such as interview protocols, selection of participants and problem formulation. Therefore, all interview notes and other documentation within this study have been surely stored in one place, in order to facilitate the possibility for other people to follow the research process. Additionally, the process of how the thesis project was conducted is described in this methodology chapter and the interview templates used can be found in Appendix A.

Confirmability

Confirmability is related to the quantitative measure of objectivity (Bryman and Bell, 2015). This criterion deals with making the study as objective as possible even though complete objectivity is not attainable. In order to do so, the researcher should be shown as acting in good faith, that personal values have not influenced the findings too much. Shenton (2004), states that it is important that the informants' experiences and ideas form the basis to the findings rather than the preferences of the researcher. Also here triangulation was used to prevent effects of author bias. Shenton (2004), also discusses the importance of motivating the reason for decisions and methods adopted. In this research this was done by clearly stating the choices made of what to include and exclude from theory and in addition to that reflect over other decisions taken.

3 THEORETICAL FRAMEWORK

In this chapter the literature review is presented. Initially, the broad concept of technology development is described followed by an introduction to the development funnel used for project selection. Secondly, theory about project portfolio management is reviewed, and more specifically, how the selection of projects to a portfolio can be done most effectively. Furthermore, some tools that can be used in order to obtain the objectives of project portfolio management are discussed. Lastly, the concept of S.M.A.R.T goals are described to give insight in some important criteria for setting goals and targets.

3.1 TECHNOLOGY DEVELOPMENT

Technology development projects form the foundation for new products and is therefore essential for the growth and survival of the company (Cooper, 2006). In addition, also Akhilesh (2014) emphasizes that competitive advantage of an organization is heavily dependent on a firm's technology development and innovation. Activities within R&D contribute to a firm's organizational performance and growth. According to Cooper (2006), technology development is a particular kind of development projects that should deliver new knowledge, new technology or technical capability which, in most cases, lead to several commercial projects like new products or new process development. However, these projects are often rarely seen within companies' portfolios since management focus tends to be on short term and immediate financial return. These projects tend to be mismanaged more frequently, leading to negative results, which can create a resistance to undertake such projects again. Cooper (2006) further states that these projects are fragile and should not be managed with conventional management techniques. In order to pick the right projects companies cannot rely on traditional methods such as financial analysis and profit criteria. Financial values such as expected sales, cost, investment and profits tend to be inadequately estimated, because the degree of uncertainty that characterize these projects.

According to Gupta and Wilemon (1996) the importance of having R&D is substantial, but it is not about how much money that is spent on R&D, it is rather about in what way the funds are invested. One common challenge within R&D management is how managers can align R&D efforts with corporate objectives to rapidly bring new products to the market. Messner (2013) presents R&D investments as means to secure the place in a business area for a company in the future. Gupta and Wilemon (1996) state that some companies insist on having an integrated R&D process with all parts of the company, the customers and the suppliers is crucial for their business success. Furthermore, several skills and knowledge are critical to incorporate in R&D management since they have great effect on the R&D performance. These are; understanding customer need, monitoring market developments, commercializing new technologies, building cross-functional teams, managing multiple R&D projects and accelerating new product development. In addition, the importance of aligning R&D with business needs is highlighted.

3.1.1 DEVELOPMENT FUNNEL

According to Wheelwright and Clark (1992), the aim of product development is to convert an idea into a product that can meet the customer needs. A product development process always

starts with several development project ideas that can be realized, but often the resources are not sufficient to develop all projects, therefore selection is needed. To facilitate this process a development funnel can be applicable. Hakkarainen and Talonen (2014) state that the purpose of a funnel process is to gradually mature a raw idea into a concept and finally a product, while at the same time filtering out unbeneficial ideas at the gates between development phases. Hence, the goal is not only to divide the limited resources to the projects with highest expected payoff, it is rather to provide the best project portfolio that meets the business objectives (Wheelwright and Clark, 1992). Furthermore, it is important that the market and technology risks, investment levels, competitive realities, organizational capabilities, and unique advantages, along with financial returns, are all considered in the selection process to generate the best decisions. It is of high importance to highlight the complexity of making sure that the right ideas with most potential make it through the screening (Hakkarainen and Talonen, 2014).

Wheelwright and Clark (1992) mention three main tasks in a development funnel; *widen its mouth, narrow the funnel's neck* and *ensure that selected projects deliver on predetermined objectives*. Widen its mouth indicates that the firm has to expand their knowledge base in order to find new products and process ideas. The second task, narrow the funnel's neck, refers to when the projects ideas are screened by a set of criteria which leads to investment in the most attractive opportunities. There is a complexity of knowing what criteria and information that are relevant while screening the projects as well as how they should be weighted relative to each other to ensure their potential success. The third main task is to ensure that the projects deliver on the objectives that were announced when the projects were selected. It is crucial to specify when and how process specifications should be developed and in place to ensure that the project moves to the right target.

Wheelwright and Clark (1992), describe an innovative and focused development funnel which has three main phases with screenings in between the phases, see figure 2. Phase one encourages to enlarge idea generation by expanding the mouth of the funnel through gathering ideas from all parts of the company as well as from customers, competitors and suppliers. Providing time and funding for people within the company, motivates and encourages this type of incentives for idea generation. The first screening aims to narrow the funnel, which can be seen as a mid-level screening with the purpose of determining what additional information regarding each idea that is needed. Worth mentioning regarding the first screen is that this can be done by a cross-functional team. In this initial screening it is crucial that the ideas are evaluated on if they fit with the technology and market strategy. It is not a decision regarding go or no-go, it is rather a "readiness" review. This screening aims to provide feedback for additional information that is crucial for the final decision regarding go or no-go.

Phase two includes taking the best ideas and develop them further with more details and analyzing their potential. The gathered information aims to provide senior managers with enough data to enable comparison of competing and complementary projects. In the second screening, senior management determines what ideas that will be developed further and become real projects. This is a go/no-go decision point where the projects selected will be funded and get allocated resources. Furthermore, in phase three, the approved projects will be staffed and become focused development projects. These projects have to match the available project resources and have high profitability on delivering upon predetermined strategies and objectives for the business.

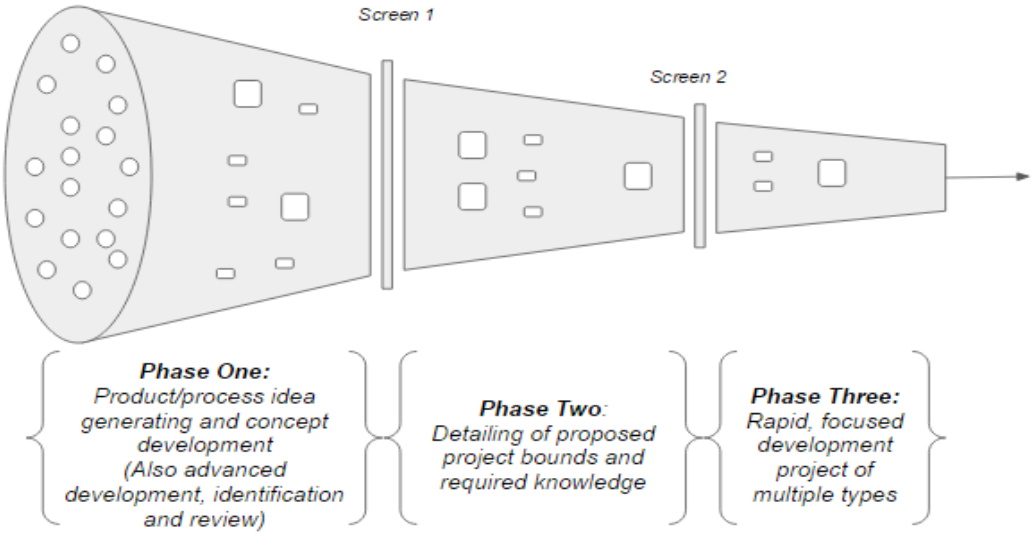

Figure 2. Innovative and focused development funnel

(Developed from Wheelwright and Clark, 1992)

3.2 PROJECT PORTFOLIO MANAGEMENT

This chapter introduces the concept of project portfolio management and how it relates to program and project management. Furthermore, the objectives of project portfolio management are presented and followed by a description of tools applied in order to obtain the objectives. The chapter further describes specifically the selection process of projects to a portfolio with the activities strategic considerations, project evaluation and portfolio selection.

3.2.1 PROJECT PORTFOLIO MANAGEMENT DEFINITION

Project Portfolio Management (PPM) refers to the arrangement of grouping several projects within an organization so they can be managed collectively as a portfolio (Morcos, 2008). A project portfolio consists of a group of projects that are performed under the sponsorship of an organization, competing for the same resources not sufficient to cover all proposed projects (Archer and Ghasemzadeh, 1999). According to Kodukula (2012), PPM can be utilized at various levels in the organization, from enterprise level down to department level given that the organizational unit has a budget responsibility. PPM extends further than only deciding the right amount and right type of projects, it also aims to provide a good mix of investment projects (Griffin et al., 2002). Beric et al. (2012) elaborate this further by stating that PPM is about how corporations should, most effectively, optimize their R&D investments.

Beric et al. (2012) stress that due to an increasing pressure on competitiveness in the global economy in the 1990s, PPM got important and relevant. According to EPMC (2011), PPM accomplishes its purpose by ensuring that projects are aligned with strategies and goals of the business, communicating the project's benefits and costs in a detailed way as well as managing projects as a whole. Solely one project does not contribute to achieving

organizational goals, it is rather several projects, both related and interdependent, that achieve these goals, ultimately generating results and success (Beric et al., 2012).

3.2.2 RELATIONSHIP BETWEEN PROJECT, PROGRAM AND PORTFOLIO MANAGEMENT

Project, program and portfolio management all refer to how to lead and manage projects, however from various aspects and abstraction levels. Bojeun (2014) provides a descriptive figure of how the terms project, program and portfolio are related to each other, see figure 3.

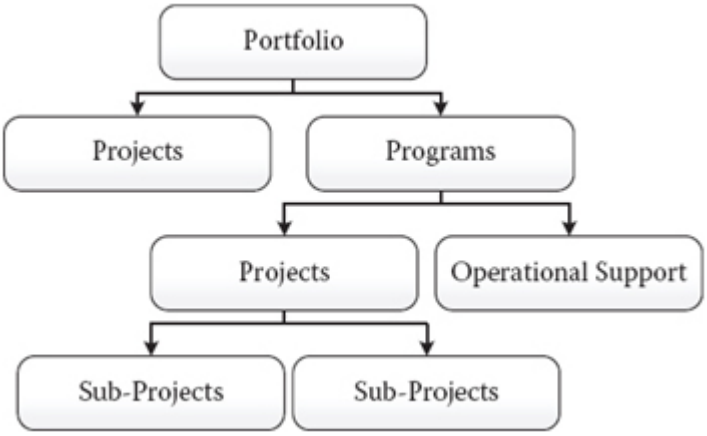

Figure 3. Portfolios, programs and projects (Bojeun, 2014)

Project, program and portfolio management are similar in the sense that they are all connected to; aligned with or driven by the organizational strategies (P.M.I, 2013a). However, there are differences between how these three disciplines contribute to the achievement of the strategic goals (P.M.I, 2013b). Portfolio management ensures alignment with organizational strategies by accurate selection of projects and programs, prioritization of them and having the resources available to execute them. The programs and projects within a portfolio are not necessarily connected or dependent on each other, however they are part of the same organizational unit and use the same resources. Program management serves to coordinate different project and check the interdependencies of projects to make sure that the desired benefits are obtained. Since the projects of the same program are grouped together by its characteristics, managing them collectively will provide benefits that would not be reached by solely individual management of projects. The project management ensures that a plan is developed for the execution of projects so that they reach the objectives of the program and/or portfolio they belong to, which subsequently serves the organizational strategies.

In project management the focus lies on managing individual projects to ensure that the goals in terms of scope, time and cost targets are reached (Kodukula, 2012). However, this project triple constraint is just the tip of the project iceberg in PPM where factors such as various stakeholder value and organizational goals are also addressed, see figure 4. It is important to ensure that what brings value to one stakeholder does not compromise the value of other stakeholders. In comparison to project management, PPM addresses the effectiveness, doing the right things, by selecting the most appropriate projects for investment within the portfolio

whereas project management addresses the efficiency, executing each project the right way (Kodukula, 2012). As a company matures, the need for a more strategically and collective approach to projects increases. Therefore, there is a transition of moving from solely project management to PPM along with the maturity of the company. As the company grows, the perspective becomes more holistic with realization that stakeholder's interests need to be met by several projects.

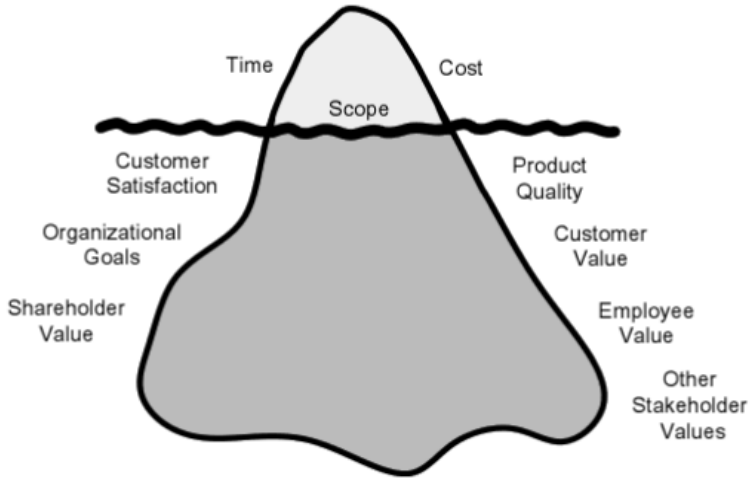

Figure 4. Project Iceberg (Kodukula, 2012)

3.2.3 PROJECT PORTFOLIO MANAGEMENT OBJECTIVES

Cooper et al. (2001) describe three goals of PPM, see figure 5. The first is *maximizing the value of the portfolio* in terms of various business objectives such as profitability, strategy and acceptable risk among others. The second is to create a *strategic balance* of the projects in terms of risk, duration of projects, technologies and market segmentation. The last is to have *alignment with the business strategy*, that investments in projects reflect the direction of the strategy. This is aligned with the definition of a project portfolio provided by Kodukula (2012) namely, *"a collection of strategically aligned, value-generating projects that help achieve organizational goals"*. These three goals also correspond to what EPMC (2011) and Dickinson et al. (2001) describe as the main focus areas in the creation of the "right" project portfolio.

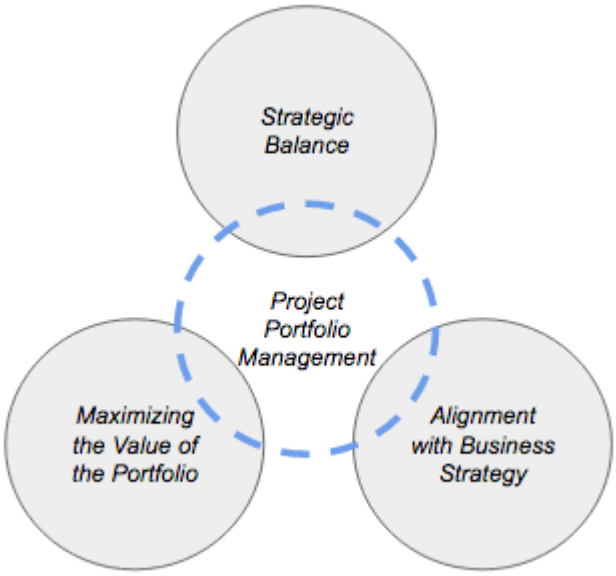

Figure 5. The three objectives of Project Portfolio Management
(Developed from Cooper et al., 2001)

Maximizing the Value of the Portfolio

If resources were unlimited, there would be a possibility to optimize each project so that it results in the highest achievable value. However, in reality this is rarely the case, instead prosperous projects of lower value are postponed and others are done with a suboptimal number of resources (EPMC, 2011). A normal mistake made by companies is to have too many projects running of which all are under resourced, thus not maximizing the value. Instead, organizations need to make trade-off decisions to select fewer projects that are resourced adequately and have a higher potential payoff. Cooper et al. (2001) discuss some challenges related to maximization of the portfolio. There is a challenge in finding an appropriate method for valuation of projects, because if the value of each project cannot be measured, it is impossible to understand how the value of the entire portfolio can be maximized. Furthermore, it is challenging to define the suitable criteria and select the right method to rate and rank projects.

Cooper et al. (2001) present numerous of financial methods for project evaluation such as for instance net present value (NPV) and expected commercial value (ECV). The former, NPV, is commonly used as it functions as a part of the development of a business case. It can be used both for decisions about individual projects, when a positive NPV is a must, and as a comparison to other projects, however, in this case additional information such as resource requirements need to influence the decision (Cooper et al., 2001). The latter method, ECV, provides an advantage against NPV as it incorporates risk and probability in the equation. The method approach is based on a decision tree, where probability of technical and commercial success, development cost and commercialization cost is included in addition to the NPV (Cooper et al., 2001). These methods can be helpful, especially since each project can be described with a few key numbers during portfolio review or project gate review meetings. However, merely relying on financial criteria in portfolio decisions is not preferable since the financial data is often wrong and uncertain before the projects are started. Instead, financial methods should be combined with other methods such as scoring models. Poh et al. (2001) present a comparative study of some of the methods that could be used for evaluation, where their conclusion is that the most favorable method is the scoring model.

The result was based on a number of preferences where the most important were; ability to deal with multiple objectives and consider the risk and uncertainty involved with project proposals. The scoring model will be further described in chapter 3.2.4 Project Portfolio Management Tools.

Strategic Balance

In the creation of a balanced project portfolio there are numerous of trade-offs to consider (EPMC, 2011). EPMC (2011) brings up the primary trade-off of risk versus return, where a suitable portfolio contains projects that differ in their degree of risk and in expected return. Other such balancing key parameters are short-term or long-term projects, projects supporting existing markets or new markets and projects dealing with core business or new business. Furthermore, also Archer and Ghasemzadeh (1999) mention some key parameters to balance such as risk, size of the projects, and short versus long term projects. In all these dimensions the desire is to have a mix of projects, however exactly what a good mix and balance is can be very subjective according to EPMC (2011). Cooper et al. (2001) state that having unbalanced portfolios are common within the industry, where especially extensive focus on short-term projects is frequently seen. To aid in the balancing of the portfolio, visual tools can be used as discussion triggers, where one common tool is bubble diagram, further presented in chapter 3.2.4 Project Portfolio Management Tools.

Alignment with the business strategy

In order to get results from strategies they need to be operationalized in the organization, by making investments and determining which projects to engage in (Cooper et al., 2001). Mikkola (2001) highlights the importance for companies to evaluate their R&D projects from a portfolio perspective. Portfolio thinking can help strategic managers to evaluate the project portfolio's long-term corporate growth and profitability. In order for projects to be strategically aligned in a portfolio they need to be necessary and sufficient for the strategy to succeed, according to EPMC (2011). Cooper et al. (2001) provide a breakdown into three objectives to reach strategic alignment in PPM. The first is *strategic fit*, indicating the need to ensure that the undertaken projects are actually in line with the strategy that has been decided. The second objective is *strategic contribution*, which refers to if the projects are vital to obtain the goals and ultimately realize the business strategy. The final objective is *strategic priorities*, dealing with the question if the strategic priorities are reflected into how investments are distributed. Cooper et al. (2001) describe some approaches that could use to gain strategic alignment, described further in chapter 3.2.4 Project Portfolio Management Tools.

3.2.4 PROJECT PORTFOLIO MANAGEMENT TOOLS

In this chapter, tools to achieve the aforementioned objectives are presented. Firstly, the scoring model, a tool used to maximize the value of the portfolio is presented. Thereafter, the bubble diagram, a tool to facilitate discussion for balancing the projects in a portfolio, is described. To achieve strategic alignment in PPM different approaches can be used, and these are presented last.

Scoring Model

The scoring model is a method to rate projects based on a list of criteria (Cooper et al., 2001). The method begins with formulating and setting criteria based on the desired project characteristics according to the organizational objectives (Kodukula, 2012). Kodukula (2012)

states that the scoring model can be either weighted or unweighted. The weighted version is to prefer, however it poses some challenges as it requires setting the appropriate weights based on the organizational objectives. The weights are determined, that is establishing their relative importance, usually by awarding each criteria a percentage summing up to 100% for all criteria. Finally, the projects are scored on each criteria and result in an aggregated score representing each project's merits.

Cooper et al. (2001) develop a best practice scoring model that has a generic application. This scoring model is based on six main factors, all including sub elements, see Appendix B. These factors are: strategic alignment and importance, product and competitive advantage, market attractiveness, leverage core competencies, technical feasibility and financial reward. A key in creating a scoring model that provides benefits to the company is in the development of a list of appropriate criteria; if poorly constructed the model might not be widely used (Cooper et al. 2001). Cooper et al. (2001) further give some advice in the development of these criteria to consider. For one, it is important not to include an extensive number of criteria since this results in a time consuming process of assessing each criterion, especially when it is done for multiple projects. Secondly, Cooper et al. (2001) also mention the wording of the questions related to each criterion as important, since easily understood questions contribute to a better scoring model.

Kodukula (2012) states that the scoring model is commonly applied and emphasizes the reason for that to be the method's ease of use. Cooper et al. (2001) also discuss the benefits of the scoring model stating that, except for the ease of use, it can also ensure both strategic fit and maximize key variables. It is also a method that can function both as a tool in individual project review meetings and in portfolio reviews where multiple projects are investigated. Some of the strengths of the model are also presented by Cooper et al. (2001). It is a model that includes multiple criteria where there is not a major emphasis on financial criteria, which are often unreliable in the early stages of project development. It forces managers to deeper reflect over projects, can function as a discussion trigger and is facilitating the assessment of the strengths and weaknesses of projects. The result from the scoring model is a tangible number that can be used in the comparison between projects (Cooper et al., 2001; Henriksen and Traynor, 1999). Henriksen and Traynor (1999) state that the scoring model is an advantageous method to use when the projects evaluated have a low degree of interdependence. The fact that the criteria, hence the scoring model, can be customized to each organization also poses as a benefit.

Cooper et al. (2001) also discuss some weaknesses or pitfalls with the model that require consideration. It is easy to have an over-reliance in the precision of the result, however the tangible result is based on uncertain information and cannot be overused in decision making. Another common problem while scoring projects is that a high score in one criterion, increases the tendency that this project also scores high in other criteria. A part of this problem could be that the criteria are overlapping or are rephrased duplications, hence it is of great importance to clearly distinguish between criteria and ensure they serve different purposes. Cooper et al. (2000) also discuss some weaknesses of the scoring model when it comes to discriminating projects. They discuss that the scoring model tend to be used to rate project against absolute criteria instead of against other projects. It also normally fails to include the resource constraint in the scoring, leading to a ranked list of projects having very resource intensive projects at the top and projects that are in the bottom might not have scored as high but would be rather inexpensive to perform. Another pitfall with the method is

that the result easily ends up in the middle; 50 out of 100, which makes it harder to see huge differences between different projects.

Bubble Diagram

In order to understand the distribution of projects in the portfolio, charts can be used as visual aid (Cooper et al., 2001; Mikkola, 2001). These charts can provide a visual description of the balance, something that ranked-ordered lists, scoring models and financial methods lack (Cooper et al., 2001). These tools are primarily there to aid discussions about the balance and clearly depict the current state and less to function as means to create balance in itself. According to Cooper et al. (2001), one frequently used visualization tool is the bubble diagram where projects are displayed as bubbles within a two-dimensional plot. In these plots, the X and Y axes can describe one dimension each, and the size and colors of the bubbles can illustrate additional dimensions. The dimensions used depend on which balancing factors the company finds most essential. Cooper et al. (1997) provide the following list of possible dimensions to use, where they can be combined any way desirable:

- Fit with business or corporate strategy.
- Inventive merit and strategic importance to the business.
- Durability of the competitive advantage.
- Reward, based on financial expectations.
- Competitive impact of technologies (base, key, pacing, and embryonic technologies).
- Probabilities of success (technical and commercial success).
- R&D costs to completion.
- Time to completion.
- Capital and marketing investment required to exploit.

However, one combination that is a frequently used plot is that of risk versus reward, see figure 6. In this plot, Cooper et al. (1997) suggest that one axis relate to some measure of the reward to the organization and the other axis deals with the possibility of success. To further extend the visualization of the projects in the plot, varying sizes of the bubbles is here used to illustrate the amount of resources committed to each project. Additionally, colors provide information to the analyst about the maturity of the project, light color indicating that the project is in a very early stage of a stage gate system.

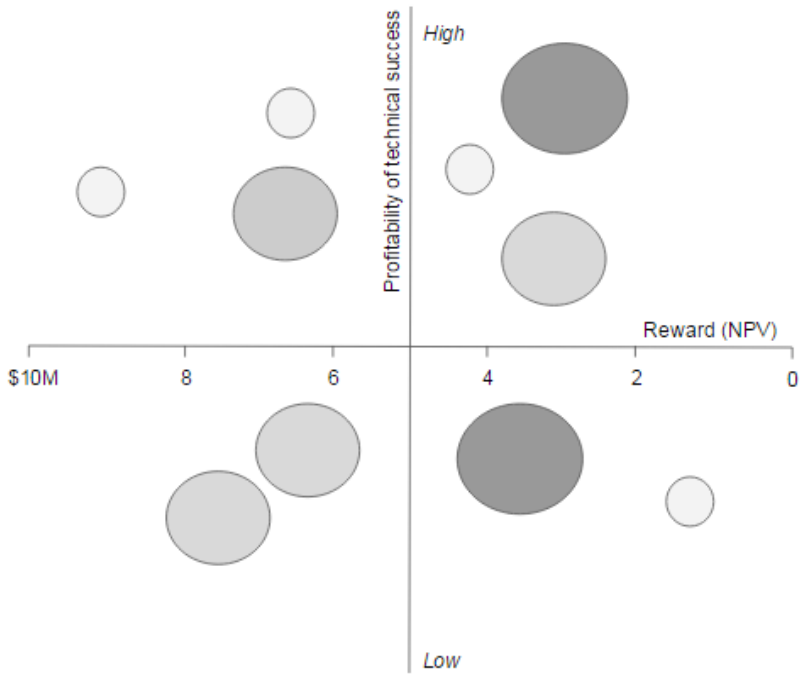

Figure 6. Bubble diagram visualizing a risk-reward profile
(Developed from Cooper et al., 1997)

Strategic Alignment Approaches

Cooper et al. (2001) describe three types of approaches that companies could use to handle strategic alignment; *top-down, bottom-up* and *a combination of top-down and bottom-up*. In the first approach, top-down, the process begins with formulating the vision, goals and strategy and based on this, the project initiatives are decided upon both in terms of timing and how to allocate resources. In the second approach, bottom-up, the process starts with identifying opportunities by creating proposals originating from the whole organization, thereafter screened to solely fund the good ideas. This approach focuses on project selection and the prerequisite are thorough reviews of projects and that the strategic criteria are incorporated into the selection process to ensure that the screening will result in a portfolio of projects that are strategically aligned. However, using the bottom-up approach still requires the business to have a strategy, vision and goals stipulated. The last approach is a combination of the two aforementioned where the process is started from both directions, top strategy development and bottom creation and selection of projects, and both sets of decisions are harmonized through iterations.

Within the top-down approach, Cooper et al. (2001) discuss two commonly used methods that could be used together or separately; the product roadmap and the strategic buckets model. The product roadmap is an effective way for management to map out which products, and when they should be launched, and ensure that capabilities are in place in time to reach the objectives. The second method, strategic buckets model, is a way to ensure that the investments are reflecting the business strategy and the strategic priorities formulated. It is done by developing a strategy and according to that strategy, divide the spending on different kinds of projects, in so called different buckets. These buckets can be based on project type, market, geography or product area (Cooper and Edgett, 2010). One example of project type buckets is presented in figure 7. Each bucket is given a spending target and the projects are

evaluated and prioritized within each bucket (Cooper et al., 2001). This way unrelated projects are not competing against each other and sub-portfolios are created within the main portfolio. It is a way to avoid investments in merely inexpensive and simple projects, since they would outcompete the more substantial projects (Cooper and Edgett, 2010). Using the strategic buckets method ensures a balanced portfolio that reflects the strategic priorities of the company.

Figure 7. Example of strategic buckets by project type
(Developed from Cooper et al., 2001)

3.2.5 PROJECT PORTFOLIO SELECTION PROCESS

According to Archer and Ghasemzadeh (1999), project portfolio selection is a periodical activity where project proposals and active projects are being selected into the portfolio to fulfill the objectives of the organization without excessive use of resources or compromising other constraints. Beric et al. (2012) state that it is relevant and important to look at several projects' overall impact on organizational results, rather than only consider individual projects' success and result. This means that it is critical to observe the entire project portfolio's effect on the strategic goals and overall organizational result. According to Beric et al. (2012), an efficient and effective project selection with a strategic approach is extremely important for an organization's survival. The process of project portfolio selection does not have any integrated framework for carrying this out, but there are several available techniques that assist in this process which can be more or less suitable for each situation (Archer and Ghasemzadeh, 1999). A selection process should be divided in a number of stages including the use of different theoretical models to simplify the process so decision makers can follow the selection process more logically (Archer and Ghasemzadeh, 1999). Each stage accomplishes several objectives and at the same time deliver new information to the next stage.

Archer and Ghasemzadeh (1999) refer to three phases to simplify the project portfolio selection, illustrated in figure 8; *strategic considerations, individual project evaluation* and *portfolio selection*. In the first phase the strategic focus and direction and the overall budget for the portfolio is determined. The second phase handles the evaluation of projects individually, independent of other projects. In the third phase the actual selection occurs

based on, for instance, the projects' interdependencies to each other and resource constraints affecting the whole portfolio.

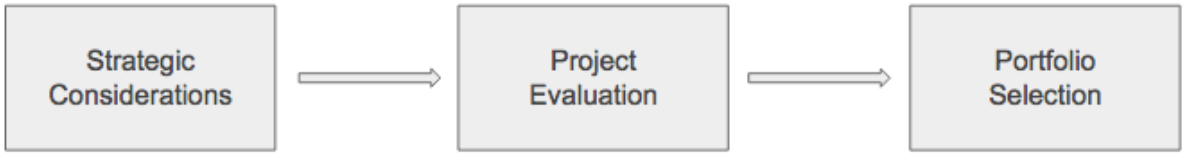

Figure 8. Three phases in the project portfolio selection process
(Developed from Archer and Ghasemzadeh, 1999)

In the first phase, strategic considerations, it is crucial to determine the company's strategic direction and the overall budget, before considering any individual projects (Archer and Ghasemzadeh, 1999). The strategic consideration can be complex and vary in its setup, it involves both external factors, such as the marketplace, and internal factors such as the strengths and weaknesses of the company. Considering all of these factors should contribute to a broad perspective of a company's strategic direction and focus, as well as provide possible competitive advantage initiatives. Worth mentioning is that it is of no value to be overloaded with unnecessary data, but all relevant data should be accessible if needed.

The second phase, evaluation of projects, is done to facilitate the subsequent activity of selecting the projects to a portfolio (Kodukula, 2012). To perform the evaluation there are numerous of methods that can be used and the performance of the evaluation depends highly on what method that is applied (Poh et al., 2001). The choice of method is dependent on the situation (Archer and Ghasemzadeh, 1999). Regardless of which evaluation technique used to determine the measures, these measures will need to be generic for all projects to enable a comparison of projects in the subsequent phase of portfolio selection.

EPMC (2011) and Messner (2013) state that even projects that are mandatory to do, which often refer to legal requirements, are still important to evaluate based on their merits. This is because mandatory projects can have alternatives that can make use of resources in a much more efficient way and still provide the same solution (EPMC, 2011). Messner (2013) argues that each alternative is likely to have different risk profile while providing the same solution as well as having different levels of expensiveness, comfortability and efficiency. Typically, these project proposals are not concerned with measuring the return on investment since these projects are necessities even if they do not generate economical return. Therefore, "must do" project proposals have to be compared to other alternatives according to their relative advantages and disadvantages, costs, time and resource requirements.

The great number of projects considered for the portfolio consequently increases the complexity of making elaborate and sound business decisions. Therefore, Archer and Ghasemzadeh (1999) propose that the initial screening should be made to eliminate projects that do not align with the strategy or deliver the adequate information needed to make logical decisions, before the portfolio selection phase starts. They further describe the screening to be based on thoroughly specified criteria to support this elimination.

The last phase, portfolio selection, includes several comparisons of projects based on specific criteria to end up with a desirable ranking of projects (Archer and Ghasemzadeh, 1999). While selecting projects to a portfolio there can be multiple and conflicting objectives. In

addition, projects can be highly interdependent which has to be taken into consideration. Cooper et al. (2000), state that one of the many risks and challenges when selecting projects to a portfolio is that the projects are not ranked against each other but only against objective criteria. The result is that many projects are passed and little discrimination is made among the projects, resulting in that too many projects are being undertaken. Furthermore, Cooper et al. (2000) explain that this forced-ranking of projects, meaning that they are ranked against each other, is necessary but tough to make and result in a prioritized list. Based on this list the top ones should be financed until the resource limitation requires the lower ranked projects to be put on hold or killed.

3.2.6 CHALLENGES WITH PROJECT PORTFOLIO MANAGEMENT

PPM requires difficult decision making and Cooper et al. (1997) present some important challenges to take into consideration. For one, the decisions are based on uncertain and sometimes unreliable information since it deals with events situated in the future. This is also discussed by Ghasemzadeh and Archer (2000) as well as by Wang and Hwang (2007) stating that this uncertainty increases the complexity. Secondly, the environment in which decisions are made is dynamic where the available project information is constantly changing (Cooper et al., 1997). Furthermore, projects are being compared and evaluated on their relative performance to each other despite being at different stages of development with varying detailed level of information. Lastly, there is a resource constraint and funding of one project might require a transfer of resources between projects, something that is not always smooth. Ghasemzadeh and Archer (2000) also mention that one major reason for why projects are selected but not finalized, is due to this lack of resources and that these resource limitations are not initially stated during the selection process.

Furthermore, Ghasemzadeh and Archer (2000) mention several difficulties associated with project portfolio selection. Firstly, the fact that there are often multiple and conflicting objectives in a project portfolio selection makes it hard to prioritize. Secondly, due to that some objectives can be of qualitative character contributes to a more complex process. Moreover, additional factors that increase the complexity are; the fact that the portfolio need to be balanced in terms of risk and time to completion, projects can be interdependent and the numbers of feasible portfolios are often enormous.

According to Cooper et al. (2000) firms trying to adapt to PPM in order to find the best collection of projects in their portfolio face challenges with using portfolio techniques. Balancing the portfolio with limited resources is one commonly mentioned challenge as well as prioritizing projects when several seem to have potential. Furthermore, the fact that a go/no-go decision have to be taken based on early, and sometimes unreliable, information is challenging. Lastly, Cooper et al. (2000) state that there is often too much emphasis on minor projects in the portfolio, resulting in a smaller proportion of major projects that contribute to technical, market and financial breakthroughs.

3.3 S.M.A.R.T GOALS

Locke and Latham (2006) describe that studies have shown that having specific and hard goals rather than vague, abstract or easy goals lead to higher task performance. One way to accomplish this is to have S.M.A.R.T goals. According to Haughey (2014) the acronym

S.M.A.R.T was first established in 1981 by George T. Doran. The acronym stands for **S**pecific, **M**easurable, **A**ttainable, **R**ealistic and **T**ime-sensitive (Shahin and Mahbod, 2007) see figure 9.

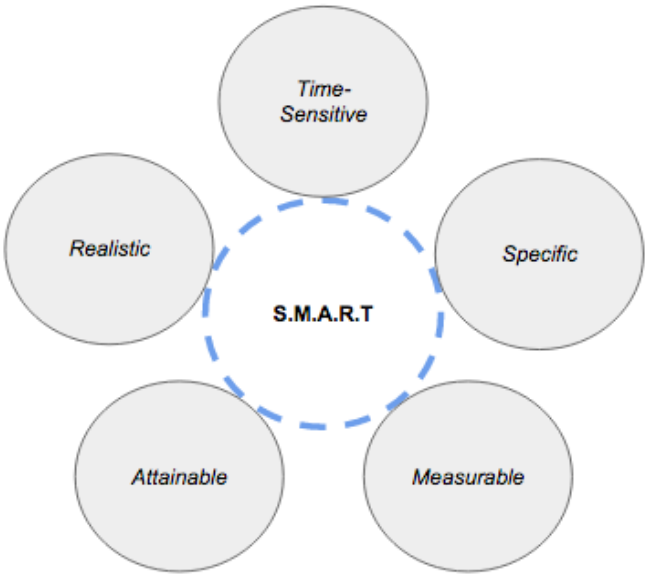

Figure 9. S.M.A.R.T criteria
(Developed from Shahin and Mahbod, 2007)

The first criterion refers to having goals that are as detailed as possible. When goals are specific it is easier to assign someone the responsibility of the achievement. The second criterion stands for creating goals that are measureable in order to determine if the objectives have been achieved. Goals need to be stated clear and concrete rather than ambiguous. The measure could be both quantitative and qualitative, the importance lies in having a measurement that could be compared to a standard. The third criterion refers to setting up goals that are within reach. However, there need to be a balance in how attainable versus how challenging the goals are. The fourth criterion, realistic goals, is an extension of having attainable goals in terms of the goal being realistic in the working environment. If the goals are realistic it will facilitate the examination of resource availability. The final criterion indicates that goals should have a time frame for completion. Setting a deadline should be a part of the goal creation and help in the development of a realistic action plan.

3.4 MAIN FINDINGS FROM THEORETICAL FRAMEWORK

Technology development is largely important for firms' survival and competitiveness. Technology development projects are fragile and should not be managed with conventional methods focusing on financial analysis and profit, since there is a high degree of uncertainty characterizing this types of projects. The development funnel aims to convert an idea into a product that can meet customer need by filtering out unbeneficial ideas at the gates between development phases. A development funnel facilitates the process of selecting the right projects when resources are limited. The three main tasks in a development funnel are; widen its mouth, narrow the funnel's neck and ensure that selected projects deliver on predetermined objectives.

PPM aims to group several projects within an organization so they can be managed collectively as a portfolio. PPM extends further than only deciding the right amount and right type of projects, it also aims to provide a good mix of investment projects. Moreover, PPM strives to obtain three objectives; maximizing the value of the portfolio, strategic balance of projects and alignment with business strategy. To achieve these objectives three tools can be applied, which are scoring model, bubble diagram and different strategic alignment approaches. It is important to review the entire project portfolio's impact on organizational results, rather than only consider individual projects' result. There are three main phases in the project portfolio selection process; strategic consideration, individual project evaluation and project selection. Studies have shown that having specific and hard goals rather than vague, abstract or easy goals lead to higher task performance. One way to accomplish this is to have S.M.A.R.T goals.

4 EMPIRICAL DATA

In this chapter the process of selecting AE projects at Volvo Cars, referred to as the needs/means process, is described. The following sub chapters aim to provide an insight in how these activities are performed based on interviews held with actors involved in the process. The activities are described in detail with emphasis on the needs and means generation. Additionally, improvement suggestions received at the interviews are stated.

4.1 ANNUAL CYCLE OF ADVANCED ENGINEERING INVESTMENTS

The needs/means process is part of the initial stages of the technology development process at Volvo Cars and more specifically the research and AE process. Despite being an existing process at Volvo Cars, the details of each activity of the process are not clearly stated today and there are variances in procedures within different departments. This process is annual, which means that each year decisions regarding which project ideas to execute are made. These project ideas lead to new technology that aim to be implemented in future car projects. In order to understand which AE projects that should be invested in they are guided by *needs* which are developed based on the strategy. These needs are thereafter supposed to be met by a number of *means*, which are ideas about AE projects that could be performed to satisfy the stated needs. The needs/means process is annual and each activity within this cycle reappear but how each activity is performed varies between departments. The annual cycle is illustrated in figure 10.

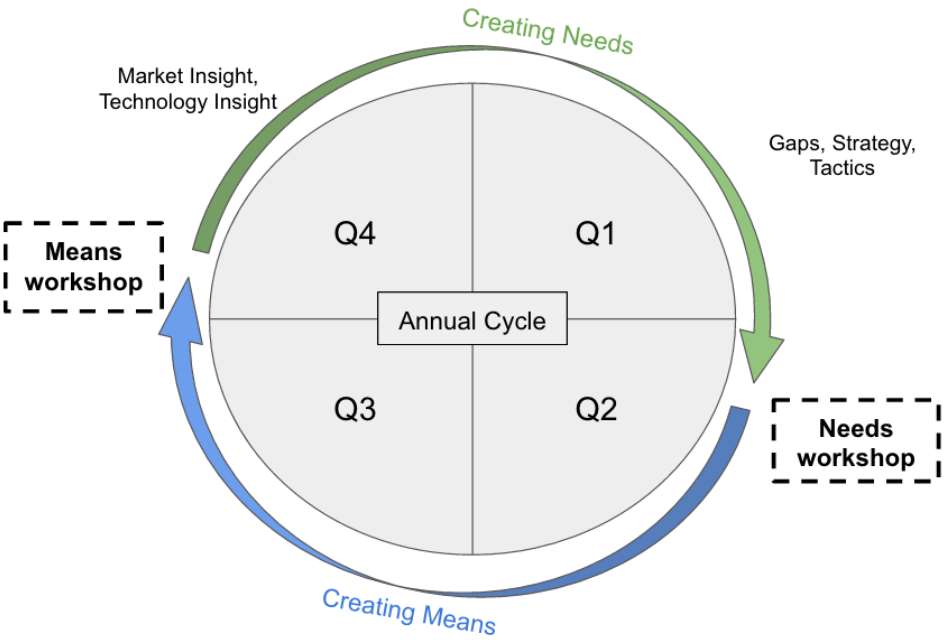

Figure 10. Annual cycle of advanced engineering investment projects

The process initially starts with a strategic update and a gap analysis, which results in the creation of needs. The needs are further presented in a needs workshop. The needs come from different *Attribute Areas* and each of these needs are aiming towards one or several *Engineering Units*. An Attribute Area is responsible for developing its attribute from strategy to product and an Engineering Unit is responsible for engineering the attributes allocated to

that Engineering Unit and achieve targets on own components. The Engineering Units are responsible for developing the solutions, means, that fulfill the needs stipulated. The solutions will further be presented from each specific Engineering Unit at a means workshop, where people involved in the need/means process participate to make sure that the needs are met in a good way. The budget for the AE projects is divided per Engineering Unit and is based on the budget allocated to each Engineering Unit the previous year with considerations from high level strategy and trend analysis conducted. It is the strategic implications that guide the changes of budget from one year to another. This study is focusing on describing how needs and means are created as well as the two workshops where the needs and means are presented, illustrated in figure 11.

Figure 11. Need/means process of advanced engineering projects

In order to obtain a full understanding of the selection process and find improvements areas within the process at Volvo Cars, nine interviews have been conducted with people involved in the process. These people selected for interviews is representing a wide spectrum of the environmental council participants. These interviews have been divided into two main parts and one minor part based on what activities that are performed and what role the interviewee has; creating needs, creating means or leading the Governance Board. This division is made because depending on if they work within an Attribute Area, creating needs, or within an Engineering Unit, creating means, they contribute to the overall process in different ways. Four people have been interviewed from Engineering Units as well as four people from Attribute Areas and will further be described in detail in the following chapters. In addition to the interviews held with Engineering Units and Attribute Areas representatives, one leader of the Governance Board has been interviewed for a more general perspective of the process. In addition to the interviews, existing templates within the process have also been screened.

4.2 ACTORS IN THE NEEDS/MEANS PROCESS

In the needs/means process, several different Engineering Units and Attribute Areas are involved, see figure XX. The Attribute Areas are responsible for providing the annual needs, while the Engineering Units respond to the needs with different means. There are ten different councils where the Environmental Council is one of them, and is the focus of this study, indicated in blue in figure 12. This council meets every other week to discuss the status of the needs/means process.

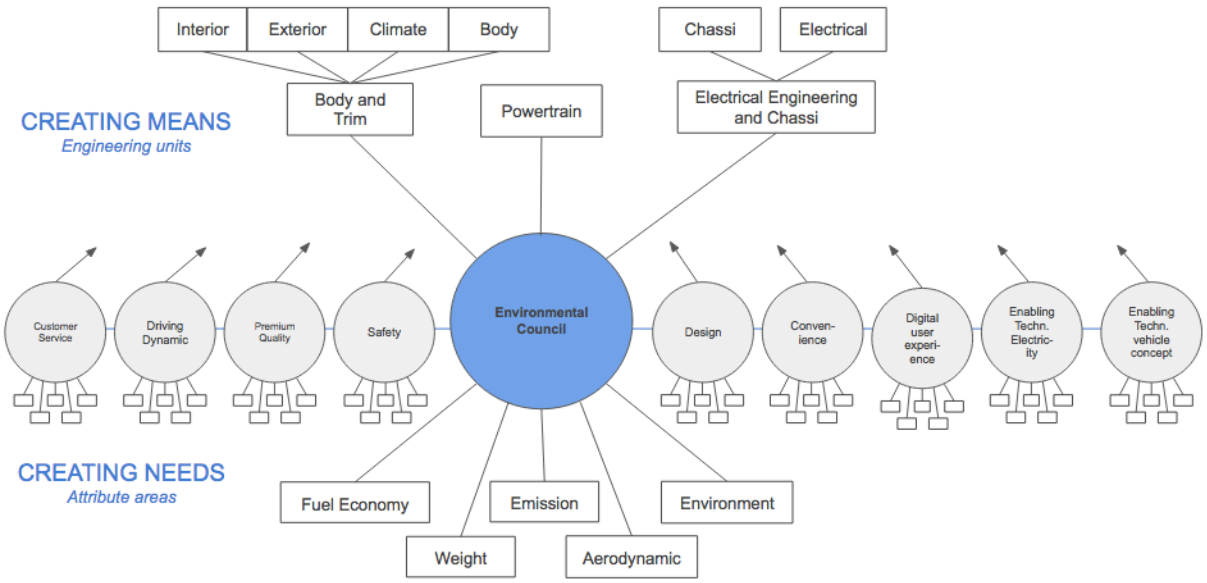

Figure 12. Organization chart of the Environmental Council

Each council have a number of Attribute Areas appointed to them, hence the Environmental Council's Attribute Areas are Fuel Economy, Weight, Emission, Aerodynamic and Environment which further have sub-areas. The main responsibility and task of the Attribute Areas in this annual selection process is to provide the most relevant and crucial needs that are important to find solutions to. These needs are created based on the company's overall strategy. There are three main Engineering Units, some which are further divided into subunits; Body and Trim, Powertrain and Electrical Engineering and Chassi. These Engineering Units are generic, hence they are not connected to a specific council, and should therefore provide means for all of the needs presented by each council.

A meeting point where one representative from each Engineering Unit as well as the leaders of each council meet is called the Governance Board. Here discussions are held regarding the needs created and the means presented for solving the yearly needs, see organization chart in figure 13. These meetings are held weekly and address the status of the needs/means process within each attribute council. The purpose of the Governance Board is to reach a mutual understanding and agreement upon the means that will be invested in and how well they fulfill the needs created. It is also important that the means not selected for execution, due to lack of resources or deprioritizations, are presented as well. The role of the Governance Board leaders is to make sure the process is continuously moving forward and that the project selection is balanced and correct. Correct in terms of initiated with the right timing and that the right resources are available.

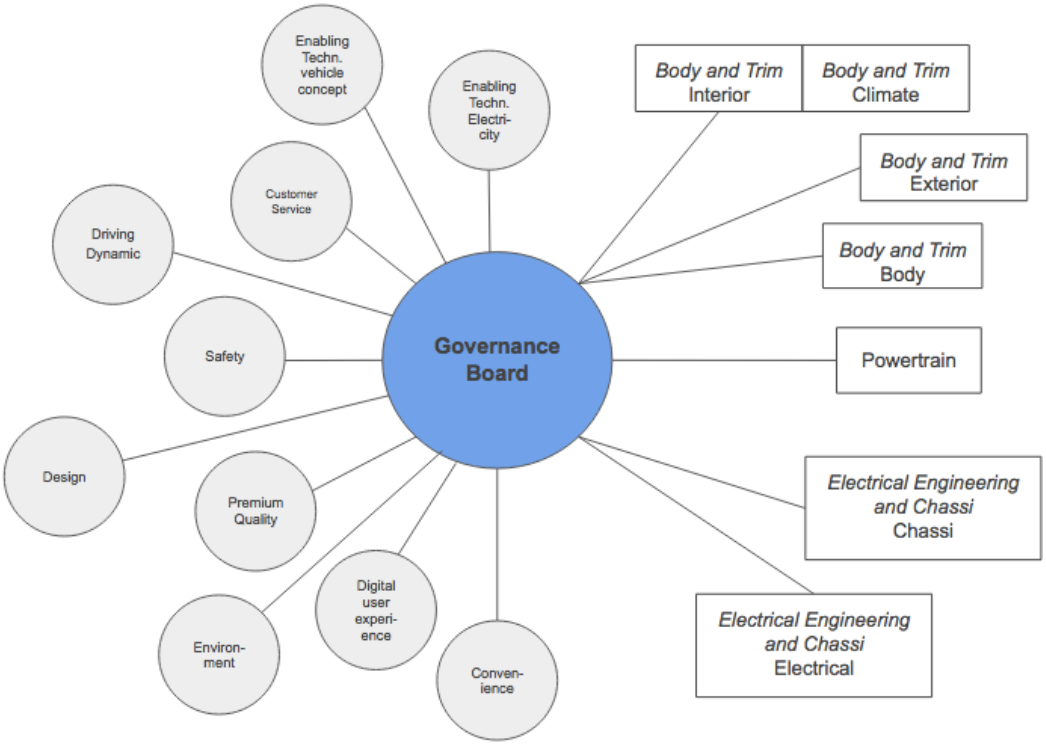

Figure 13. Governance Board representatives

4.3 CREATION OF NEEDS

The initial stage of the needs/means process is to develop needs, which is a result of the strategic update and gap analysis, that will serve as a base for the creation of means. These needs are created by the Attribute Areas and presented to the Engineering Units for further development of means. In this chapter, the process of creating needs is presented, followed by a description of what documentation is used and how the needs are presented to the Engineering Units. The information provided during interviews with some Attribute Areas, as highlighted in figure 14, as well as observation of documentation used form the foundation of this chapter.

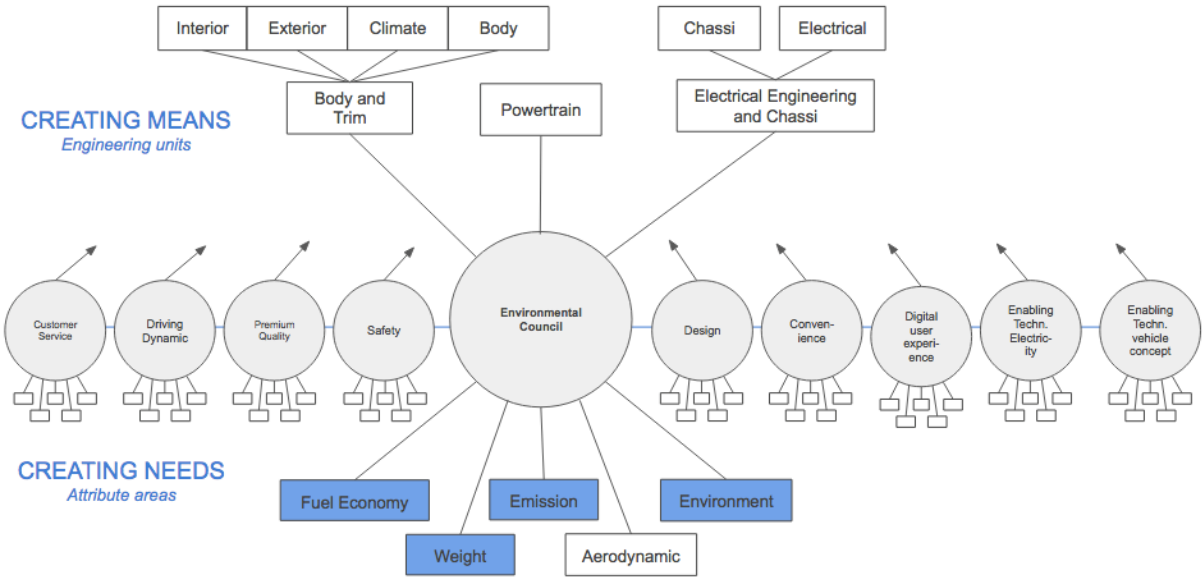

Figure 14. Organization chart of the Environmental Council: Attribute Areas interviewed

As described earlier the focus of the study starts with the creation of needs, see figure 15. The needs are created based on a number of factors, varying slightly depending on Attribute Area. These needs are described in a template and summarized in a list, which is the input to the subsequent needs workshop.

Figure 15. Need/means process of advanced engineering projects: creating needs

4.3.1 FACTORS GENERATING NEEDS

The needs are created based on factors and depending on which Attribute Area it concerns, the factors that are used differ. Most interviewees, from the participating Attribute Areas, state that these factors are *strategic implications* and *legal requirements*. According to the interviewees, the strategy on environmental level form the basis to the needs created. In this environmental strategy Volvo Cars is describing where they would like to be positioned in comparison to their competitors within the different Attribute Areas. One interviewee also describes having a strategy specifically for their Attribute Area, in addition to the overall environmental strategy, where more technical data is used to base the needs on. This strategy is however linked to the overall environmental strategy only with more details.

To be able to translate the strategy into graspable needs and take strategic implications into consideration, a technology insight is required. A technology insight analysis is initiated by determining a competitive set of what competitors with similar products to include, and perform a benchmark on their performance. By knowing what performance competitors have and knowing the performance of Volvo Cars, an identification of gaps can be made. These gaps between competitors' and the current performance of Volvo Cars contribute to the creation of needs stated by several interviewees. However, where to position yourself in

relation to your competitors' performance depend on the strategy, whether it is to be competitive, leading or non-competitive.

One interviewee mentions that sometimes trend analysis in other industries can also function as a technology insight to create needs. In these cases, studies can be made about technology enhancements in various textile industries to find new innovative technologies that could be used in cars in the future. In addition to technology insight, one interviewee also mentions market insight to be a useful analysis to do in order to realize gaps that need to be closed by different means. In this kind of analysis taxes, benefit systems and customer behaviors in various countries need to be studied. For instance, if levels are set for maximum CO_2 emissions for a car to be classified as an environmental car, leading to tax deductions, this can affect sales. Additionally, the same interviewee states that sometimes companies can set their own limitations of CO_2 emission levels on their company cars as a part of their environmental policy, hence also influencing the sales if these levels are not reached.

How these technology and market insights are made varies between the different Attribute Areas. Some of the interviewees state that the benchmark towards other competitors is performed by the Attribute Area itself to be able to state the needs with a target level to reach. In other Attribute Areas, the needs do not have a fixed target level, but rather information about the relative level to the competitors' which is desired, hence it is up to each Engineering Unit affected by the need to perform a benchmark and to know the level of performance of the competitors within their field of expertise. Therefore, the technology insight can be seen also performed at the Engineering Unit, more focused towards their area of expertise.

The other factor influencing how the needs within the Environmental Council are developed is legal aspects. Interviewees states that most of the time there are several regulations, such as maximum levels of emissions and prohibitions of materials that automotive manufacturers need to adjust to. In some cases, these legal requirements are not determined until after the AE projects have to be started, thus estimations and predictions of future legislation is commonly used to create the needs. The character of the legal requirements can vary, for some attributes areas the legislation is referring to the whole car fleet and an average value determines if the legal requirements will be met or not. When this way of measuring is used, more predictions are needed about the expected sales quantity of each car model and the performance of them respectively. In other cases, the legislation implies that there is a strict limit for all cars that each individual car model need to meet, whether it is a complete prohibition or a level that cars need to relate to.

Several interviewees emphasize that the unreliability is evident both in the competition benchmarking and in the prediction of upcoming legal requirements, since most of the projects that are started now will reach car projects that are launched to the market in five to ten years. It is also explained from some Attribute Area representatives that a combination of competition benchmark and legislation changes are taken into consideration when forming the needs.

Some of the interviewees mention that sometimes the process is not made in chronological order of developing needs and thereafter means to meet the needs. In some cases, where frequent discussions are held in between the workshop occasions and the Environmental Council meetings, needs can be developed as a result of the means that the Engineering Units

want to undertake. It could be that the Engineering Units have seen technologies used elsewhere and want to investigate the possibilities for Volvo Cars to implement it, and desire a need that requires an investigation. Therefore, means can already have been developed during an earlier stage than needs have been created and therefore the needs are created for the coming year's process where there is already an existing answer. This is also evident at another Attribute Area where the interviewee describes the needs/means process as more of a guide for deadlines than an actual process. It provides information about when certain things need to be done because without these time reference points, much action would come to nothing.

4.3.2 NEEDS PRESENTATION

To present the needs to the Engineering Units, and also to the Governance Board for approval, a template is used which is covered in one page. In this need template, brief information about the need is presented such as description of the need including target measure and timing and what Engineering Unit that serves as the main recipient. Additionally, strategic drivers, customer benefits and business potential are stated in the need template. There is space for the needs provider to develop and include the information that is subjectively thought of as most important apart from the generic fields. This way charts and other background information can be provided if wanted, but the format is not strictly structured leading to different quality of information provided.

Several years ago the number of needs was a lot more substantial, but today the needs are subjected to prioritization and the number is significantly reduced. All the needs are also described in an Excel file where needs from all councils are compiled. In this list, clearly all information cannot be presented, so the information provided is a summary description. This summary includes the headlines of the needs, brief description, which Engineering Units it is targeting, both main and others, and presumable internal customer. However, in the presentation of needs there is no information about who the creator of the need is.

All of the Attribute Area interviewees think that the need template is sufficient the way it is structured today, however some of them realize that more than just the template and the list of needs is necessary for the Engineering Units to fully understand what is demanded. Some of the interviewees emphasize the need of face to face communication with the construction engineers who are supposed to create means satisfying the needs. The reason for this is that all information cannot be summarized to create full understanding in a document, hence explanatory dialog is needed to extend the message of the need. Furthermore, one interviewee states that, in the case where the needs are explicitly aimed at a certain Engineering Unit, communication beyond the need template is held. However, when there are several Engineering Units that could provide solutions to the same problem, there is a resource constraint on how many further discussions that could be held. As one interviewee states, it can also be difficult for them at the Attribute Areas to know exactly who to talk to and explain the need more in detail. In those cases it is necessary that the Engineering Unit, and more specifically the construction engineer, that is receiving the need actively contacts the need provider for more information.

4.3.3 EXPECTATIONS ON MEANS FROM ATTRIBUTE AREA PERSPECTIVE

The expectations on the means are in most cases not clearly defined. One interviewee states that what is expected of the Engineering Units when handling the needs is that they can provide suggestions of possible solutions to meet the needs. These solutions could be something that already exists or something that has to be developed. The same interviewee emphasizes that focus is on how it can be solved, but usually more input is needed as to if the solution is good from a business perspective as well. It is up to the Engineering Units to show how the gap can be closed and what it would cost, then decisions need to be made regarding whether or not to finance it.

Another interviewee explains that in the list that is provided by the Engineering Units, presenting all the possible means to solve needs, there is too much emphasis on cost of the project. This interviewee is not interested in the cost but rather how much this mean is able to close the gap, which internal car project it aims for and when in time it will be implemented. Furthermore, it is requested that the means are more quantified so that a summary of several means can provide an idea about how much of the gap that is being handled. According to an interviewee, in an ideal case, the list of means would contain information about how much the gap can be closed, what it would cost and how it would affect for instance the manufacturing process.

Furthermore, another interviewee mentions that the expectations on the means from Engineering Units where continuous communication has been held are higher than on the ones where no communication except for the need template has been used. The reason for this is that these units are assumingly possessing a better understanding of the needs. The additional communication is mostly done with the Engineering Units that are supposed to solve a need solely aimed towards this Engineering Unit. In the case where a need is aimed at more than one Engineering Unit it is more difficult to provide extra information about the need to all affected units, unless they actively search for it.

If the targets that the means should meet are quantified or not, differ between the different Attribute Areas. In one case explained by an interviewee, where the Attribute Area solely aim the need towards one Engineering Unit, there are clear target levels and therefore easier to measure if a mean is fulfilling the need or not. For other Attribute Areas it is harder to state if a mean is meeting the need or not. One interviewee states that the needs they develop are not specific enough for Engineering Units to know if they fill the gap or not. The reason for this is that there is a large number of ways of how the need can be solved. This interviewee further explains that there is a dilemma regarding the level of details in the need information. If the need should have a target for the whole car or if the target should be broken down per part system of the car. In the best case, according to this interviewee, all units should try to deliver as much as they can. However, the interviewee explains that the Engineering Units claim that unless they know what is demanded they cannot say what they can deliver.

Additionally, one interviewee explains that they do not have any clear target for their needs to evaluate how well the means fulfill the needs, it is rather a question about gut feeling. This interviewee says that more information is desirable in order to decide if the means fulfill the need, however it is not possible to acquire all information before the project is started, the information will be gather first during the initial stages of the project. To try to get

information earlier is not something this interviewee thinks is possible, due to the nature of AE projects being to test new solutions.

Most of the interviewees state that all the needs are usually not met, they could be met to a certain degree, however not completely satisfied. One interviewee describes that one reason for why needs are not met could be that there are suggestions of possible solutions provided but they are seen as too expensive to be undertaken, and therefore not executed. Another interviewee states that the reason that all gaps are not met is because there are not enough means suggestions provided. One interviewee presents a particular case, weight reduction, where the need is based on competitors' abilities and not legal requirements, thus not an obligation to fulfill. In this case an unfulfilled need only implies that other areas need to increase their efforts to, for instance, reduce fuel consumption or improve the driving experience since weight has an impact on these areas as well. Furthermore, another interviewee states that usually all the needs are touched by some means, however not fully meeting the desired level. Despite that, this interviewee has seen an improvement of means meeting the needs the last year, probably because of the new environmental strategy and the outspoken environmental positioning that Volvo Cars is striving for. When it is anchored in the corporate strategy it is easier to set higher demands on the solutions provided by the Engineering Units.

4.4 NEEDS WORKSHOP

The needs workshop is arranged by the Governance Board leaders and is a workshop where the Attribute Area representatives, or council leaders, get the chance to present the needs, see figure 16. The purpose of this workshop is for everyone involved in the process to know what the needs from the various councils are and create awareness of the big perspective. Within this workshop there is only room for a brief introduction to the needs, and above all, a way to present new needs or modifications to needs that are reused. The idea is that there should be opportunities to both listen and influence the list of needs if something essential is missing.

Figure 16. Needs/means process of advanced engineering projects: Needs Workshop

The selection is initiated already during the needs generation, since each council can only have a limited amount of needs that should be assessed each year and therefore prioritization of the needs is also required. Usually the needs dealing with legal requirements are the ones highly prioritized.

4.5 CREATION OF MEANS

As aforementioned, the main task for the Engineering Units in the needs/means process is to provide sufficient solutions to the needs. This chapter presents the creation of means process, how needs are handled as well as what selection criteria that are used when evaluating the different means. All information was collected during interviews with Engineering Units

representative, highlighted in figure 17, as well as observation of documentation used in this process.

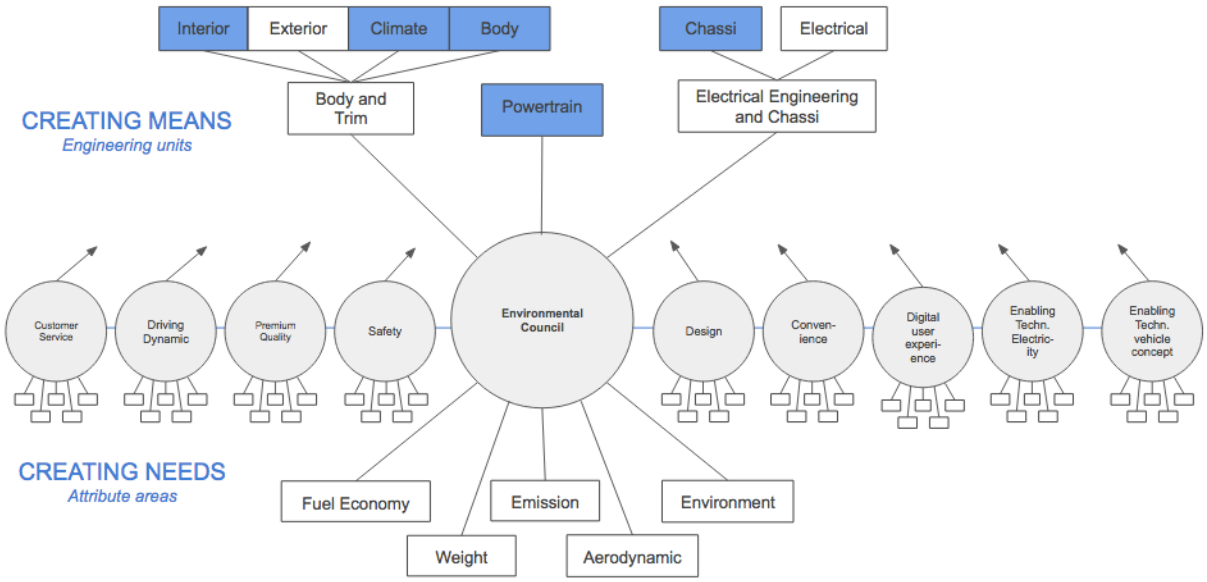

Figure 17. Organization chart of the Environmental Council: Engineering Units interviewed

The means creation process takes place after the needs have been presented by the Attribute Areas and until the final recommendation regarding what means to execute is presented at a means workshop, highlighted in figure 18. The creation of means can differ between the Engineering Units.

Figure 18. Needs/means process of advanced engineering projects: creating means

4.5.1 NEEDS HANDLING BY ENGINEERING UNITS

Needs from the attributes areas are presented in the need template described earlier. According to one interviewee, the template visualizes the information in a graspable and understandable way. However, another interviewee states that the information presented in the need template can be unclear and described very fuzzy. In addition to this template, the Engineering Units also receive information about the needs at the aforementioned needs workshop. During this workshop Engineering Units try to grasp what needs that are critical for their unit, since all needs are not relevant for all units. After the units have understood what needs that are aimed towards them, it is important to understand in detail what the needs are asking for. To get this full understanding of what is demanded, discussions can be held in separate meetings with each Attribute Area respectively, because solely receiving the need template is not sufficient. One interviewee mentions that for these discussions to be held, this Engineering Unit invites the creators of needs aimed at their Engineering Unit to further explain the needs at a brainstorming workshop. However, this is not the reality for all Engineering Units. The same interviewee mentions that these meetings can contribute to idea

generation and suggestions of how to move forward in order to find sufficient solutions for the needs.

Several interviewees highlight the value of having discussions and the importance of taking the time to verbally extend the need description. However, several interviewees also state that the process would have been simplified if the need, from the very beginning, was more specific and presented with a target. According to one interviewee, the needs can initially be presented very broad and unspecified, but to move forward in the process the needs have to be more detailed. If the targets are not clear from the beginning, more time is needed for discussions with these Attribute Areas, thus more resources are involved in the process of clarifying the needs than actually needed. If there are clear targets, it is easier to measure the outcome and performance of the means. The same interviewee mentions that there are cases where the same need can address several Engineering Units, and in these cases it is even more crucial that each unit knows how much of the stated need they are supposed to satisfy respectively. Environmental needs are not varying substantially from year to year, this is the case even if previous years' means partially solved some needs although they were not completely fulfilled.

4.5.3 MEANS GENERATION

Several interviewees state the importance of having an internal customer, usually an upcoming car concept, to be the receiver of a means project, since it is crucial that there is a plan for where the newly developed technology will be implemented. One interviewee mentions that it can be useful to arrange discussions between the one responsible for the means project and the car concept leader of the project that functions as the internal customer, in order to get a greater understanding of important factors to consider. Furthermore, one interviewee explains that workshops with manufacturing are also held in order to investigate if the means have an impact, and how substantial it is, on the manufacturing process. For instance, means can require the manufacturing department to invest in new equipment and having their support during the whole project is therefore very important.

To find means corresponding to the needs, one interviewee mentions that department meetings are held to generate ideas. Furthermore, the same interviewee explains that ideas are also generated through workshops where technical experts and system responsible participate to brainstorm ideas about various needs. Another interviewee mentions that in the process of creating means, the Attribute Areas are not deeply involved, they do have some meetings to clarify the needs where some idea generation could occur as well together with Engineering Units.

According to one interviewee, some needs are harder to find means to than others, one example is needs for weight reduction since there is no actual business within this area and no legal requirements pushing for means creation. It is often harder to find a business perspective on environmental projects than other projects, since they are primarily seen only as a cost and are usually very expensive to implement.

4.5.4 MEANS DOCUMENTATION

Documentation regarding the means during the needs/means process is primarily filling in the Excel file with project titles, which need it corresponds to, associated cost aspects and

suggested project leader among other information. After the means have been accepted for initiation, more detailed information is collected and documented in an GTDS (global technology development system) project template. This template provides a “one pager” where description and information about the project are stated. This document is used for all initiated AE projects and the information is the same regardless of which department it originates from.

In the template there are some cells that are mandatory to fill in while others are voluntary. In addition, the template provides the key contacts within the project such as project leader, project champion, portfolio manager and key customer contact. Usually this template is used first when the project idea has been approved and financed. However, some Engineering Units use this template even before the decision is taken to execute the project since it is a convenient way of collecting sufficient amount of information to take the right selection decision. One interviewee states that one mean can solve additional needs beyond the one that is in focus, which also is documented in the same Excel file. Another interviewee emphasizes the importance of not going into details too early in the development phase, and can find the Excel file too detailed.

4.5.5 DEADLINES WITHIN THE MEANS CREATION PROCESS

In the process of creating means two deadlines are mentioned by interviewees. Firstly, one interviewee describes a list of all proposed project ideas being developed before the summer vacation, which briefly describes the means in order to continue to select and prioritize the means after the summer. Since the sum of all means in this list is costlier than the budget allows, the means have to be prioritized. This list includes both ongoing projects from previous years as well as new projects, which compete for the yearly budget. Secondly, two other interviewees state that their units have a final meeting before the means workshop with section manager and department manager to make sure the right projects are presented.

4.5.6 MEANS SELECTION

If there are several means responding to the same need there has to be a selection of the mean that is most suitable for satisfying the need. However, one interviewee states that there is no selection done at all on their environmental projects because of the scarcity of ideas. Therefore, all means that are created are also executed. Worth mentioning is that one mean can also solve several needs but is always connected to a main need that is in focus. One interviewee highlights the importance of considering the total impact of all means and not only reviewing each mean separately, if all of them can contribute to solving the same need together. One interviewee mentions the importance of not only presenting all means that are proposed to be executed, but also present the means that are not being executed and the reason why they are deprioritized. Furthermore, another interviewee states that discussions and feedback from Attribute Areas are appreciated in the selection process, for instance during the Environmental Council meetings where a presentation regarding the means status is held every second week. However, one interviewee also emphasizes that the Attribute Areas could possibly be more involved in the selection process than they are today.

There can be several factors reducing the number of matching means, for instance a car concept remaining on the same platform can have *restrictions* regarding the radicality of the

projects that could be implemented. Therefore, some means projects get screened out because they require a change of the platform that cannot be made on that particular car concept. One interviewee highlights the importance for Attribute Areas to have good communication with other strategically impacting departments, affecting the future car concept, when creating the needs. This is because means are sometimes terminated further on in the developing process due to other departments' restrictions even though they were agreed upon within the needs/means process. This interviewee further explains that when creating means that never get approved, employees of the Engineering Units lose their motivation to create new means, especially when the reason for rejection is that there are misunderstandings and poor collaboration between departments regarding restrictions.

Furthermore, *cost* is a common factor to take into consideration when selecting the means. Calculations of cost can be made in different ways, depending on in which Engineering Unit it is done. One unit collaborates with manufacturing departments and other departments that can be of interest to really understand what the actual cost of implementing the technology would be and in addition consider their expertise regarding the probability of execution. Questions such as how the new technology would impact the ordinary manufacturing have to be discussed and understood. Another unit only calculates the engineering hours in order to estimate the cost variable. One interviewee states that the cost factor sometimes get too much attention when making investment decisions, it is not realistic to only look at the cost factor since it is only a rough estimation in this early stage of development. Another factor that is used to facilitate the selection of means is the *probability of success*, that the project can be fully executed.

Additionally, depending on what Engineering Unit it concerns, there are different, more specific, criteria to evaluate the means on. For instance, one unit with focus on CO_2 emissions and fuel economy have *cost per gram of reduced* CO_2 as a criterion. According to one interviewee, needs that arise from legislation are crucial to address with means in order to prevent being prohibited of selling cars. Therefore, *risk* is taken into consideration since the means corresponding to these legal requirements have to be successful and therefore these projects should have a low risk profile. The consequences of not meeting these needs are severe, which result in that they are performed even if they are very costly. According to another interviewee, more risk projects would be appreciated since it generates future knowledge and increases the level of innovation.

4.5.7 ATTRIBUTE AREAS' INVOLVEMENT IN MEANS SELECTION

One interviewee from the Attribute Areas explains their involvement in the means selection as expressing their opinions about the proposed means, rating and prioritizing the ideas from their point of view. However, the budget is set on Engineering Unit level so the decisions are made within the Engineering Units, where they can choose to consider the suggestions from the Attribute Areas or not. The same interviewee says that it is up to the Engineering Units to select the means that they feel satisfy Attribute Areas the most. Another interviewee expresses the desire to be more involved in the selection of means and to have the possibility to see all the ideas that are created, not just the ones that are presented at the Environmental Council meetings. However, this interviewee realizes that in order to participate in the selection process the Attribute Area representatives need to collaborate more with the Engineering Units, which is an extensive work to do.

Furthermore, it is expressed that there is an issue in the fact that the people that are executing the projects are the ones deciding which projects to undertake. This interviewee explains that by having that structure, some ideas can be deprioritized on the wrong pretenses where the actual issue is that the project poses a too big of a challenge, something the Engineering Units do not want to take on. This can lead to personal interests influencing in the decision making rather than only the project's merits.

Furthermore, another interviewee says that attending the Environmental Council meeting is the main point of involvement in the selection process. During this meeting the mean proposals are shown in a list and the means that are aimed at that interviewee's Attribute Area are viewed. Usually not a lot of means are created for this interviewee's Attribute Area, the means that are created are therefore undertaken. Therefore, there is not a suggestion of how to prioritize from their point of view. However, this interviewee also expresses the will to see more of the means ideas that have not been selected at the Engineering Units. The interviewee further explains that if there are few means suggestions aimed at their needs they might approve it even though it is not an idea they believe in. The reason for this could be that the budget is divided per Engineering Unit and not per attribute council or area. This interviewee further describe that the budget is in theory determined per council. However, in practice the Engineering Units are assigned a budget based on the previous year's budget.

4.6 MEANS WORKSHOP

The means workshop is an opportunity for the Engineering Units to present the means developed to meet the needs aimed at their specific Engineering Unit, see figure 19. The purpose of the workshop is to understand and agree upon the means that each unit will undertake, confirm that prioritized needs are met, get information about key communication points and agree also on the means that will not be executed. The workshop is a way for everyone involved to get a holistic perspective of the AE projects that will be initiated. However, the means created have already before, and after, this workshop been discussed at the Governance Board meetings. In these meetings it is essential to get input from the representatives from the councils since their knowledge about whether or not a need is met is very important. It is up to each Attribute Area representative to determine if the efforts proposed are sufficient to fulfill the needs, and in this analysis a holistic perspective of all means is needed.

Figure 19. Need/means process of advanced engineering projects: Means workshop

The means workshop is a final draft of which projects that will be financed but the final decision is taken a few weeks after the workshop has been held. However, the financed means are usually not deviating significantly from the workshop proposal. The decision about which projects to invest in is to some degree restricted to the amount resources each Engineering Unit manages, which rarely varies substantially from year to year. The reason for this is that major organizational changes and transfers of people are difficult to make. The

engineers working at one specific unit are usually specialized within that area and cannot easily be transferred to another specialization area.

4.7 IMPROVEMENT AREAS WITHIN THE NEEDS/MEANS PROCESS

In general, many interviewees describe that more personal engagement and communication need to be held beyond what the needs/means process requires. One interviewee from an Engineering Unit mentions that it is essential that the creators of needs ensure that the message reaches the people it is aimed for and is well understood. The process in itself is not by default enhancing discussions outside the workshops. Another interviewee from an Attribute Area describes the process of presenting the needs and the means as very structured, however there are no real guidelines as to how the means idea generation should be performed or handled.

There is no transparency into how the ideas are created and what ideas that have been deprioritized from the Engineering Units' side to the Attribute Areas. Furthermore, one interviewee from an Engineering Unit would like to see more involvement from the Attribute Areas in the means creation process since their expertise is valuable in this process. An idea proposed from one interviewee is therefore to use another tool for collecting and refining ideas that is currently used in other innovation processes within Volvo Cars. It is called the Idea Generator and can function as a support to the creative process and increase the collaboration between Attribute Areas and Engineering Units, more details about the Idea Generator is described in chapter 4.8 Idea Generator.

Interviewees from both Engineering Units and Attribute Area emphasize that needs have to be presented with more specific targets in order to facilitate the creation of means as well as the selection of them. Furthermore, also the presentation of the means has to be more quantified in terms of target levels, in order to understand how well it meets the need. Additionally, presenting the importance of fulfilling needs and inform what happens if the need is not fulfilled, are asked for from the Engineering Units.

Another common comment is that the Excel file used to consolidate the needs and the means is suboptimal. One interviewee mentions that the Excel file is not a good communication tool since there is no space to either provide sufficient information about the purpose of the needs or detailed enough descriptions of the means. There is a need for a better communication tool where more information can be transferred between the Attribute Areas and the Engineering Units. The interviewee desires a communication tool that could be used for discussions around the means and their significance.

Another interviewee states that the version handling of the Excel file is also creating problems with not knowing the latest update of the list. Furthermore, a comment from another interviewee is that the Excel list of means should describe to what extent each need is fulfilled by means but this is hindered by the fact that most means are stated to meet more than one need. In this case it is not clear how much the need will in fact be solved by the specific mean. Furthermore, other interviewees mention that sometimes it can be too much focus on the project's cost and budget than on what the actual means are generating when evaluating them.

4.8 IDEA GENERATOR TOOL

This chapter is based on an interview with a representative from the corporate innovation office, written documentation about the tool and some testing of the functionality of the tool called Idea Generator. The vision for the tool is to provide one way of collecting ideas, where multiple organizations can be addressed (Volvo Cars, 2016b). It is furthermore a way to create transparency among ideas, prevent duplications to appear and provide availability for everyone to view and comment on created ideas. Furthermore, the tool is supposed to encourage more collaboration and a way to change the behavior to be more open and global within the organization.

The interviewee describes how the tool is primarily used for a yearly big innovation challenge within Volvo Cars globally called Global Idea Generation (GIG). Under a limited time period all employees at Volvo Cars has the opportunity to create ideas linked to the topic that will be the main focus of that particular year. However, the Idea Generator can be used for more challenges than the GIG, it is a tool that is open all year around and can be used by anyone interested in creating a challenge to increase the idea generation within a particular area (Volvo Cars, 2016c). The person responsible can choose for how long time there is a possibility to add ideas, decide who has accessibility to add ideas and is free to design the challenge based on its own preferences.

The process for using the tool is that a challenge is defined in collaboration with the Corporate Innovation Office and an idea box is created (Volvo Cars, 2016b). This idea box is the place where all the ideas generated which are aimed at this challenge are compiled. The idea box should contain explanation about the challenge and what will happen with the ideas submitted, for instance information about how they will be evaluated. Idea givers submit ideas and these ideas can thereafter be commented upon by other employees to improve the idea further as well as be liked to show appreciation of the idea. The idea box manager, the person initiating the challenge, hereafter sets up the evaluation which can be aided by predetermined evaluation criteria, number of comments and likes that each idea has been given. Eventually, the ideas that are found fulfilling the purpose of the challenge can be selected and developed further.

The interviewee explains that the Idea Generator can have a wide range of applicability and is currently used for minor challenges in addition to the GIG. It is a way to handle and sort ideas which can be a useful function for other idea generation processes. Within the tool it is possible to design the box quite freely. In the administration mode the box information can be edited and the owner is able to create a template for the idea submissions. This way the information gathered from each idea can be generic and structured. There is also a possibility to add what information that is required to provide, thus an idea cannot be submitted without adding this particular information. Within this tool also the evaluation criteria can be determined and people can be assigned to be evaluators of the challenge. The tool has the functionality of different filtering options and extracting excel lists of the ideas with the submitted information. When an idea giver is submitting an idea, the name of that person is connected to the idea, thus traceability of the origin of the idea is enabled.

4.9 MAIN FINDINGS FROM EMPIRICAL DATA

There is a need for more collaboration between the Engineering Units and the Attribute Areas. For one, the Engineering Units representatives state that the Attribute Areas could be more involved in the selection of means projects, and the Attribute Areas representatives also express the will to be more involved and to have the chance to see all the ideas that are being developed. Currently, the need/means process does not require personal engagement, however some interviewees says that this is something needed to improve the performance of the process. Another issue expressed is that there is no transparency in how the ideas are created and how the ideas not proposed have been deprioritized. Furthermore, the Excel file is suboptimal and another tool for collaboration and communication is desired. Additionally, discussions with the car concept leader, functioning as the internal customer, are needed in the development of means projects to ensure that the technology developed will be implemented and is something that the customer requests.

There are some issues about the selection of projects. First of all, there is sometimes a lack of ideas which leads to ideas being selected even though they are not fully believed in. Furthermore, there is a problem in the fact that the same people that will perform the projects are also the people most influential in the selection of these projects. This way, projects can be deselected based on the wrong pretenses. Another outspoken issue is that the financial aspects get too much attention, where project reviews tend to focus on the cost and budget more than other characteristics.

Furthermore, several interviewees from both the Engineering Units and Attribute Areas state that the targets for the needs have to be clearer and more precise. More specific targets increase the understanding of what needs to be done in terms of means and it also facilitates the evaluation of means proposals. Moreover, it is essential that also the means are presented with quantified numbers of how much of the needs that are met, this makes it easier in a compilation to understand how much the means are collectively solving the needs.

5. ANALYSIS

In the following chapter, the theoretical framework and the empirical data are combined to address the three research questions. Firstly, the question about the activities and actors within the process is discussed, followed by an assessment about what tools that could be beneficial to use in the need/means process. Finally, the analysis chapter ends with a discussion about what kind of information that is needed, and where, in the process.

5.1 ACTIVITIES AND ACTORS IN THE NEEDS/MEANS PROCESS

To answer the first research question, *what activities should be performed, and with which actors, in the project selection process to ensure investments in the right projects?* an analysis is made regarding how various literature reviews can be combined and to what extent this is reflected at Volvo Cars as of today. The right projects refer to projects that are aligned with strategy, that is responding to the needs, and maximize the value of the portfolio. The chapter is initiated with a description of how theories can be merged and how Volvo Cars is currently working to find a suggestion of which activities to include in the needs/means process. Furthermore, each activity is analyzed and described in more detail and a suggestion of which actors that should be involved in the activities is presented.

5.1.1 ACTIVITIES WITHIN THE NEED/MEANS PROCESS

As input to the construction of a selection process for development projects, there are two theoretical frameworks that have been discussed. Based on the theory about the development funnel by Wheelwright and Clark (1992) and the portfolio selection process by Archer and Ghasemzadeh (1999) one consolidated process can be constructed. The first phase described by Archer and Ghasemzadeh (1999), strategic considerations, is not part of the development funnel, however the subsequent phases of project evaluation and portfolio selection can be connected to the screenings that are separating the phases in the development funnel.

Archer and Ghasemzadeh (1999) state that in the project evaluation phase, projects should be evaluated individually and function as an initial screening to eliminate the projects that do not align with strategy nor can provide sufficient information. This can be compared with the purpose of the first screening in the development funnel by Wheelwright and Clark (1992) which is to determine what additional information is needed. The first screen should be a way to narrow the funnel, which is described being done by removing projects that do not fit with the technology and market strategy, similar to what Archer and Ghasemzadeh (1999) discuss about the project evaluation phase.

In the portfolio selection phase, Archer and Ghasemzadeh (1999) state that comparison between several projects is needed based on some predetermined criteria. In this phase it is important that projects are not just compared against objective criteria but also compared relative each other (Cooper et al., 2000). This can be compared to what Wheelwright and Clark (1992) state about the second screening being a point where decisions about what projects to fund are made, thus it is important that the right ones are funded. Furthermore, this screening aims to do a comparison of competing and complementary projects. This leads to the development of a merged theoretical selection process visualized in figure 20.

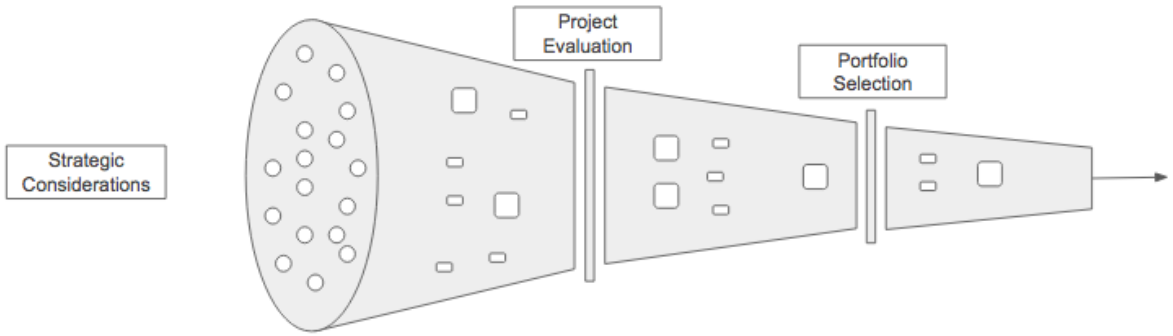

Figure 20. Merged theoretical selection process

The first phase mentioned by Archer and Ghasemzadeh (1999), strategic considerations, can be seen performed to some extent in the current process at Volvo Cars. The fact that needs are created based on the formulated strategy and that the means should respond to the needs creates a linkage between the strategy and the projects executed. However, there are different ways this linkage is done depending on Attribute Area. Furthermore, the second and third phase, project evaluation and portfolio selection, also mentioned by Archer and Ghasemzadeh (1999), can be seen partly done at Volvo Cars when Engineering Units create means. In the creation of means, Engineering Units select what means to propose at the means workshop. However, there is not one structured way this is done among the Engineering Units. Some Engineering Units have more or less structured project selections, however the common thing between all Engineering Units is that the selection is done with limited participation from the Attribute Areas. In what way the theory has been applied to the needs/means process is visualized in figure 21.

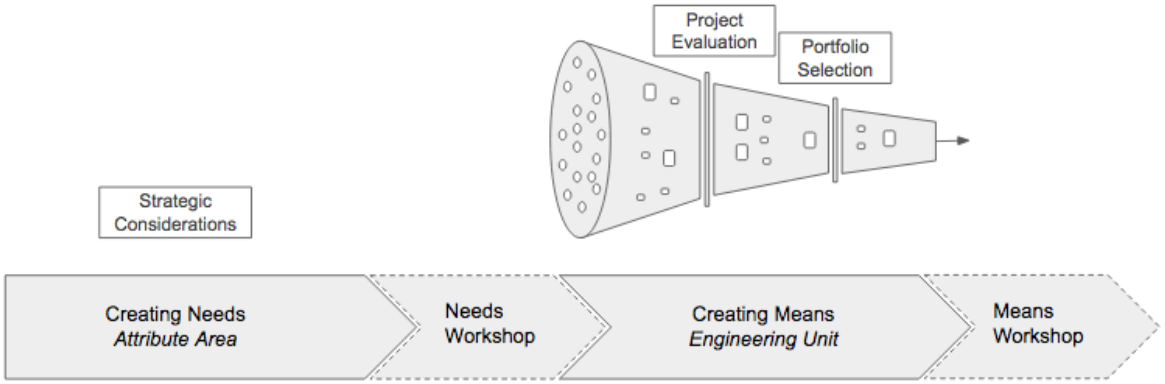

Figure 21. Theory applied to current need/means process at Volvo Cars

Based on the theoretical selection process and the connection made to what Volvo Cars is currently doing, a suggestion of an expansion of the stages, creating needs and means, is made and can be seen in figure 22. The stage of creating needs and means are further analyzed in the following sub-chapters where connections between theory and empirical data are made in more detail. The workshops in between creating needs and means are, according to interviewees, seen as valuable deadline points and activities that make sure that everyone is aware of which needs and means are in the pipeline.

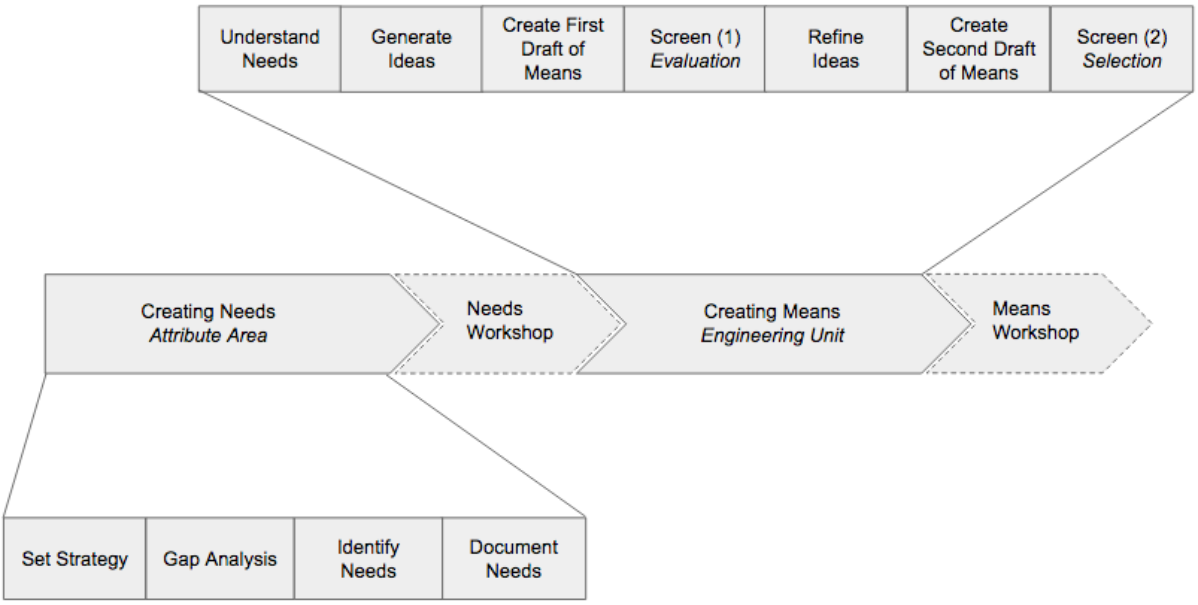

Figure 22. Expanded stages within the needs/means process with activities

5.1.2 ACTIVITIES AND ACTORS WITHIN NEEDS GENERATION

In the first stage, creating needs, there are four main activities identified; set strategy, gap analysis, identify needs and document needs, see figure 23. These are all connected to the first phase described by Archer and Ghasemzadeh (1999) of making strategic considerations.

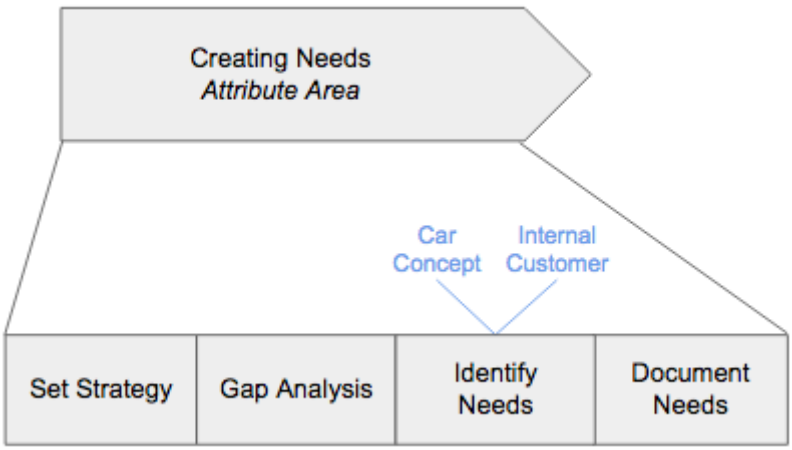

Figure 23. Activities and actors in the stage of creating needs in the need/means process

As described by Archer and Ghasemzadeh (1999), in the phase of strategic considerations, the strategic direction needs to be determined before any projects can be considered. The first activity, *set strategy*, can be seen as a mean to set the strategic direction by developing the environmental strategy. In this strategy, Volvo Cars is explaining where they would like to be positioned in comparison to competitors. In order to develop the environmental strategy, Volvo Cars is using technology insight and market insight to understand how they are performing in regard to their competitors and upcoming legal requirements. These initial insights give a brief idea of within which Attribute Areas the strategy need to change and where most efforts are needed. Having this initial activity, set strategy, in the needs/means

process also implies that one of the objectives of strategic alignment, strategic fit, described by Cooper et al. (2001) is being addressed. This objective is explained as only undertaking projects that are in line with the strategy.

When creating needs based on the strategy a linkage between projects, that correspond to the needs, and the strategy is generated. Thus, the needs are the link that bind the strategy to the means projects. As stated by interviewees, having this strategy alignment makes it easier to communicate the importance of a need and also to get people more motivated to develop means. Another comment from interviewees is that when the needs are anchored to the strategy, higher demands can be put on the means.

The second activity is making a *gap analysis*, where the strategy is translated to tangible needs. Volvo Cars is doing a gap analysis by performing technology insights and market insights. This can be connected to the strategic considerations phase described by Archer and Ghasemzadeh (1999), where input should be gathered from both external factors, like the marketplace, and internal factors, such as the company's strengths and weaknesses. In these analyses competitors' performance is assessed to enable a comparison to the performance of Volvo Cars which result in a realization of the existing gap.

The technology insights are not only performed against other competitors, but also sometimes towards other industries. As described by Wheelwright and Clark (1992), the first task in the development funnel is to widen its mouth, which refers to expanding the company's knowledge base. One way that Volvo Cars is doing this is by performing these technology insights towards other industries such as various textile businesses. This way the knowledge about technologies in related industries can be used to improve the product of Volvo Cars. As expressed by an interviewee, benchmarks towards different textile industries' development of sustainable materials can function as a source of information on how to enhance the material choices in the car to be more sustainable. However, it is important that this knowledge is transferred to the means generation stage where the project ideas are developed.

Once the gaps are determined, they have to be turned into graspable needs, thus the subsequent activity is *identify needs*. One important comment from interviewees is that there is a need to have stronger collaboration with other actors within the company when translating the gaps into needs. Some of the Engineering Unit representatives desire better communication between the Attribute Areas and the car concept department as well as the potential internal customer to ensure that the need is requested for and projects ideas are not developed in vein. This refers to the fact that the generated means can be suitable for the need but are eliminated or killed later on due to other restrictions from other departments. Therefore the needs creation, especially the anchoring to the overall strategy of the car concepts and specific car models, needs to be performed more cross-functional. The Attribute Areas need to keep a dialog with departments that might influence the means aimed at their needs to prevent ideas being created and then stopped due to restrictions elsewhere within the organization.

The final activity within the stage of creating needs is *document needs*. This is an important activity since it is one way to transfer the information about the need to the means creators, which is vital to ensure that the strategy is reflected into the means. Based on the theory by Cooper et al. (2001) about strategy alignment, it can be concluded that the link between strategy and the projects undertaken is the needs. Therefore, it is essential that the

documentation of the need addresses the connection to strategy and communicate the importance of creating means corresponding to the need. This is in line with the comment from one interviewee about more strategy alignment can be a motivation to increase the means idea generation to correspond to the need. In the documentation of needs it can therefore be beneficial to discuss why it is important to fulfill the need, both from a company strategic perspective and a market perspective. Since this strategy linkage, as one interviewee mentions, creates an urgency to deal with the need and a way to enable higher demands to be put on the corresponding means. The existing template used today contains a header called strategic drivers, however there can be different interpretations of what this means which lead to varying information input. The content of the documentation in the need template is further analyzed in chapter 5.3.2 Information in Documenting Needs.

5.1.3 ACTIVITIES AND ACTORS WITHIN MEANS GENERATION

There are seven main activities that should be performed in the stage of creating means and in some of them cross-functional work with other actors than the Engineering Units are recommended, illustrated in figure 24.

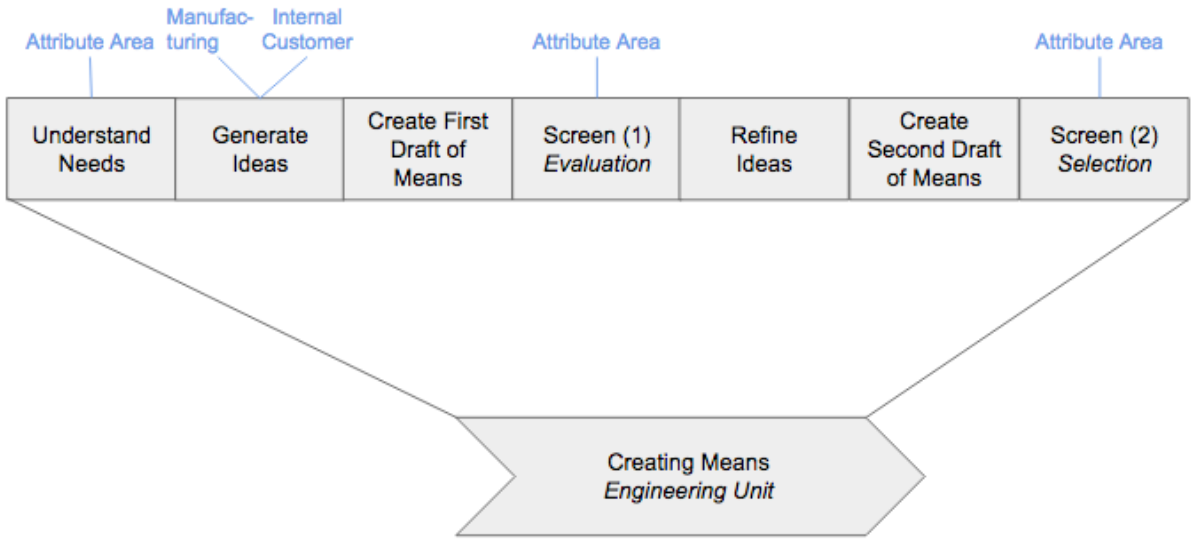

Figure 24. Activities and actors in the stage of creating means in the need/means process

In the first activity, *understand needs*, it is of high importance that Engineering Units and Attribute Areas communicate and collaborate in order to fully understand what the needs are asking for. The Attribute Areas, creating needs, have valuable expertise that should be transferred to the Engineering Units that will develop the project ideas further for each specific need. Furthermore, several interviewees stress the importance of having face to face communication in order to understand the needs and satisfy them in the best way. As discussed before one need can aim at several Engineering Units, which therefore require a lot of communication with different departments. Hence, knowing that these discussions can be time-consuming and dependent on resource availability, it is crucial to find a balance and not spend an excessive amount of time on it.

Some interviewees state that the presentations of needs in the need template can be very fuzzy and therefore find these additional discussions valuable, however they also state that

the process would have been simplified if the needs from the very beginning were more clear and presented with a target. Having targets and goals is described by Locke and Latham (2006) as something that lead to higher task performance. In addition to understanding the needs this activity can also generate project ideas and facilitate the process of going forward, mentions one interviewee.

According to Wheelwright and Clark (1992), a product development process always starts with several project ideas, but often resources are not sufficient to develop and realize all project ideas. Therefore, a development funnel can be applied in order to simplify the selection of projects. This development funnel can be applied to the activities within the stage of creating means in the need/means process as illustrated in figure 25.

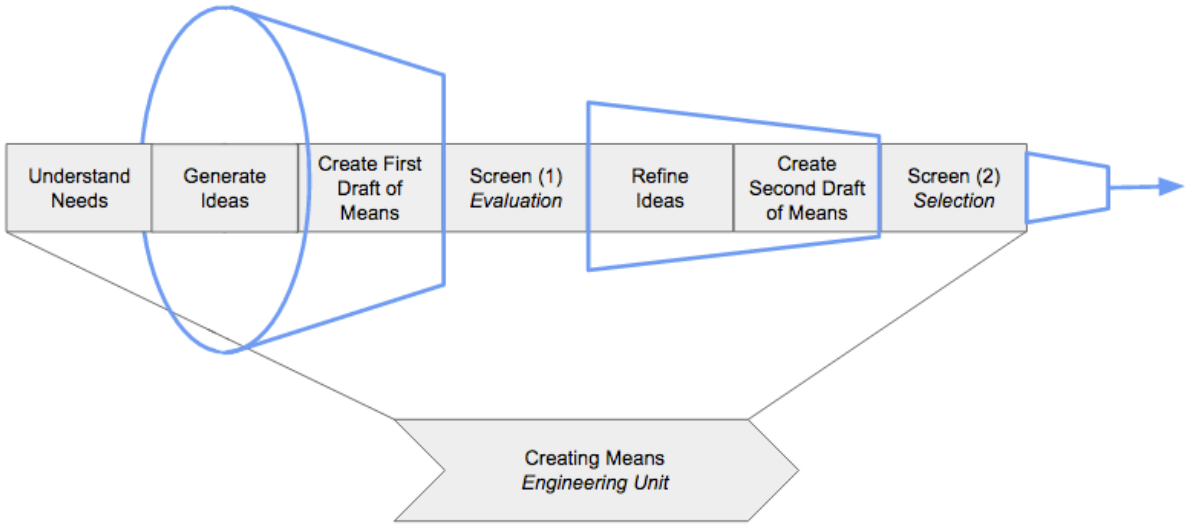

Figure 25. Development funnel applied on activities within the stage of creating means

The second activity, *generate ideas*, can be seen as the first phase mentioned by Wheelwright and Clark (1992) which aims to generate projects and concepts. This phase involves one of the main tasks within the development funnel, namely widen the mouth, which focuses on expanding the knowledge base in order to find project ideas (Wheelwright and Clark, 1992). In addition, Gupta and Wilemon (1996) also state that idea generation should be done cross-functional. This is the reality for some Engineering Units where the knowledge base is expanded by collaboration with manufacturing and internal customers when generating ideas, however this is not done by all. Collaboration with manufacturing is beneficial since they have expertise regarding how the AE projects can have an impact on the manufacturing process and they could assist in the estimation of the total cost of the project. Collaboration with an internal customer results in information regarding the critical factors to consider in the project development and what the demand is from the internal customer's perspective. Having cross-functional collaborations can be time-consuming, however Wheelwright and Clark (1992) state that providing time and funding for people motivate and encourage these types of collaborations.

According to one interviewee there can be too few ideas generated which can result in a poor selection of ideas further on in the process. Therefore, it might be valuable to have additional cross-functional collaborations and brainstorming sessions with other departments in order to solve the scarcity of ideas and expand the knowledge base.

The third activity in the process, *create first draft of means*, should provide input and information in order to perform the first screening of project ideas. The degree of detail in this first draft is very brief because, according to Wheelwright and Clark (1992), the first screening aims to narrow the funnel and determine what additional information regarding each project idea that is required. One interviewee highlights the importance of not going into details too early in a development process, which can respond to the concept presented by Wheelwright and Clark (1992) stating that early on in the development process information collection should only be brief. Therefore, the first draft of means should contain only the most essential information needed to perform the first screening, which can be collected in a documentation template to ensure that the same information is provided from all types of project ideas.

Currently, Volvo Cars is within some Engineering Units compiling a list of project ideas at an early stage, only indicating the title of the project and a brief description which can be seen as the first draft of means. This is aligned with the theory presented by Wheelwright and Clark (1992) about how the information functioning as input to the first screening should be. From this list some of the project ideas will be developed further when a first assessment has been made. However, this procedure is not existing within all Engineering Units. What exactly the documentation template should include is further discussed in chapter 5.3.3 Information in Create First Draft of Means.

In the subsequent activity, *Screen (1) Evaluation*, an individual evaluation and feedback session on project ideas independent of other projects, should be performed according to what Archer and Ghasemzadeh (1999) state about project evaluation. The feedback should focus on what additional information that need to be gathered in order to do an appropriate final screening. This first screening also refers to one of the main tasks in a development funnel, narrowing the neck, since it is a way of eliminating projects not aligned with strategy according to Wheelwright and Clark (1992). As of today, there is no structured or generic way to perform screenings of project ideas at Volvo Cars. Each Engineering Unit, creating the means, have unique ways of selecting which project ideas that should be invested in. Therefore, there is not either any generic format or standard criteria for all Engineering Units to base the evaluation on in the first screening. However, Archer and Ghasemzadeh (1999) emphasize the importance of having generic measures regardless of what evaluation technique that is used in order to facilitate a comparison of projects in the second screening, portfolio selection.

The first screening is not time sensitive since projects are not compared to other project at this stage, therefore the first screen can be done within a wider time span as long as it is done before the refined idea need to be screened a second time. In addition, also Cooper et al. (2001) state that it is crucial to find an appropriate method for valuation of projects, since this simplifies the subsequent screening that aims to present the total value of the portfolio. This first screening, as stated, aims to eliminate project ideas that are not align with strategy and provide feedback to potential projects (Wheelwright and Clark, 1992; Archer and Ghasemzadeh, 1999). This results in two main parameters to include in the evaluation; namely strategic alignment and providing feedback.

Moreover, as previously stated the Engineering Units who are currently taking the decision regarding which projects to eliminate and they are also the ones who have created them. According to interviewees, this can be a risk of biased decision making and therefore

decisions should rather be taken in collaboration with the Attribute Areas. This is something that Wheelwright and Clark (1992) stress, stating that these screenings are beneficially done in cross-functional teams. Cooper et al. (2001) emphasize the importance of determining the strategic contribution, one of the objectives of strategic alignment, of projects and make sure the projects are necessary to obtain the organizational goals. Thus, this is another reason to involve Attribute Areas in the first screening since they can support with determining the degree of strategic alignment for the project ideas, being the creators of needs based on the overall strategy. In addition, interviewees from Attribute Areas have emphasized that they would like to have more transparency in the selection process of project ideas and want to be informed about what projects that have been eliminated, which would be realized if they participated in the screenings.

As mentioned before, Archer and Ghasemzadeh (1999) argue for having generic measurements regardless of which evaluation techniques that are used. Therefore, an example of an evaluation template for this first screening is developed specifically for this need/means process, see table 1. The first screening is performed in an early stage of development, focusing on evaluating strategic alignment and provide feedback for what additional information is required in order to do the final screening. Therefore, the template of evaluation criteria should provide low degree of details, which is also mentioned by an interviewee. Furthermore, interviewees have emphasized that some projects ideas can be eliminated even if they are agreed upon in the need/means process due to that the project ideas require platform changes. Thus, this should therefore also be addressed in the evaluation template early in the development process since knowledge regarding platform restrictions already exist at that point in time. Projects that require changes to the platform, but are developed in a timeframe for when the platform cannot be changed, should be put on hold.

Table 1. Evaluation template

1	Does the project have strategic alignment?	*Yes/No*	*Engineering Units & Attribute Areas Responsible*
2	Do the project change the platform?	*Yes/No*	
3	Feedback for Screen (2) Selection		*Attribute Areas Responsible*

The next activity is *refine ideas,* which aims to further develop the best project ideas that pass the first screen with more details and analyze their potential in accordance to what Wheelwright and Clark (1992) describe about the second phase in the development funnel. The further developed ideas should provide enough detailed information to enable a comparison of complementary and competing projects in the final screening. When the project ideas have been refined they also have to be clearly described in a documentation template. This is done in the activity of *create second draft of means,* where the purpose is to provide input to be able to perform the second screening. Exactly what is needed in terms of information is further discussed in chapter 5.3.4 Information in Create Second Draft of Means.

The final activity within the stage creating means is *Screen (2) Selection*, where the project ideas that will be suggested for execution at the means workshop are determined. Stated by some interviewees from the Engineering Units, meetings are held within the Engineering Units just before the means workshop in order to make sure everyone agree on the suggestion of means that will be provided. Currently, all screening done within the process is performed by the Engineering Units with limited input from the Attribute Areas. However as mentioned regarding the first screening in order to ensure that the projects are strategically contributing as stated by Cooper et al. (2001), it can be beneficial to involve Attribute Areas in the final screening as well as in the first screening. As previously stated by an interviewee there is subjectivity in the decision making when the screenings, and ultimately the decisions, are taken by the same people developing the ideas and furthermore will be executing the project if it is funded. Additionally, interviewees from both Engineering Units and Attribute Areas state that it would be desirable to have Attribute Areas more involved in the selection of the means.

Archer and Ghasemzadeh (1999) state that the portfolio selection phase should include several comparisons between projects to create a ranked list, which can be created by selecting criteria that each project should be evaluated on. Also Beric et al. (2012) describe the necessity to look at the overall impact of several projects and not just the impact of an individual project. This is furthermore also expressed by an interviewee, stating that the sum of several means has to be considered when assessing how well a need could be met. Therefore, it is essential that the second screening is performed on several projects at the same point in time to enable comparisons. Hakkarainen and Talonen (2014) highlight the complexity of making sure that the right ideas make it through the screening.

Currently, the prime focus when comparing projects to each other is cost, however more criteria need to be taken into consideration when comparing the means ideas. As described by Cooper et al. (2001) it is important to find good valuation methods, since the lack of a good method results in difficulties assessing the total value of the portfolio. Cooper et al. (2006) state that companies evaluating technology development project should not rely on financial analysis and profit criteria, because of the degree of uncertainty characterizing these projects. Therefore, it can be favorable to use a scoring model as an aid in this second screening since it is a way to compare projects based on a number of criteria and reduce the focus on financial aspects of the projects. This tool is further described in the chapter 5.2.5 Scoring Model Setup. In addition to the scoring model it is also important to compare the means ideas based on their merits and to be able to summarize the results of many projects, which require that standardized information is provided about the mean ideas. The merits that need to be provided are target fulfillment, weight impact and project cost, which are described further in chapter 5.3.4 Information needed within the Needs/Means Process. In table 2 a summary of the assessment needed for the second screening is presented.

Table 2. Second screening assessment

1	Percentage of Target fulfillment	*%*
2	Quantified Weight Impact	*kg*
3	Project Cost	*kkr*
4	Score in the Scoring Model	*0-60*
5	Bubble Diagram Discussion	

Many of the needs created within the Environmental Council are related to legal requirements where there is a higher pressure of finding means and above all ensure that the projects are successful. There can be a tendency to not evaluate these projects against other projects due to their legal character and that they are seen as "must do" projects. Nonetheless, both EPMC (2011) and Messner (2013) emphasize that also the mandatory projects should be evaluated and compared with alternatives since there can be a varying degree of resource efficiency and risk. However, these projects should not compete with projects that are not mandatory or are solving different problems. They should be compared against other project ideas that aim to solve the same problem in accordance to what Messner (2013) states. Thus, the legal requirement projects need to be separated from other projects and one way to separate them is presented in the application of the bubble diagram discussed in chapter 5.2.6 Bubble Diagram.

5.2 TOOLS IN THE NEEDS/MEANS PROCESS

To perform the activities stipulated in the first chapter, there is a need for aiding tools. In this chapter an analysis is made regarding the second research question, *what kind of tools can be used in the project selection process at Volvo Cars to enable good investment decisions regarding environmental advanced engineering projects?* This chapter is initiated with analysis about which tools that can be applied to the activities in order to increase discussions and facilitate communication. Furthermore, each tool is described in detail and applied to Volvo Cars' needs/means process to aid discussions and decision making.

5.2.1 OVERVIEW OF TOOLS IN THE NEEDS/MEANS PROCESS

To be able to perform the activities successfully, there is in some cases a need for tools supporting the activities. In figure XX, all the tools that could be applied to the need/means process are visualized and connections are shown to which activities they relate to. The tools suggested are a combination of theories about project portfolio management specific tools and tools proposed based on the input from the interviewees. Kodukula (2012) states that the prerequisites for defining a project portfolio is that the organizational unit owning the portfolio has budget responsibility. In order to apply the tools to the needs/means process

within the Environmental Council it is assumed that the budget is divided per council and that the Environmental Council budget is allocated to the various Attribute Areas based on the established environmental strategy. Currently, which is stated by interviewees, the budget is divided among the Engineering Units based on historic information about previous year's budget. Therefore, a budget allocation change might be needed to fully take advantage of the tools from the project portfolio management theory.

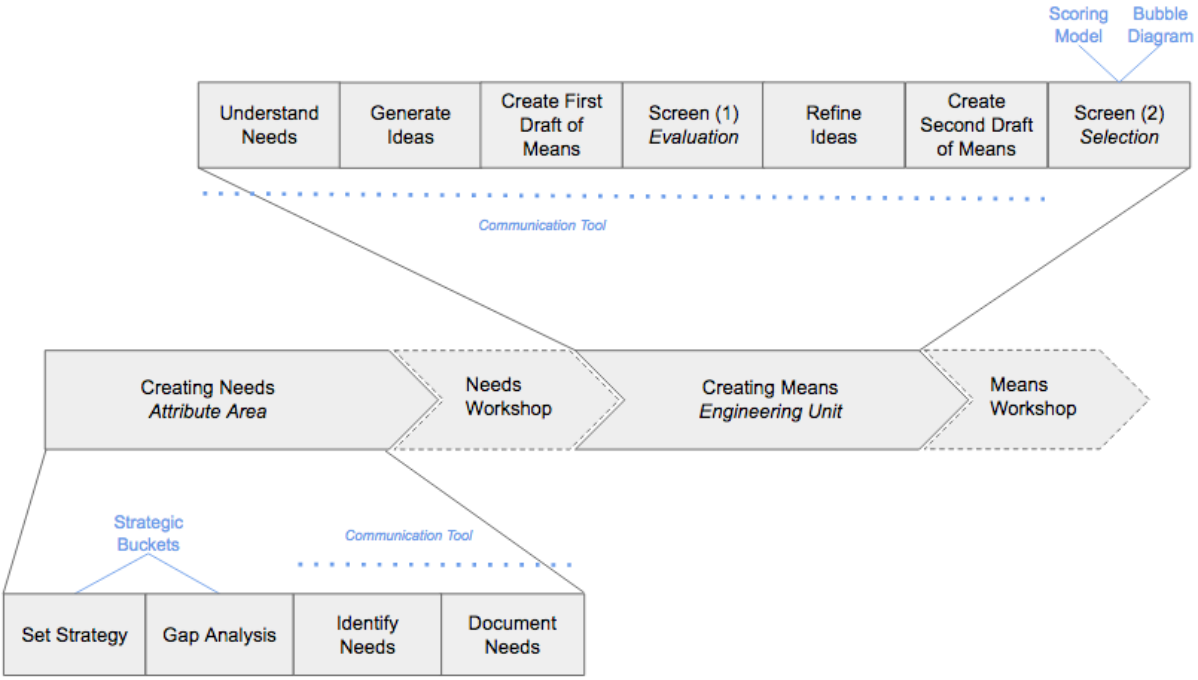

Figure 26. Tools within the needs/means process

5.2.2 STRATEGIC BUCKETS MODEL

In the first activity of creating needs, set strategy, the strategy should explain where Volvo Cars would like to be positioned in comparison to their competitors as mentioned previously in chapter 5.1.2 Activities and Actors within Needs Generation. In the theory, three approaches are discussed, top-down, bottom-up and a combination of the two aforementioned. Volvo Cars' strategy development is reflected in the top-down approach where the goals and strategy guide the future project initiatives. Therefore, this approach and the its related tools are suggested. Cooper and Edgett (2010) present two tool called strategic buckets model and product roadmap. The product roadmap is more suitable for product development where the launching time of the products are used for the creation of a map, thus not included in the suggestion of what tools to apply to the needs/means process.

The strategic buckets model is a tool to ensure that investments reflect the business strategy and strategic priorities, and this is the tool proposed for Volvo Cars. Cooper and Edgett (2010) state that in order to ensure that the strategy is reflected in the actions the organization takes, the budget should be divided according to what the strategy presents. This is in conformance to one of the objectives of strategic alignment presented by Cooper et al. (2001) called strategic priorities indicating that the priorities should be reflected in how the investments are distributed. The investments are divided into so called buckets which are predetermined based on how the organization want to distribute the investments.

Since the environmental strategy covers the Attribute Areas connected to the Environmental Council, one suggestion is to have each Attribute Area as a strategic bucket. The Attribute Areas are the ones who set the strategy and perform gap analysis of their specific Attribute Area and should therefore be able to present where the biggest gaps are and suggest a distribution of investments accordingly. Furthermore, Cooper et al. (2001) state that each bucket should illustrate a spending target, where all projects are evaluated and prioritized within each bucket. Therefore, the Attribute Areas' spending requests should form the base for the budget distribution and can be visualized in a pie chart. An example of how the budget can be distributed is illustrated in figure 27. According to Cooper and Edgett (2010) this strategic buckets tool ensures a balanced portfolio that reflects an organization's strategy.

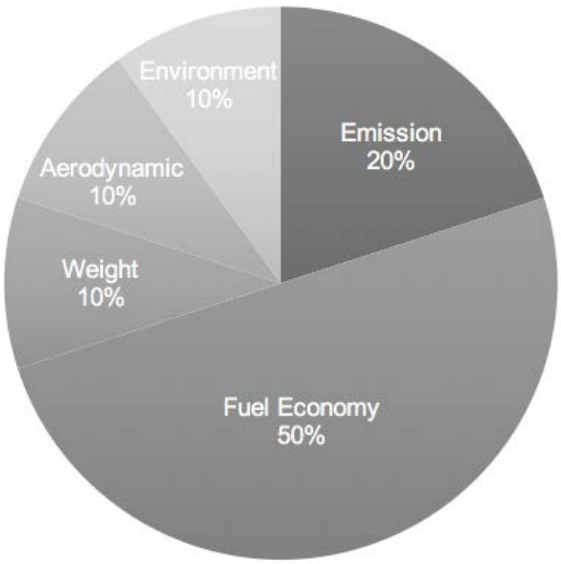

Figure 27. Example of budget distribution for the Environmental Council

5.2.3 COMMUNICATION TOOL

Several interviewees from both Engineering Units and Attribute Areas raise the wish to have the Attribute Areas more involved in the creation of means since their expertise is valuable and could contribute to the generation of projects ideas. Furthermore, it is also stated that more communication is needed in general and that another tool apart from the Excel file for communication would be favorable. Increased communication and collaboration is needed from when the needs are documented and throughout the means creation stage. One way to increase the transparency and involve people in more activities could be to use the Idea Generator presented in chapter 4.8 as a communication tool, a suggestion first given by an interviewee. This would provide a place where project ideas and their progression can be viewed by multiple people and additional input can be given in an easy way.

As described, the tool enables creation of idea boxes to gather ideas about a certain topic, and one application could therefore be that the Attribute Areas create an idea box for each need respectively. In this way the needs creator gets an indication of the progress of the project idea generation aimed at the need. This earlier transparency could be beneficial since it provides a continuous status about the amount of projects ideas, rather than only at a few meeting occasions. This can mitigate one of the challenges mentioned by Cooper et al. (1997)

that information is constantly changing in a selection process and the environment in which decisions are made is dynamic, hence constantly updated information is useful.

The tool is also able to mark certain information as mandatory to provide, which ensures that all project ideas are more comparable and that no essential information is missing. By having the means ideas within this tool, it can possibly function as a substitute or support to the Excel file currently used to present the means. Communication can to some extent be held within the tool which reduces the dependency of finding times to meet. However, more investigation into how the tool could be applied to the needs/means process is needed to ensure that the tool is of use.

5.2.4 SCORING MODEL SETUP

In the second screening there can be a need for several aiding tools to facilitate the selection. Primarily, this activity is supposed to be a cross-functional discussion about the project ideas and one tool that could be used as a discussion tool and an assessment of the project ideas' abilities is the scoring model. As stated by Cooper (2006), there should not be a reliance on only financial criteria when it comes to technology development projects due to the uncertainty connected to these projects. This is also discussed by some of the interviewees, stating that there is sometimes too much focus on cost. Cooper et al. (2001) state that one of the advantages with the scoring model is that it includes multiple criteria and that there is not an over-emphasis on financial aspects.

Furthermore, Cooper et al. (2001) explain that the tool can be used when several projects should be compared to each other, as well as at individual assessments. Therefore, it can be a useful tool in this second screening dealing with multiple project ideas simultaneously. Another strength of the scoring model, described by Cooper et al. (2001), is that it can ensure strategic fit and maximize key variables, hence the tool aid two PPM objectives; maximize the value of the portfolio and align with strategy. Both Henriksen and Traynor (1999) and Cooper et al. (2001) state that the tool is a good way to trigger reflection regarding the project ideas and be a discussion initiator as well as an assessment of project's strengths and weaknesses. In addition, the result for the tool provides a tangible number that can be compared to other projects.

Wheelwright and Clark (1992) discuss the fact that it can be difficult to know which criteria to screen on and how each criterion should be weighted. This can be connected to what Cooper et al. (2001) describe, stating that the key to a widely used scoring model is to create an appropriate list of criteria. Furthermore, Henriksen and Traynor (1999) state that the scoring model can be adapted to the organization in which it is used. Due to its ability to be customized, the scoring model is chosen as a suggestion of one tool to be use in the second screening. To ensure that the model will fit to the process and be of benefit to the actors involved, the scoring model setup has been developed in collaboration with the Environmental Council leader.

Cooper et al. (2001) state that it is essential to ensure that the criteria chosen to the scoring model are not overlapping, that each criterion has a purpose that differ from the other criteria. This was taken into consideration when developing the scoring model, by comparing the criteria to each other to ensure they serve different purposes. When they were not, one of the duplicates was removed. Another issue to bear in mind when creating the list of criteria,

stated by Cooper et al. (2001), is that the list of criteria should not be too long. There needs to be a balance in degree of detail and amount of effort required to complete the scoring model evaluation. Therefore, the number of criteria was set to six, similar to the number of criteria used in the best practice scoring model by Cooper et al. (2001), visualized in Appendix B.

In the best practice scoring model developed by Cooper et al. (2001), one of the suggested criteria is strategic alignment and importance. Since the first screening is evaluating the strategic alignment of the projects, this criterion is excluded from the scoring model used in the second screening, which is consecutive to the first screening. During the interviews, it has been stated from both Engineering Units and Attribute Areas that more specific targets for the needs are desired and more quantification is requested from the project ideas to understand how much each need is met. Therefore, the first criterion that is suggested to the scoring model is *target fulfillment*. The purpose of this criterion is that each project idea is evaluated on how well the target is reached in relation to what the need requested.

Another criterion selected based on interviews is *weight impact*. Weight is, as stated by interviewees, affected by all projects undertaken since most changes made to the car will impact the weight in some way. Therefore, the impact from all means projects will need to be summarized to create insight into how the weight is changing due to the projects being undertaken, and not just review the project ideas primarily performed for weight reduction. A first indication of this can therefore be given in the scoring model, if the project idea is affecting the weight positively or negatively. Furthermore, cost is an essential aspect to consider since new technology can be expensive and increase the production cost substantially. Therefore, it is important to consider the change of *part price*, that is how much the replacement of technology affects the cost of that particular part, in the evaluation of the project ideas.

Furthermore, Kodukula (2012) state that it is important to consider various stakeholder value when evaluating projects in a portfolio and not just the time, cost and scope of the project. It is also emphasized by the interviewees that it is essential to find what the customer benefits are of performing the means projects, something that is reflected in the templates for needs documentation and means documentation as well. Therefore, *customer benefits* is included as a criterion in the scoring model. Another determining factor if project ideas will be executable or not is how they *impact the manufacturing process*. This is emphasized by interviewees as something to consider when selecting the means projects since new technology implementation can affect the manufacturing extensively and could be a decisive factor if a project should be executed or not.

The final criteria suggested is *organizational capabilities*, something that both Wheelwright and Clark (1992) and Cooper et al. (2001) discuss as an important factor to reflect over in the selection of projects. If there is a lack of organizational capabilities there might be a need to increase the knowledge, either by enhancing the knowledge of existing employees by external courses or by attaining the knowledge by employing someone possessing the knowledge or outsourcing the project completely. Therefore, there needs to be an awareness of how the project idea fit with the current organizational capabilities and whether or not it is worth the investment if the capabilities are currently not in-house. The scoring model template can be viewed in table 3 where rating guidance is provided for each criterion.

Table 3. Scoring model suggestion

Scoring Model	Rating Scale				Score	
Criteria	0	4	7	10	Score	Weighted Score
Target fullfullment	Target is not fulfilled at all (0%)	Target is fulfilled to a small extent (40%)	Target is fullfilled to a higher extent (70%)	Target is completely fulfilled (100%)		
Weight impact	Weight is substantially increased	Weight is moderatelly increased	Weight is moderatelly dereased	Weight is substanitally decreased		
Cost: Part Price	Part price is substantially increased	Part price is moderately increased	Part price is moderately decreased	Part price is substantially decreased		
Customer Benefit	There are no customer benefits	There are few customer benefits	There are fairly high customer benefits	There are high customer benefits		
Degree of impact on manufacturing	The project is affecting the manufacturing process substaintially	The project is affecting the manufacturing process quite substainatially	The project is affecting the manufacturing process moderately	The project is not affecting the manufacturing process		
Organizational capabilities	There are no capabilities in-house	There are few capabilities in-house	There are fairly high capabilities in-house	There are high capabilities in-house		
				Total	0	0

In the usage of the scoring model it is important that the result is not over-emphasized and that the resulting score is not the only factor considered in the decision making, as expressed by Cooper et al. (2001). Furthermore, Cooper et al. (2000) state that another weakness with the scoring model is that the project tends to be rated against absolute criteria and not against other projects, which is something to keep in mind when performing the second screening.

As the scoring model does not include resource constraints in the scoring Cooper et al. (2000) state that this usually lead to that resource demanding projects end up in the top of a rated list. Therefore it is essential, as stated in the analysis of the second screening, that also some characteristics of the project ideas are reviewed as a complement to the scoring model. For instance, by stating the project cost and comparing among the project ideas, this issue is somewhat dealt with. Another pitfall with the scoring model, described by Cooper et al. (2000), is that the scoring result tends to be in the middle, leading to limited distinction between the projects. It is therefore important to not use middle scores to a great extent, if not necessary, and should be considered when assessing each criterion.

5.2.5 BUBBLE DIAGRAM

As mentioned in the previous chapter 5.2.4 Scoring Model Setup, there are several possible tools that could be used in order to facilitate decision making regarding project investments, where bubble diagram is an additional tool that can be applied. According to Cooper et al. (2001) bubble diagram is not a tool that will create balance automatically, it rather aims to create discussions about the project portfolio balance, which the aforementioned scoring

model lacks. Therefore, this tool could be a complement to the other assessments in the final screening before the means workshop for the project within the Environmental Council portfolio.

Cooper et al. (2001) further describe this tool to provide the possibility to include four different dimensions; X and Y axes, size and colors of the bubbles. Moreover, EPMC (2011) states that the dimensions chosen to be used in a bubble diagram can be very subjective which is an argument for adjusting the dimensions to the particular situation in order to obtain the purpose specific for the situation. This is why there can be a numerous of different trade-offs to consider. The dimensions recommended for this needs/means process are therefore decided upon in collaboration with the Environmental Council leader, and is illustrated in figure 28.

The three different dimensions that are suggested to be use in the bubble diagram are; probability of success, project cost and differentiation of legal and non-legal project. Firstly, as stated by Wheelwright and Clark (1992), Poh et al. (2001) and Cooper et al. (2001) risk is an important factor to consider when evaluating projects. Additionally, this is also expressed by some of the interviewees, stating that the risk of the projects has to be regarded. Therefore, *probability of success* is suggested to function as the Y axis in the bubble diagram. Secondly, Archer and Ghasemzadeh (1999) present size of the project to be a key parameter to balance.

The size of the project can be visualized by the *project cost*, which is a commonly used parameter while evaluating projects of today at Volvo Cars according to interviewees, and can be useful to include in the bubble diagram. Moreover, Cooper et al. (1997) present R&D cost to completion, as a possible dimension to add in a bubble diagram, and therefore support the argument for having project cost as a dimension on the X axis.

Lastly, according to EPMC (2011) and Messner (2013) even projects which refer to legal requirements are important to evaluate based on their merits. Furthermore, an interviewee highlights the importance of evaluating the risk profile for project ideas that correspond to needs that are mandatory to do since these projects should preferably have low risk profiles, which can be analyzed and discussed in a bubble diagram. Therefore, the colors on the bubbles in the diagram differ in two shades of gray differentiating between projects depending on if the projects are created based on *legal requirements or not*.

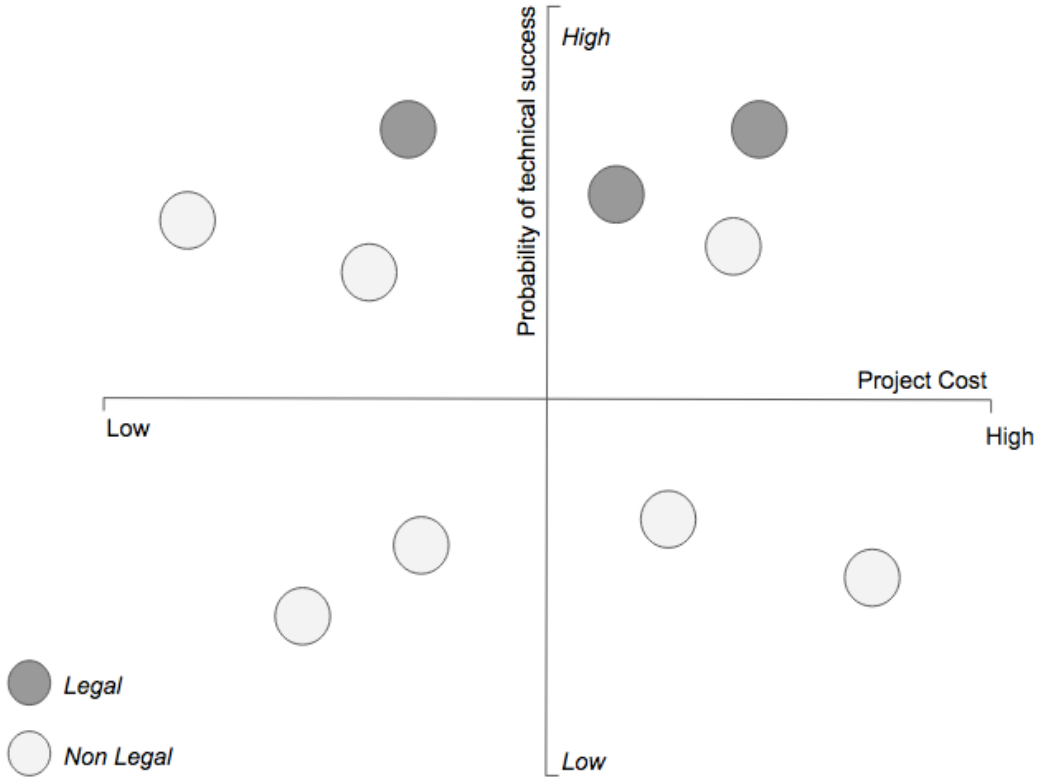

Figure 28. Bubble diagram balancing probability of success and project cost

5.3 INFORMATION NEEDED WITHIN THE NEED/MEANS PROCESS

To ensure that the activities, and the aiding tools, are performed in the most efficient way it is important that the right information is provided at the right times. This chapter aims to analyze the third research question *what information is required, and when, to streamline the project selection process?* by identifying which activities that require specific kind of information. Initially, the timing in terms of where in the process information is needed is assessed, followed by an analysis of what kind of documentation templates that can be used to facilitate this information distribution.

5.3.1 GENERAL INPUT REGARDING INFORMATION IN THE PROCESS

Within the needs/means process there are mainly three activities focusing on information sharing between Attribute Areas and Engineering Units; document needs, create first draft of means and create second draft of means. These activities are marked in figure 29. One interviewee mentions that the process is a guide for deadlines, therefore these three activities should also be seen as deadline points. However the last activity, create second draft of means, is the one with the strictest deadline, since all drafts have to be collected at the same time in order to perform the second screening where multiple project ideas are viewed simultaneously. The other two, document needs and create first draft of means, are not as time sensitive and can be presented at different times, however it is still important that the same information is documented and presented before the next coming activity.

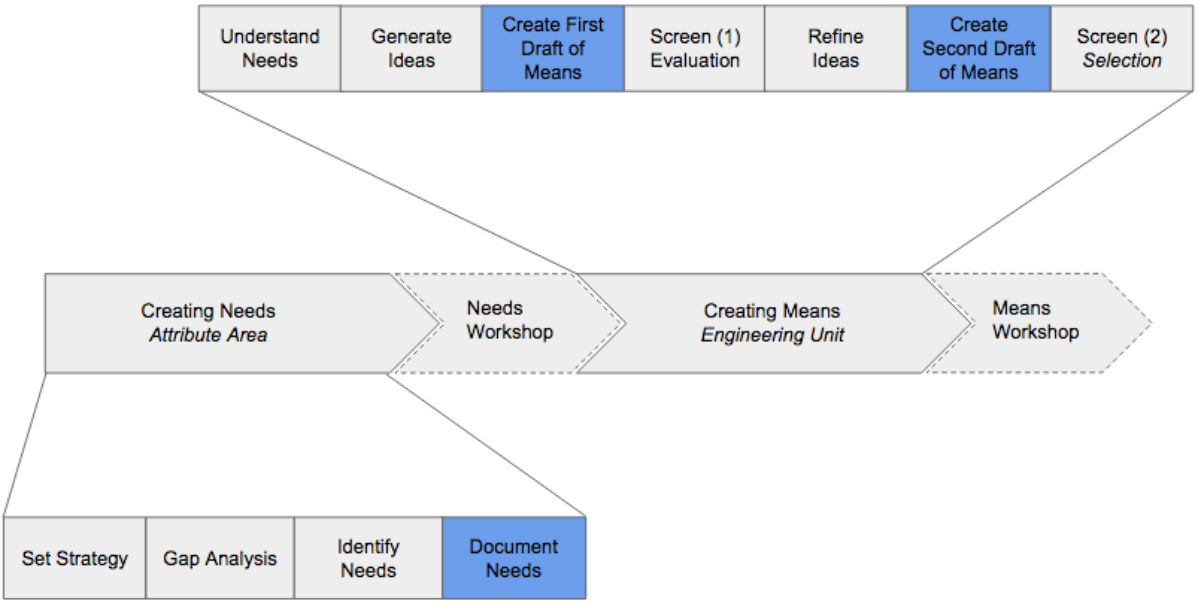

Figure 29. Information sharing activities within the needs/means process

5.3.2 INFORMATION IN DOCUMENT NEEDS

In the activity of documenting needs more quantified information is needed according to several interviewees. It is emphasized by both Engineering Unit and Attribute Areas that in order for the Engineering Units to respond and present how well a need is fulfilled, quantified targets are required from the very beginning when first describing a need. This can also be seen in the theory about S.M.A.R.T goals where Locke and Latham (2006) argue that having specific goals rather than vague, result in higher task performance. Also Shahin and Mahbod (2007) discuss the fact that specific goals simplify appointing the responsibility of achievement to someone. Furthermore, as mentioned by Shahin and Mahbod (2007), to be able to determine if a goal is reached or not it is necessary to ensure that the goals are measureable. Therefore, setting targets for the needs that are specific and measurable can facilitate the understanding of to what extent each need is fulfilled and increase the task performance. Furthermore, Shahin and Mahbod (2007) argue that the goals need to be attainable and reachable, which refers to setting up realistic goals that are within reach. Therefore, it is important that the targets for the needs are determined based on what can be achieved by the Engineering Units who are assigned the responsibility to create means to solve the need, otherwise there might be a lack of motivation to create means.

However, since needs can aim at several Engineering Units, the Attribute Areas interviewed state that they do not want to limit where the solutions can come from by specifying how much particular Engineering Unit should provide in terms of reaching the target. They further state that this can minimize the efforts from other units, which are not assigned with a specific target fulfillment goal, but could potentially also provide solutions for the need. This is one of the downsides of setting too specific targets that have to be considered, because specific targets to some Engineering Units removes the responsibility from the Engineering Units where no target has been set. One way to mitigate this is to be clear in the communication of the need that also the Engineering Units that are not assigned a specific target can still present project ideas to aid the overall fulfillment of the need. However,

Shahin and Mahbod (2007) state that when the targets are as detailed and quantified as possible, it is easier to assign someone the responsibility of the achievement.

Currently, the need template includes information regarding who will be the internal customer, namely what car model the solution should aim for, and when in time it has to be completed. Having this information provided is beneficial according to Shahin and Mahbod (2007) stating that time sensitivity is an important aspect to consider when setting goals. This means that there should be a timeframe to relate to, which is given when stating which car model the need is aiming for and when in time that is. Furthermore, Shahin and Mahbod (2007) state that having time sensitivity and deadlines facilitate the development of a realistic action plan for a project.

Overall the interviewees feel satisfied with how the need template is designed and the level of details, however interviewees have stated some improvements possibilities regarding the information to fill in. Firstly, that the documented information regarding the needs have connections to the strategy is demanded, since it gives higher motivation and increases the importance of finding project ideas for the need. Secondly, the existing need template lack information about the creator of the need, mentioned by the interviewees as something challenging that slows down their working process since they do not know who to contact if they have questions regarding the needs. Thirdly, the information in the need template can be presented very different due to that different people interpret what to fill in differently, which subsequently lead to needs being presented with different level of details. Both the second and third challenge can be improved by implementing the communication tool, presented in previous chapter 5.2.3 Communication Tool, to enable quick and easy communication possibilities if things are unclear.

5.3.3 INFORMATION IN CREATING FIRST DRAFT OF MEANS

There needs to be a balance regarding how much information that should be provided in an early stage of a development process. According to one interviewee, information that is collected in an early stage of development might be less realistic, which is a reason not to force a collection of very detailed information early on in the means generation. In addition, Archer and Ghasemzadeh (1999) also discuss the necessity of not being overloaded with data, however the data that is relevant should be accessible when needed. Before the first screening the information should, as mentioned earlier, be very brief and have the purpose of facilitating the assessment of the criteria about strategic alignment and platform restrictions as well as something to give feedback on. Thus, this implies that only the title and a short description of the project idea is needed, as long as it is sufficient to make that assessment.

In addition to this, it can be beneficial to provide information about the person responsible for the means idea. This will increase the traceability, which is something requested by the interviewees. It will also enable the Attribute Area representatives to contact that specific means creator to have further discussions if something about the project idea is unclear.

5.3.4 INFORMATION IN CREATING SECOND DRAFT OF MEANS

As input to the second screening, more detailed information is needed to evaluate the project ideas and to be able to compare them to each other. It is stated by the interviewees that the information about how well the means ideas meet the needs have to be better quantified.

Otherwise it is difficult to summarize the means ideas and get a full understanding of how well the need is met, and also to deal with the first criteria in the scoring model being the fulfillment level of the target. Furthermore, as the scoring model assesses the weight impact caused by the projects this is also essential information to obtain and need to be included in the documentation of the second draft of means.

Both the target fulfillment and the quantified weight impact can be beneficial to reflect over not just in the scoring model but also assess these measures and compare various projects on these measures in the second screening. This is also essential for the understanding of how several projects complement each other in target fulfillment and also to get an overview of how the total weight of coming cars will be according to the estimations of weight impact made for each mean project. Because, as stated by Beric et al. (2012), solely one project does not contribute to achieving organizational goals. It is rather several projects that achieve the goals and generate results and success. In addition to these measures, information about the estimated cost of the projects is needed to facilitate the usage of the bubble diagram and also to be able to assess which of the projects the budget will allow to be undertaken.

One comment from interviewees is that more information is needed about the origin of the means, hence who the creator of the means is, have to be stated in the documentation which is not currently done. Having information about the means creator contributes to better traceability as it enables the Attribute Areas representative to easily contact the person for further description of the means. Another important information to include in the second draft of means is how the means project can be of benefit to the customers. This information can currently be provided in the need template by needs creators and also in the one pager for the means that some Engineering Units use in the documentation of means. Having this connection to one of the stakeholders, the decisive actor who ultimately influence sales, is also in line with what Kodukula (2012) states about taking stakeholders into consideration when creating a portfolio. Furthermore, as stated in previous chapters, it is of high value to have continuous collaboration with the manufacturing department when creating the means projects and the knowledge they provide about the impact on the manufacturing process is needed for the scoring model, should be included in this second draft of means.

6 CONCLUSION

The main purpose of this study has been to investigate how the process of selecting environmental advanced engineering projects at Volvo Cars can be improved in order to create more alignment with business goals and maximize the value of the projects. In general, there is an increasing demand for sustainable products in society and high pressure from environmental regulations within the automotive industry, which makes it crucial to invest in the right technology development projects. By applying selection theory to the current process at Volvo Cars, identification of actions aligned with literature has been made and improvements have been suggested to how investments can be more efficiently done. In order to obtain the purpose of this study three research questions have been addressed.

What activities should be performed, and with which actors, in the project selection process to ensure investments in the right projects?
By combining theory regarding development funnels and the selection process described within the PPM literature and applying it to the current process, an establishment of an improved process has been made. In this expanded process a description of the activities that are aligned with the theoretical implications is provided with suggestion of which actors that should be involved. The changes proposed focus mostly on the screening structure, where it is recommended that two distinct screening activities should be performed in accordance to what is described in theory. Furthermore, as can be seen in the visualization of the process in figure 30, there is a need for more cross-functional collaboration in several of the presented activities. It is essential that the screenings are performed cross-functional since there are tendencies of subjectivity in the selection of projects, which ultimately could lead to investments in the wrong projects. The influence from various other departments is needed throughout the whole process to ensure that the project ideas are anchored within the organization and to the overall company strategy.

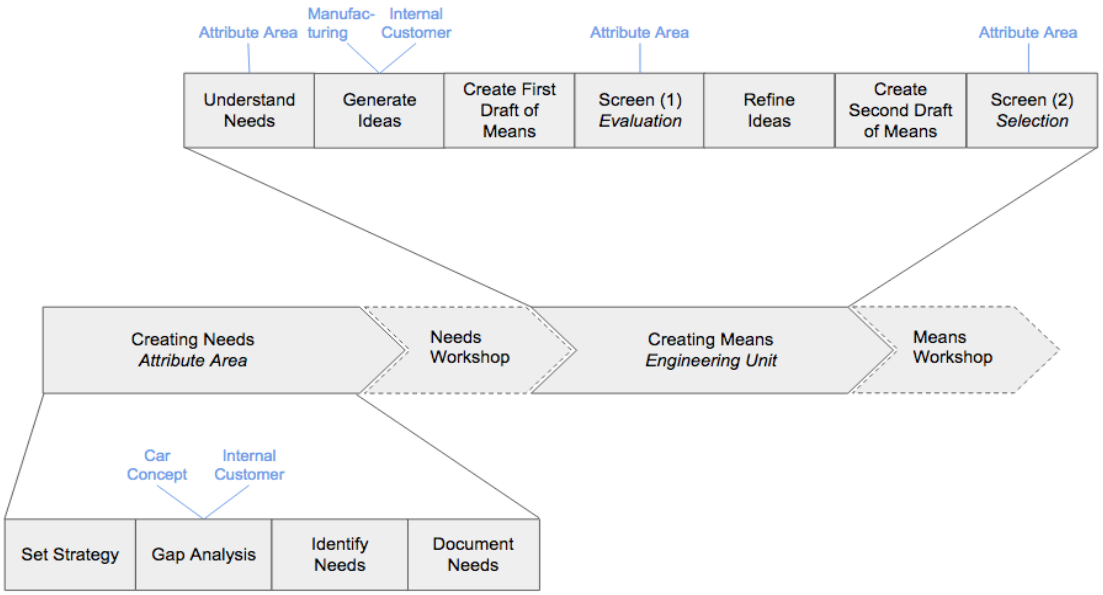

Figure 30. Activities and actors in suggestion of an improved needs/means process

What kind of tools can be used in the project selection process at Volvo Cars to enable good investment decisions regarding environmental advanced engineering projects?
The second research question have been answered by suggesting four aiding tools that can be applied to the needs/means process; strategic buckets model, communication tool, scoring model and bubble diagram, see figure 31. These tools have been identified from a combination of theory based on PPM as well as input from interviewees. All suggested tools aim to provide different contributions in different activities in the process.

The strategic buckets tool aims to strategically distribute the budget in accordance to the strategy and is therefore applied to the Attribute Areas within the Environmental Council. This is because the environmental strategy covers the various Attribute Areas. According to interviewees, there is a need for an easier way of communicating and knowledge sharing throughout the whole process and this is the reason why a communication tool has been suggested. The communication tool is known in the organization today, but is used for another purpose than suggested within this need/means process.

Moreover, two tools have been suggested to support the final screening within the process; scoring model and bubble diagram. These tools are complementary to each other, hence both aim to compare different projects to each other but in different ways. The scoring model provides a score of how well the project ideas fit in regard to some predetermined criteria. The score of each specific project idea can further be weighted and compared to other project ideas in order to distribute the investments in the most suitable way. Furthermore, the bubble diagram is suggested to be applied in order to get an overview of the project portfolio and find a balance of the projects to invest in.

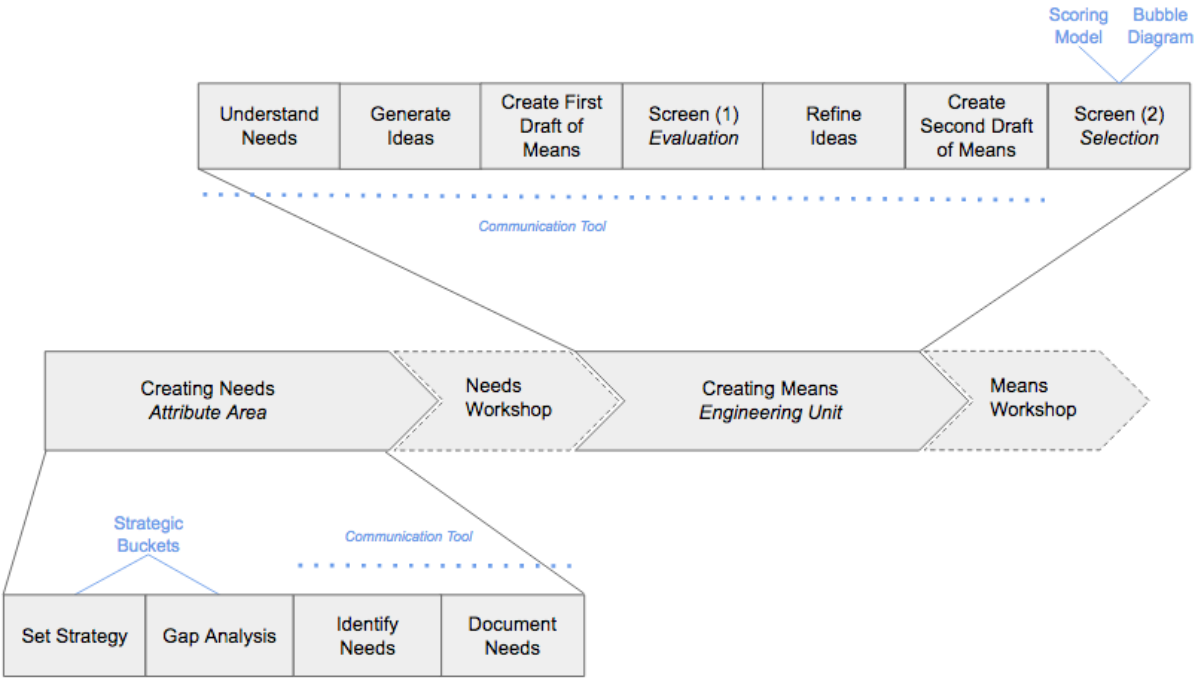

Figure 31. Suggested tools within the needs/means process

What information is required, and when, to streamline the project selection process?
The third research question is answered by reviewing what input that is essential throughout the process. It can be concluded that three activities function as information generating activities, namely document needs, create first draft of means and create second draft of means, see figure 32. In the documentation of needs it is of high importance that the targets are quantified and that the needs' importance is clearly stated. To increase the traceability and facilitate communication between Attribute Areas and Engineering Units it is beneficial to also include the creator of the need in the documentation. Furthermore, establishing a time frame by stating the potential first internal customer in the documentation goes in line with the theory about goal setting and further enhances the purpose of developing means idea, which is currently done in the need template.

The two subsequent information generating activities should provide input to the two screening activities suggested. In order to successfully screen and assess the potential of project ideas, it is vital that there is sufficient information in place before the screenings are conducted. For the first screening only brief information is needed to determine if the project ideas are aligned with the strategy and if the project idea will be limited by platform restrictions. In addition, other feedback regarding the project ideas can be provided by the need creator within this screening. Furthermore, this screening does not necessarily need a strict deadline, however the earlier the first screening is done the more time is given for refining the project idea until the next screening. The refinement of the project idea should result in more information about the project ideas for the second screening which is compiled in the second draft of means. The information required is possible target fulfillment, weight impact, project cost, impact on the manufacturing process and what customer benefits the project idea brings.

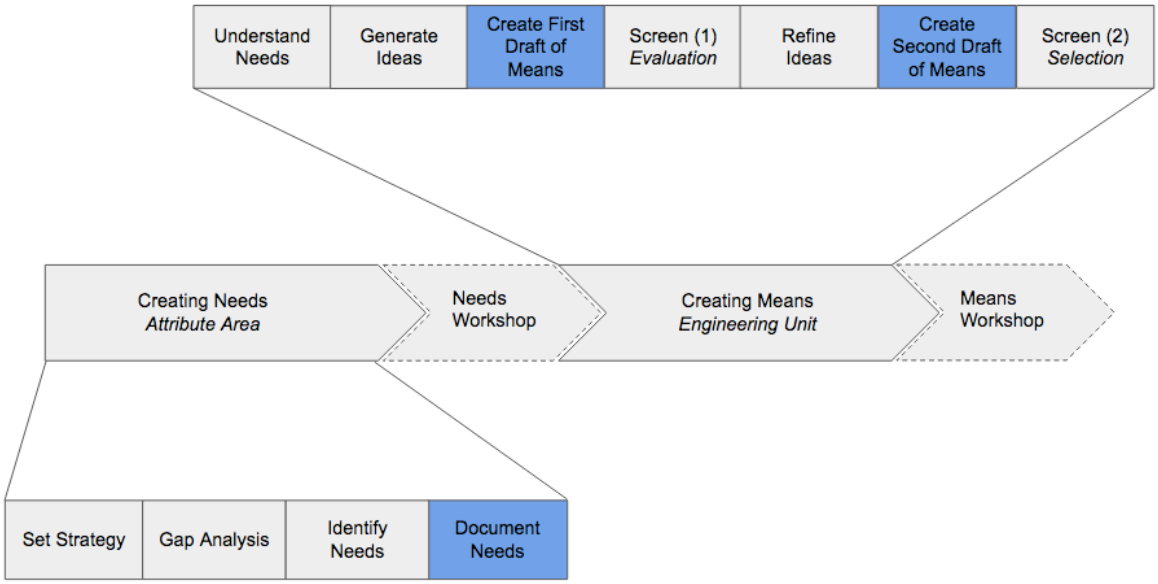

Figure 32. The information generating activities in the needs/means process

7 RECOMMENDATIONS

To fulfill the objective of this study, based on the answers to the research questions, some recommendations for possible actions to take in order to improve the needs/means process at Volvo Cars are suggested.

Distribute budget per Attribute Areas
The strategy is covering the different attributes connected to the Environmental Council and in order to ensure that the strategy is reflected in how the investments are distributed it can be beneficial to divide the budget on the various Attribute Areas. By having this distribution, Attribute Areas get more involved in the decision making and the connection between the strategy and execution of projects increases. This will also facilitate the usage of the proposed tools, since a prerequisite for a project portfolio is that the organizational unit has budget responsibility. Hence, the Environmental Council should be responsible for one part of the overall AE project budget.

Set targets for the needs and respond with quantified means
Having specific targets for the needs simplifies the understanding of the needs and the Engineering Units get an awareness of what is expected from the corresponding means ideas. By setting specific targets for the needs, the evaluation of how well each need is met is enhanced as well. However, in order to evaluate the need fulfillment it is also required that the means are presented in a quantified way. Therefore, the recommendation is that quantifications are made in both the needs and the means generation.

Work cross-functionally throughout the needs/means process
There is a need for more cross-functional collaborations in several of the process activities, in order to make sure that the projects most suitable for the organization are selected. First of all, cross-functionality can be beneficial in the idea generation phase since the knowledge base needs to be expanded to find the best ideas. Furthermore, cross-functionality is also required in the creation of needs to ensure that what is requested by the Attribute Areas is in line with other strategies within the organization. For instance, it is crucial that the means ideas developed to correspond to the needs are desired by an internal customer. Additionally, cross-functionality is needed in the screening activities since it is a way to mitigate biased decision making regarding what project to undertake.

Implement two distinct screening activities
Screening of ideas is needed at two points during the process since they serve different purposes. Therefore, the two screenings should be different in character and differ in what is being assessed in the activities. The first one should treat a broader perspective regarding if the project ideas are aligned with the overall strategy and if the project ideas are subject to platform restrictions or not. The first screening serves the purpose of removing the project ideas that are not suitable and provide feedback regarding what information that is required for the second screening. The second screening has the purpose of selecting the project ideas to a portfolio that will suit the organization in the best way and ensure that the strategy is reached. In the final screening, it is important to view the big picture and see how projects complement each other to obtain the organizational goals.

Use aiding tools for decision making and discussions throughout the process

Having aiding tools throughout the needs/means process can improve decision making when comparing different project ideas as well as be an aid to follow up the performance of the process by investigating if the spending distribution is aligned with the strategy initially set. It is recommended to use aiding tools to improve decision making and this study provides a suggestion of three tools that can be applied within the process. However, the tools have to be customized and therefore the users' comments regarding the applicability of the tools have to be taken into consideration to ensure that the criteria and parameters selected are appropriate.

Investigate the possibility to use the Idea Generator

This study has explored a communication tool supporting Attribute Areas and Engineering Units to have the possibility to frequently collaborate with moderate resources. The communication tool does also provide the possibility to obtain standardized information, since the tool gathers information that is requested for and requires that mandatory fields are filled in before the ideas can be submitted. However, in order to fully implement this tool, further investigations are required and a pilot test is recommended. A pilot test can be beneficial to do since a trail with a sufficient amount of people can provide essential feedback to take into consideration, before involving all people engaged in the needs/means process.

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APPENDIX A - INTERVIEW TEMPLATES

GENERAL INTRODUCTION IN ALL INTERVIEW TEMPLATES

Everything will contribute to our master thesis so no information should be confidential.

Interviewee:

- Date:
- Name:
- Department:
- Role:

Brief introduction to the study and its purpose
We are looking at the process for selecting which R&D projects within the Environmental Council that should be recommended for funding. Our purpose is to investigate how the selection process is currently performed and how well R&D projects are aligned with business goals and the company strategy, in order to find improvement possibilities.

GOVERNANCE BOARD INTERVIEW TEMPLATE

In general:

1. **What is your role and main task in the needs/means process?**
   Vad är din roll och huvuduppgift i needs/means processen?

2. **What is the purpose of PAC-GB and what does the board do?**
   Vad är PAC-GBs huvudsyfte och vad görs inom PAC-GB?

Governance specific:

3. **Do you make any decisions regarding what means to undertake?**
   Tar du några beslut om vilka means man ska genomföra?

    a. **What criteria are the projects evaluated from?**
       Utifrån vilka kriterier utvärderas projekten?

4. **What do you think about the needs workshop?**
   Vad tycker du om Needs workshopen?
5. **Do the way needs are presented differ between different councils at the needs workshop?**
   Skiljer sig sätten som needsen presenteras från de olika råden på needs workshopen?

6. **What do you think about the way needs are documented?**
   (need template and one pager)
   Vad tycker du om dokumentationen av needs?

7. **What do you think about the means workshop?**
   Vad tycker du om Means workshopen?
8. **Do the way needs are presented differ between different councils at the means workshop?**
   Skiljer sig sätten som means presenteras från de olika råden på means workshopen?

9. **Are you missing any information regarding the means?**
   Känner du att det är någon information du saknar?

10. **What do you think about the way means are documented?**
    (one pager and excel list)
    Vad tycker du om dokumentationen av means?

11. **How is the size and distribution of the annual budget determined?**
    Hur tas beslut om hur stor budgeten kommer bli och hur den är fördelad mellan olika avdelningar?

In general:

12. **Is the needs/means process functioning like you would like to?**
    Fungerar needs/means processen som du skulle vilja att den gör?

13. **What would you see as improvement possibilities to the process?**
    Vad skulle du se som möjliga förbättringar i processen?

NEEDS INTERVIEW TEMPLATE

In General:

1. **What is your role and main task in the needs/means process?**
   Vad är din roll och huvuduppgift i needs/means processen?

Needs specific:

2. **How are the needs created?**
   Hur skapas needs?
   a. **What specific factors and knowledge are taken into consideration when creating the needs?**
      Vilka faktorer och vilken kunskap är tagna i beaktande när man skapar needs:en?
3. **How are the needs connected to the overall strategy?**
   Hur kopplas needs till den övergripande strategin?
4. **How and with what information are the needs presented to the means provider?**
   Hur och med vilken information är needs presenterade till idégivarna?

   a. **What do you think about the need template?**
      Vad tycker du om Needs mallen?

5. **What are your expectations on the means?**
   Vad är dina förväntningar på projektidéerna?
   a. **What is required of a mean to meet a need?**

Vad krävs för att ett means ska möta ett need?

6. **Do you feel that the needs are usually met?**
   Känner du att needs oftast möts av means?

7. **What happens when a need is not fully met by means?**
   Vad händer när ett need inte möts av means?

8. **Except from creating the needs, are you involved in the screening of ideas?**
   Förrutom att skapa needs, är du involverad i gallringen av projektideer?

In general:

9. **Is the needs/means process functioning like you would like to?**
   Fungerar needs/means processen som du skulle vilja att den gör?

10. **What would you see as improvement possibilities to the process?**
    Vad skulle du se som möjliga förbättringsmöjligheter i processen?

MEANS INTERVIEW TEMPLATE

In general:

1. **What is your role and main task in the needs/means process?**
   Vad är din roll och huvuduppgift i needs/means processen?

Means specific:

2. **Are you satisfied in the way the needs are presented? Enough detailed and informative or too much information?**
   Är du nöjd med sättet som needs:en presenteras? Är de tillräckligt detaljerad och informativa, eller för mycket information?

3. **Are the needs from the different attribute areas (such as safety, environment, design etc.) handled separately or collectively, while creating ideas?**
   Hanteras needs:en från de olika egenskapsområdena separat eller gemensamt när idéer skapas?

4. **How does the means working process look, starting from receiving the specific needs until providing an idea that correspond to the needs?**
   Hur ser arbetsgången ut för att ta fram projektidéer, från det att man har fått ett behov till att man hittar en lösning som svarar på behovet?

5. **Do you use any template/guidelines to know what information about the idea that needs to be provided?**
   Använder du dig av någon mall/riktlinjer för att veta vilken information om idén som ska presenteras?

6. **Do you have any deadline when the final idea has to be presented as well as milestones when given information have to be provided?**

Finns det några riktlinjer för när den slutliga idén behöver presenteras och andra milstolpar för när viss typ av information ska tillhandahållas?

In general:

7. **Is the project selection process functioning like you would like to?**
   Fungerar urvalsprocessen som du skulle vilja att den gör?

8. **What would you see as improvement possibilities in the process?**
   Vad skulle du se som möjliga förbättringar i processen?

INNOVATION OFFICE - IDEA GENERATOR INTERVIEW TEMPLATE

1. **Can you describe the tool called Idea Generator?**
   Kan du berätta om verktyget som heter Idea Generator?

2. **How is this tool used and in what way?**
   Hur och på vilket sätt används Idea Generator i dagsläget?
3. **Is it possible to use this tool within the needs/means process?**
   Hur ser möjligheterna ut för att använda det i needs/means processen?
   a. **Are there any implementing barriers for this tool?**
      Vad skulle du se som barriärer för att implementera verktyget?
   b. **Does the capacity allow the tool to be used in the needs/means process, can all needs be idea boxes?**
      Är det kapacitetsmässigt möjligt att ha som verktyg i needs/means processen, kan man ha alla needs som idéboxar?
4. **We have seen that R&D councils have boxes in the Idea Generator, in what way are they used?**
   Vi har sett att olika R&D råd har boxar i Idea Generatorn, på vilket sätt används dom?

5. **How does the administration look for being an owner of an idea box?**
   Hur ser administreringen ut för att vara ägare av en idea box?
6. **What information can be shared, are there any limitations or restrictions for this?**
   Vilken information kan man kommunicera, finns det några begränsningar eller riktlinjer att förhålla sig till?
7. **How are ideas evaluated and what criteria is used when selecting ideas?**
   Hur utvärderas idéer och vilka kriterier använder man när idéer väljs ut?

APPENDIX B - BEST PRACTICE SCORING MODEL

(Cooper et al., 2001)

	Rating Scale				
Key Items	0	4	7	10	**Rating**
1. Strategic Alignment & Importance ✓ **strategic fit and importance** ✓ **fits our strategy** ✓ **important to do** ✓ **high impact on our business**	Product not in alignment with or important to our business strategy; low impact: KILL	Somewhat supports business strategy; not too important; modest impact	Supports business strategy; important; good impact	Product aligns well with our business strategy; product very important to strategy; high impact	
2. Product &Competitive Advantage ✓ **unique customer benefits** ✓ **value for money** ✓ **customer feedback in Stage 2**	None; negative or neutral customer feedback; poor value	Limited; marginally superior; fairly neutral feedback; OK value	Some new benefits; somewhat superior, good value; positive feedback	Major new benefits; very positive customer feedback; great value	
3. Market Attractiveness ✓ **market size & growth** ✓ **margins** ✓ **competitive situation**	Small or non-existent market; low growth & low margins; tough competition: KILL	Modest market; limited growth; fair margins; competitive	Significant market; good growth; good margins; modest competition	Large, growing, attractive market; good margins; weaker competition	
4. Leverages Core Competencies ✓ **technology** ✓ **production** ✓ **marketing & distribution/sales**	No opportunities to leverage competencies; required skills/ experience/ resources strengths are weak: KILL	Some opportunities to leverage our competencies; our skills/ experience/ resources are modest	Considerable leverage possible; skills/experience needed for projects are within Company	Excellent leverage of our strengths & competencies; excellent fit between project needs, our skills, experience, resources	
5. Technical Feasibility ✓ **small technical gap** ✓ **not too complex technically** ✓ **uses our in-house technology** ✓ **demonstrated technical feasibility**	Low; big gap; new science; technology new to Company; have not been able to demonstrate technical feasibility: KILL	Modest; fairly large gap; quite a few hurdles but do-able; technology fairly new to Company; limited evidence to support technical feasibility	Good; small gap; some hurdles, but attainable; have some evidence of technical feasibility	Straight-forward; largely engineering repackage; we have technology in house; have demonstrated technical feasibility	
6. Financial Reward vs. Risk ✓ **sizeable, excellent opportunity** ✓ **Payback, NPV & IRR OK** ✓ **certainty of estimates** ✓ **not too risky & difficult to do**	Poor, limited opportunity; NPV negative, payback > 5 yrs; difficult to make money here; risky & tough to do: KILL	Modest opportunity; NPV positive; payback = 4 yrs; fairly difficult to make money; fairly risky & tough to do	Fairly good opportunity; NPV positive & good; payback = 2 yrs; probably can make money; modest risk & difficulty	Excellent Opportunity; NPV positive & high; payback < 1 yr; not too risky & difficult to do	