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NPD Project Evaluation in the Manufacturing Industry

Authors: Carl Ekbohm & Alexander Wrangé

Supervisor: Ph.D. Christian Koch

Abstract

Title: NPD Project Evaluation in the Manufacturing Industry

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Authors: Carl Ekbohm and Alexander Wrangé

Supervisor: Ph.D. Christian Koch

Key words: NPD projects, evaluation methods, evaluation criteria, portfolio management, manufacturing industry

Purpose: The purpose of this thesis is to increase the understanding of how new project development (NPD) projects can be evaluated in terms of methods and processes. Furthermore, it aims at scrutinizing the impacts of actors and structures on the evaluation process. Moreover, it aims at identifying what challenges and trade-offs companies face when choosing evaluation methods and organising processes for NPD project evaluation.

Method: Qualitative multiple-case study of three large manufacturing companies in Sweden, with embedded design and influence from action research.

Theoretical perspectives: Theories in financial project evaluation, project evaluation criteria, agency theory, portfolio management

Empirical foundation: Semi-structures, in-depth interviews with a total of ten managers with different functions at the three case companies.

Conclusions: Financial methods are essential for NPD project evaluation, but complementary criteria that consider the complexity of NPD projects are necessary to include. Portfolio management can be used as a process to combine financial methods and complementary criteria. The impact of actors limits objectivity, but they provide important knowledge and experience. The structures serve as a cross-functional framework to guarantee the involvement of actors from different functions in the evaluation process. Companies face several challenges in relation to NPD project evaluation and have to choose between using a comprehensible or sophisticated evaluation method, a common method or different methods, and the same set of criteria for all projects or use different sets for different types of projects.

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Lund, May 2015

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1 Introduction

1.1 Background

Companies in the manufacturing industry constantly face new product development (NPD) projects, but before deciding whether to invest in them, these projects have to be evaluated first. The term project evaluation has an ambiguous meaning. It can both refer to the estimation of a project in the process of project selection and to a retrospective review of a finalised project. Typically, the former takes place before the start of sales of a project, whereas the latter takes place after its start of sales.

Walsh, Roy, Bruce, and Potter (1992) define NPD as “the process that transforms technical ideas or market needs and opportunities into a new product that is launched onto the market” (p. 16). In 1986, Takeuchi and Nonaka (1986) determined that the set of rules for the game of NPD were changing; simply focusing on quality, low costs and differentiation was not sufficient anymore. Furthermore, Griffin (1997) concluded that the markets and environments where companies are operating are unstable and constantly changing.

NPD projects are complex, which is due to the level of customized components and the variety of skills and knowledge that is required for development and production (Hobday, 1998). Before starting our research, we discovered that there was an interest among manufacturing companies in how to evaluate NPD projects. This interest, as well as the complexity of NPD projects, made up an appealing incentive for our study. We were specifically interested in studying how large manufacturing companies in Sweden evaluated NPD projects, as the country has strong historic ties to the manufacturing industry.

During the end of the 19th century, the industrial society had its breakthrough in Sweden. For a twenty-year period between 1890 and 1910, Sweden had the largest annual percentile change of GDP per capita in the industrial world (Schön, 2007). The importance of the industry is still substantial. According to a McKinsey (2012) report, one of the key factors behind Sweden's economic growth for the past 15-20 years is the manufacturing industry. The growth of the Swedish economy and the underlying success of the manufacturing industry can be explained by several factors.

The availability of skilled and qualified labour, deregulations and increased competition are important parts of the explanation. Furthermore, a beneficial development of the market and the success of the largest manufacturing corporations are another part. Finally, the economic-political background for this period was established during the 1990s, as a consequence of that decade's financial crises (McKinsey, 2012). Given this background, one can argue that manufacturing companies constitute the backbone of Sweden's economic growth.

As the business environment and NPD are changing and developing (Griffin, 1997; Takeuchi & Nonaka, 1986), finding appropriate ways of evaluating complex NPD projects is of the utmost importance for manufacturing companies. However, there are problems related to the evaluation of NPD projects, and by conducting a case study of large Swedish manufacturing companies, we wanted to gain a deeper understanding of them.

1.2 Problem Statement

There are several problems related to the evaluation of NPD projects. There is a wide variety of *methods* in theory for evaluating such projects (Mankin, 2007; Thamhain, 2014). In practice, decision makers use both quantitative and qualitative methods (Remer, Stokdyk & Van Driel, 1993). These include *financial methods*, but there are also other *complementary criteria*, which are relevant to consider. However, most methods for evaluating projects have limitations (Lin & Yang, 2015; Remer & Nieto, 1995), which implies that it is difficult for companies to choose appropriate evaluation methods.

Moreover, it is difficult for companies to organise the *process* of evaluation. NPD projects in the manufacturing industry are complex (Hobday, 1998), and there is a general gap between theory and practice in organisation and management (Van de Ven, 2007). Moreover, the evaluation process implicates that conflicts of interests might occur when different functions of a company are involved. Due to this complexity, it is challenging for companies in the manufacturing industry to create *structures* and decide on how to involve the *actors* in the evaluation process.

The choice of evaluation methods and the organising of the process represent several *challenges* and *trade-offs* for companies. It is difficult to compare and prioritise projects, and finding an

appropriate way to do so is a major concern for companies in the manufacturing industry. Identifying these challenges and trade-offs is necessary in order to understand the problems faced when engaging in the evaluation of NPD projects.

1.3 Research Aims

Our aim is to scrutinize how NPD projects can be evaluated by conducting a multiple-case study of manufacturing companies in Sweden. We will first focus on *methods* used for evaluation, specifically *financial methods* and *complementary criteria*. Secondly, we will focus on the impacts that *actors* and *structures* have on the evaluation process. Thirdly, we will review *portfolio management* as a means to combine financial methods and complementary criteria in the process of evaluating NPD projects. In addition, we aim at identifying the *challenges* and *trade-offs* that the choice of methods and organising of the process represent.

1.4 Research Questions

Based on our problem statement and research aims, we will answer the following question:

How can NPD projects be evaluated?

Furthermore, we aim at answering the following sub-questions:

What impact do actors and structures have on the evaluation process?

What challenges and trade-offs do companies face when choosing evaluation methods and organising processes for evaluating NPD projects?

1.5 Theoretical Contribution

There is a reason to why we have chosen to focus on the problems surrounding the *methods* and *process* of NPD project evaluation. The two topics are interrelated, but we believe that it is necessary to examine the first topic before analysing the second one. We need to understand the *financial methods* and *criteria* for evaluation and their implications before analysing how

they are used in the process of evaluating NPD projects, and how actors and structures impact on this evaluation process.

Comparisons of financial methods for project evaluation have been made extensively in literature; however, instead of focusing on the methods' theoretical foundations and mechanisms, as most of the research has so far, we will focus on their usefulness and relevance (Poh, Ang & Bai 2001). Moreover, by combining our review of financial methods with a review of relevant complementary criteria for evaluating NPD projects, we hope to provide a wider understanding of the evaluation methods. As Åstebro (2004) states, there is a lack of focus on criteria in literature.

Even though several studies have scrutinized the process and performance in NPD (Rogers, Ghauri & Pawar, 2005), we will differentiate our study by specifically examining the structures and the actors. We believe that those aspects are important to study in order to understand the complexity of evaluating NPD projects. Only scrutinizing the evaluation methods would not be sufficient. Furthermore, by conducting a case study of large manufacturing companies in Sweden, we will be able to scrutinize how NPD projects are evaluated in practice. Nevertheless, despite the practical significance that such an analysis could provide for the manufacturing industry in Sweden, in terms of theoretical contribution, we consider it necessary to elaborate the problem by scrutinizing what challenges and trade-offs these companies face in the process. Thereby, we aim at contributing to literature about NPD in general, and project evaluation in particular.

Whetten (1989) describes four building blocks, which are essential for a theoretical contribution. These blocks are formulated as questions based on (1) *what*, (2) *how*, (3) *why*, and (4) *who, where, and when*. When answering our research questions stated above, the *what* factor consists of the evaluation of NPD projects and the challenges and trade-offs that companies face in NPD project evaluation. The *how* factor explains how all factors or related in the evaluation process. *Why* it occurs can be seen as an extension of the complexity of NPD projects and the importance of the manufacturing industry. *Who, where, and when* concern the actors involved in the project evaluation process as well as its structures.

1.6 Thesis Outline

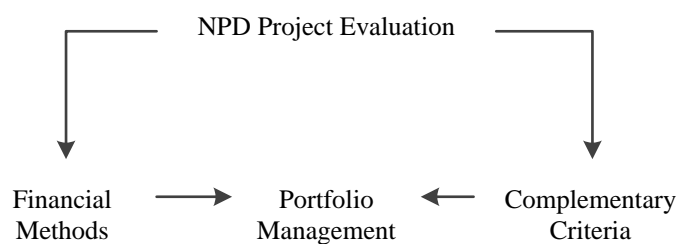
Chapter 1 introduces the thesis by presenting the background of its subject, the problem statement, the research aims, the research questions, and the theoretical contribution. Chapter 2 reviews literature on methods and processes for evaluating NPD projects; specifically financial methods, complementary criteria, actors, structures, and portfolio management. Chapter 3 the methodology: the case study research design, the case companies, the generating and analysis of data, and criteria for assessing research quality. Chapters 4-6 feature the case studies of Alfa Laval, Atlas Copco, and Trelleborg. Chapter 7 analyses the finding of the case studies. Chapter 8 discusses the findings in relation to previous research and theories in the literature reviewed. Chapter 9, finally, presents the conclusions, the theoretical contributions and managerial implications of our thesis.

2 Literature Review

Different fields within business administration are affected in this thesis. In the first part of this chapter, we will scrutinize a number of existing theoretical methods and criteria for evaluating NPD projects. We will focus on their usefulness and relevance for evaluating this type of projects, rather than their theoretical foundations and mechanisms. Firstly, we will review six financial methods and summarize their advantages and disadvantages. Secondly, we will review complementary criteria, which have been suggested in literature as appropriate to consider when evaluating NPD projects. Thirdly, we will review the process of evaluation, with a focus on the structures, formal and informal, and actors involved.

Finally, we will review portfolio management as a method to combine quantitative methods and complementary criteria in the process of evaluating NPD projects. Cooper (1999) suggests two critical factors for new product projects: the first factor is to commit to the right projects and the second one is to complete the projects in the right way. We will focus on the former factor in our review, and it is in this context that we will discuss which criteria that need to be taken into account in the evaluation of NPD projects for companies in the manufacturing industry.

Figure 1. Overview of NPD Project Evaluation as Reviewed in our Thesis



2.1 Evaluation of NPD Projects

2.1.1 Financial Methods

Financial methods are popular when project evaluation requires economic justification. By generating numeric measures, their results are easily comparable and thus enable ranking of projects (Thamhain, 2014). Remer and Nieto (1995) discuss a number of financial methods that have been developed during the 20th century. We will present five of those methods that are especially popular (Hartman & Schafrick, 2004; Thamhain, 2014), and scrutinize their advantages and disadvantages: net present value (NPV), payback period (PP), internal rate of return (IRR), return on investment (ROI) cost-benefit analysis (CBA), and expected commercial value (ECV). These six methods exist in multiple variations where one or several variables have been adjusted, but we will only give a review of the most conventional versions (Remer & Nieto, 1995). Furthermore, we will review the expected commercial value (ECV) method (Cooper, Edgett & Kleinschmidt, 2001). A combination of different quantitative methods is most common in practice when quantitatively evaluating projects (Thamhain, 2014), in order to make up for the methods' individual limitations, whereby this matter will be discussed at the end of this part. First, however, we will give a brief definition of the time value of money (TVM) and the minimum attractive rate of return (MARR).

Time Value of Money & the Minimum Attractive Rate of Return

In short, the *time value of money* (TVM) means that money makes money over time. Money today is not worth the same as money at some point in the future: "If we desire to invest capital (money) in a project today, we inherently expect to have more money in the future than we invested" (Blank & Tarquin, 2012, p. 4). This is especially apparent when the time period exceeds one year.

The *minimum attractive rate of return* (MARR) is "the interest rate for which all future cash flows can be reinvested" (Remer & Nieto, 1995, p. 84). Blank and Tarquin (2012, p. 26) give the following definition of the MARR:

"The Minimum Attractive Rate of Return (MARR) is a reasonable rate of return established for the evaluation and selection of alternatives. A project is not economically viable unless it is expected to

return at least the MARR. MARR is also referred to as the *hurdle rate*, *cutoff rate*, *benchmark rate*, and *minimum acceptable rate of return*."

Net Present Value

The *net present value* (NPV) method, also known as the discounted cash flow method, calculates the net present value of all cash flows in a project (Meredith & Mantel, 2012) and thus provides an easy technique to evaluate projects (Remer & Nieto, 1995). At an early stage in a project, the net cash flow is most probably negative due to the important outflow represented by the initial investment. However, the cash flows will start to be positive when or if the project becomes successful (Meredith & Mantel, 2012).

$$NPV(\text{project}) = A_0 + \sum_{t=1}^n \frac{F_t}{(1+k)^t}$$

$$NPV(\text{project}) = A_0 + \sum_{t=1}^n \frac{F_t}{(1+k+p_t)^t}$$

F_t = Net cash flow in period t

k = Required rate of return

A_t = Initial cash investment

p_t = Predicted rate of inflation/deflation during period t

The advantages with the NPV are that it considers time value money (TVM) and, depending on the method, shows present/future/annual consequences of a project. However, there are also disadvantages with the NPV. Firstly, it assumes that the cost of a project, if repeated, remains

constant throughout the analysis period. This might be incorrect if a project involves inconstant cost flows. Secondly, the NPV does not consider the size of the projects, which is an issue if the projects vary in size (Remer & Nieto, 1995).

Payback Period

The *payback period* (PP) calculates the number of years it takes for a project to repay its initial fixed investment (Meredith & Mantel, 2012). In other words, the PP represents "the time interval between the start of sales and the point at which the total project cash flow becomes positive" (Remer, Stokdyk & Van Driel, 1993, p. 104). The calculation is made by dividing the project's initial fixed investment with the estimated annual net cash inflows (Meredith & Mantel, 2012). In short, the PP calculates the time it takes for the project to pay for itself (Remer & Nieto, 1995):

$$PP = \text{Initial cash investment} / \text{Annual net cash flow}$$

Two disadvantages with the PP method are that it does not measure the time value of money (TVM) in a correct manner and that it ignores cash flows after the payback period (Yard, 1999; Lefley, 1996). Furthermore, the method also assumes that the cash flows actually continue long enough to cover the initial investment (Meredith & Mantel, 2012). However, an advantage is that the PP offers a quick and easily understood determination of risk (Remer & Nieto, 1995).

Internal Rate of Return

The *internal rate of return* (IRR) is the discount rate that equates the present values of expected cash inflows and cash outflows of a project (Meredith & Mantel, 2012). It "calculates the interest rate for which the present worth of a project equals zero" (Remer & Nieto, 1995). As it only represents "internal" factors, "external" factors such as the MARR are not considered. However, there are other rate of return methods that do. The IRR is a popular method due to its being simple to understand and carry out. Nevertheless, even though the calculation *per se* is rather easy to make, the IRR has several limitations. For example, it requires estimations of cash flows that can be hard to obtain, and it sometimes results in more than one solution (Remer, Stokdyk & Van Driel, 1993). Another problem is that the IRR assumes that cash flows can be reinvested at the IRR rate, which is not necessarily true. Remer, Stokdyk and Van Driel conclude that

"the IRR favours investments with short payback periods or large initial cash flows, due to high discounting at the end of the project" (1993, p. 111).

Return on Investment

There are two versions of the *return on investment* (ROI): the return on original investment method and the return on average investment method. The first version calculates the percentage relationship between the average yearly profit and the initial investment, whereas the second version calculates the percentage relationship between the average yearly profit and the average yearly investment. The major advantage with the ROI is that its results are averages. However, one of the most important disadvantages of the ROI is that it does not consider the TVM, as the amounts used to calculate the averages are not discounted. Furthermore, it does not have a set of criteria for project profitability. (Remer & Nieto, 1995).

Cost-Benefit Analysis

The *cost-benefit analysis* (CBA) is used to add up all the costs and all the benefits from a project, regardless of where they derive from (Small, 1997). An advantage presented by Remer and Nieto (1995) suggests that the CB is easy to calculate. However, at the same time, they state that the costs and benefits can be difficult to translate into money (Remer & Nieto, 1995). This disadvantage has been the topic of much research and discussion. Many economists regard it as a problem that all costs and benefits are not quantifiable (Small, 1997). Another disadvantage with the CBA is that it can be hard to identify all users of a project (Remer & Nieto (1995).

Expected Commercial Value

Cooper, Edgett and Kleinschmidt (2001) suggest the *expected commercial value* (ECV) method to be used as a financial project selection technique. This approach is quite similar to the productivity index (Cooper, Edgett & Kleinschmidt, 2000). The strength of the ECV method is its focus on the go/kill decision process for a project. Since the monetary value is recalculated to today's value, it considers the go/kill decision for projects with a longer time horizon. However, the main disadvantage of this method is its requirement of financial data and other quantitative input. Further weaknesses with the ECV method is the absence of portfolio balance, it does not consider the balance between projects of different risk levels. It neither takes into account the

balance between different markets nor different technologies (Cooper, Edgett & Kleinschmidt 2001).

$$ECV = [(NPV * P_{cs} - C) * P_{ts} - D$$

\$ECV = Expected Commercial Value of the project

\$PV = Income stream from project (discounted to present)

\$C = Commercialization costs (capital equipment & market launch)

\$D = Development costs

P_{ts} = Probability of technical success

P_{cs} = Probability of commercial success

The ECV method is not accounted for in Table 1. When Remer and Nieto (1995) compared different financial methods, the ECV method was not included in their study. However, the ECV considers TVM and MARR.

Combinations of Financial Methods

When quantitatively evaluating NPD projects, it is important to consider TVM and the MARR. If a financial method does not consider these aspects, it should be used in combination with other financial methods in order to complement for its limitations. This is the case for the conventional PP and ROI (Remer & Nieto, 1995). The NPV can, according to Remer and Nieto (1995), be used alone as a method to provide independent results. However, given the fact that it does not consider the size of projects, it has to be used together with methods that do so if a company has projects of different size, as is generally the case for companies in the manufacturing industry.

Table 1. Overview of Financial Methods

Method	Uses TVM?	Uses MARR?	Can be used alone?	Advantages	Disadvantages
Net Present Value (NPV)	Yes	Yes	Yes	Shows present consequence of the project.	Ignores size of project; repeated project assumption.
Payback Period (PP)	Yes(b)	Yes(b)	No	Offers quick determination of risk; easily understood by people unfamiliar with engineering economics.	Ignores cash flows after the payback period; may yield mis-leading results.
Internal Rate of Return (IRR)	Yes	Yes(a)	Yes	No "external" factors are considered.	Assumption of reinvesting at IRR may be unrealistic; multiple-roots.
Return on Investment (ROI)	No	Yes(a)	No	Gives "averaged" results.	Ignores TVM.
Cost-Benefit (CB)	Yes	Yes	Yes	Easy to calculate.	Sometimes difficult to identify and quantify all benefits and disbenefits into dollar amounts; also difficult to identify all users of the project.

(a) MARR used in decision-making criteria only.

(b) Applies only to modified method, not conventional.

Source: Remer & Nieto, 1995

Limitations with Financial Methods for Evaluating NPD Projects

A problem with the above-mentioned financial methods is that they rely on the *quality* of the input data. The longer a project occurs, or the longer the analysis period observed, the more difficult it is to accurately estimate its cash flows (Poh, Ang & Bai 2001). In other words, it does not matter whether a method or combination of methods is suitable for evaluating projects

as long as the quality of the input cannot be guaranteed. Poor input will give poor results. As Thamhain (2014) concludes, the usefulness and relevance of financial methods depend on the notion that all factors considered in the evaluation can be *quantified* and estimated over the analysis period.

Remer and Nieto (1995) propose nine steps for an economic evaluation of projects:

1. Define a set of investment projects for consideration
2. Establish the planning horizon (or analysis period) for economic study
3. Estimate the cash flow profile for each project
4. Specify the time value of money or minimum attractive rate of return (MARR)
5. Examine the objective and establish criteria to measure effectiveness
6. Apply the project evaluation technique(s)
7. Compare each project proposal for preliminary acceptance or rejection
8. Perform sensitivity analysis
9. Accept or reject a proposal on the basis of the established criteria

These nine steps illustrate that the challenge with evaluating NPD projects with financial methods is not only a matter of choosing the optimal set or combination of methods; they raise two more issues that are important. First, the planning horizon or analysis period has to be considered. Cohen, Eliasberg and Ho (1996) conclude that *time-to-market*, the time between the start of an NPD project and its launch on the market, varies and depends on external factors such as: "the size of the potential market, the presence of existing and new products, profit margins, the length of the window of opportunity, the firm's speed of product improvement, and competitor product performance" (p. 173).

Secondly, what criteria should be considered when evaluating NPD projects? This points to another important problem with the financial methods, as they only or mostly imply economic evaluations of projects, while NPD projects in fact involve many other types of criteria and foundations for evaluation (Poh, Ang & Bai, 2001). Thamhain (2014, p. 4) explains:

"While quantitative methods provide an important toolset for project proposal evaluation and selection, there is also a growing sense of frustration, especially among managers of complex and technologically advanced undertakings, that reliance on strictly quantitative methods does not always produce the most useful or reliable inputs for decision-making, nor are all methods equally suited for all situations; therefore, it is not surprising that for project evaluations involving complex sets of

business criteria, narrowly focused quantitative methods are often supplemented with broad-scanning, intuitive processes and collective, multifunctional decision making..."

Both quantitative and qualitative measures should be included in the evaluation according to Thamhain (2014). Therefore, we find that a review of important criteria to be considered in the evaluation of NPD projects is required. Moreover, if a company relies too much on financial methods when evaluating its NPD projects, it might result in an unbalanced project portfolio. The reason is that financial methods mostly measure profitability (Poh, Ang & Bai, 2001). Cooper (2011) is on the same track; he implies that management with an extensive focus on financial measures counteracts bold innovation projects. This is also the reason why we will review portfolio management as a method to combine financial methods with other relevant criteria in order to evaluate NPD projects.

2.1.2 Complementary Criteria

As concluded above, an evaluation of NPD projects cannot be made solely on financial methods. Other criteria have to be included in the evaluation. Lim and Mohamed (1999) define criteria in the following way, while also making the distinction between criteria and factors: "Criteria are the set of principles or standards by which judgement is made; whereas factors are the set of circumstances, facts, or influences which contribute to the result" (p. 243).

According to Åstebro (2004), literature has been criticized for not focusing enough on necessary criteria for project selection: "Recent literature on managing the innovation process has been criticized for an undue focus on the *process* of R&D project selection, while not addressing the decision *criteria* necessary to select appropriate projects" (Åstebro, 2004, p. 319). As Thamhain (2005) states, "the criteria relevant to the evaluation and selection of a particular project depend on the specific project type and business situation, such as project development, custom project, process development, industry, and market" (p. 208).

However, Akhilesh (2014) groups a number of general factors for evaluating research project proposals into seven categories: (1) technical factors; (2) research direction and balance; (3) marketability factors; (4) production factors; (5) financial factors; (6) timing of research; and (7) other factors. Apart from the financial factors that mostly concern costs, revenues, and benefits, the other factors are more difficult to quantify. They concern the availability, adequacy, and capability of necessary technology, labour skills and production facilities. Furthermore,

they relate to the compatibility of the organisation's goals and an appreciation of market potential, existing customers and competition. Moreover, he specifically brings up factors linked to the timing as well as the effects of the research (Akhilesh, 2014). Nevertheless, a challenge with such noneconomic aspects is that they tend to be intangible and very difficult to quantify (Blank & Tarquin, 2012).

Akhilesh (2014) concludes: "The existence of a fairly detailed list of factors (...) indicates both the complexity and the necessity for a systematic method of accumulating the required data and evaluating each factor. It also indicates the difficulties encountered in bringing the individual factors together into a composite judgment" (p. 88). He discusses some specific difficulties related to this process. One of them is making an estimate of the probability of technical success, a task that is very subjective and requires experience. The timing of the research is another issue, which depends to a large extent on the strategy of the organisation and whether it is engaged in defensive or offensive research in relation to a certain project. (Akhilesh, 2014)

Furthermore, according to Akhilesh (2014), the stability of the market should be taken into consideration. Products that are less vulnerable to volatile markets are more likely to contribute than unstable products, as are products protected by patents. Moreover, new marketing channels should also be evaluated: "A market comprising few large customers is different from that comprising a large number of small customers" (Akhilesh, 2014, p. 89).

In their article, "Industrial Companies' Evaluation Criteria in New Product Development Gates", Hart, Hultink, Tzokas, and Commandeur (2003) further highlight the complexity of NPD projects, but argue that this complexity can be managed by relevant criteria:

"It is agreed widely that the notion of complexity is inherent in the NPD efforts of industrial companies. However, it is agreed equally that this complexity can and should be managed for the successful development of new products. One means of doing so is by establishing guideposts against which management activity can be evaluated, controlled, and modified if needed throughout the NPD process." (pp. 33-34)

Hart et al. (2003) mean that the evaluation criteria applied by companies when evaluating NPD projects depend on the stage of the project; that is, they use different criteria at different gates of the project. The criteria and stages addressed in their study are shown below in Figure 2. The authors recommend that "managers should strive to develop and to implement evaluative criteria targeted to the specific requirements and expectations from each stage of their NPD project"

(Hart et al., 2003, p. 34). This would allow managers to stay attentive to problems and opportunities as they appear. They furthermore perceive a constant orientation to the customers and their needs throughout the projects, which they interpret as companies' attention to "the voice of the customer", and thus recommend managers to consider the customer throughout the evaluation process.

Figure 2. Evaluation Criteria at NPD Gates

		Evaluation Criteria																				
		Customer Acceptance	Customer Satisfaction	Sales Objectives	Sales Growth	Market Share	Sales in Units	Break-Even Time	Profit Objectives	IRR/ROI	Margin	Stays within Budget	Introduced in Time	Product Performance	Quality	Time-to-Market	Product Uniqueness	Market Potential	Marketing Chance	Technical Feasibility	Intuition	
NPD Evaluation Gates	Idea Screening																					
	Concept Screening																					
	Business Analysis																					
	Product Testing																					
	Test Market																					
	Post-Launch S/T																					
	Post-Launch L/T																					

Source: Hart et al., 2003

Cohen, Eliasberg and Ho (1996) discuss the trade-off between *product performance* and *time-to-market* (TTM) as goals for companies engaged in NPD. For instance, they find that a strong focus on increasing new product performance might lead to larger market shares, but due to the time required for such a maximisation, the window of opportunity might be missed. Therefore, they suggest integrative NPD parameters, which combine product performance and time-to-market criteria.

2.2 Actors and Structures of the Project Evaluation Process

“Managing new product development (NPD) is, to a great extent, a process of separating the winners from the losers” (Cooper & Kleinschmidt, 1995, p. 374). Further, Kahn, Barczak and Moss (2006) define the process in the following way: “Process represents the NPD stages, corresponding activities, and gate criteria for moving products to launch” (p. 110). To develop a

better understanding of the first quote, we will outline research within this field in this section. However, we will have a distinguished focus on the *actors* and *structures* – both formal and informal – of the project evaluation process.

A substantial amount of studies has been conducted to comprehend the *processes* and *performances* of NPD (Rogers, Ghauri & Pawar, 2005). Primarily, what is a *process* and how do we refer to it in this context? According to (Cleland, 1999, p. 45) a process is defined in the following way:

“A *process* is defined as a system of operations in the design, development, and production of something - such as a project. Inherent in such a process is a series of actions, changes, or operations that bring about an end result, in the case of a project attainment of its cost, schedule, and technical performance objectives. Another meaning of a process is that it is a course or passage of time in which something is created - an ongoing movement or progression.”

Furthermore, Akhilesh (2014, p. 85) describes project evaluation as a process:

“Project evaluation is a continuous process in R&D management. It is conducted based on the objectives of the project, milestone achievements, and the relevance of the project to the overall organizational goals. R&D project evaluation is an important decision-making activity and demands good leadership as well as participation of members of the organization.”

The process of developing new products for global markets contains numerous interactions (Rogers, Ghauri & Pawar, 2005), thus adding another layer of complexity to NPD projects. Furthermore, NPD is an interdependent process between various departments across an organisation. Manufacturing is dependent on sales forecasts, and sales promotions and activities related to the product cannot be initiated in advance (Cleland, 1999). Takeuchi and Nonaka (1986) suggest overlapping development phases to facilitate those miss-matches. The overlapping phases differ from more traditional sequential development stages. A key aspect of overlapping procedures is the sharing of knowledge,

Difficulties in measuring the NPD process stem from complications in financially assessing and estimating the time horizon of the R&D process and distinguishing benefits and profits during this process. In addition, to evaluate the input of each individual in the NPD-team could be both awkward and difficult (Rogers, Ghauri & Pawar, 2005).

Parallels can be drawn to Tushman and Nadler (1986). They suggest that successful product innovation requires close cooperation between R&D-, production-, marketing- and sales departments. Furthermore, these authors present four critical components of the organisational process of managing innovation and product development: *Tasks*, *Individuals*, *Organisational Arrangements* and *Informal Organisation* (Tushman & Nadler, 1986). Those four components will be critical for our empirical gathering and are presented in Table 2.

Table 2. Managing Innovation

Tasks	The basic work that needs to be performed
Individuals	The members of the organisation
Organisational Arrangements	The formal structures and processes for the individuals to execute their tasks
Informal Organisation	Unwritten agreements, includes <i>culture</i> , which defines how things are carried out

Source: Adapted from Tushman & Nadler (1986)

Kahn, Barczak and Moss (2006) suggest, in their best practice framework, that NPD should have a team-based focus and be cross-functional. Furthermore, these authors propose that the prominent companies have specialised NPD groups, which are committed to NPD work only. Johnson, Scholes and Whittington (2008) describe organisational culture through four different layers. Since those layers (Values, Beliefs, Behaviours and Taken-for-granted assumptions) are a part of informal structures, they might be of interest for this thesis.

When assessing actors' roles and their motivations, the agency theory could be applied. Eisenhardt (1989, p. 58) states:

“Agency theory is concerned with resolving two problems that can occur in agency relationships. The first is the agency problem that arises when (a) the desires or goals of the principal and the agent conflict and (b) it is difficult or expensive for the principal to verify what the agent is actually doing.”

In the context of thesis, the agent would be the employee who manages and prepare the basis of the NPD evaluation, and the principal would be someone who evaluates and selects projects.

Moral hazard and adverse selection are two issues that may occur (Eisenhardt, 1989). According to Holmström (1979), the risk of moral hazard arises when an asymmetrical information relationship exists between different parties. Based on the same information relations, adverse selection may also follow (Akerlof, 1970).

2.3 Portfolio Management

Portfolio management is a considerable field of study for our thesis. The concept can be described as an interdisciplinary perspective between the different financial methods discussed above and more or less nonnumeric or qualitative methods that consider the strategic fit of projects. Cooper, Edgett and Kleinschmidt (1999, p. 335) define portfolio management for new products in the following way: “Portfolio management is a dynamic decision process, whereby a business's list of active new product (and R&D) projects is constantly updated and revised. In this process, new projects are evaluated, selected, and prioritized; existing projects may be accelerated, killed, or deprioritized; and resources are allocated and reallocated to the active projects”.

Cooper, Edgett and Kleinschmidt (1999) suggest that benchmark companies (companies with whom an organisation compares its business processes) use an approach where financial-, strategic- and scorecard methods are combined. Even though Cooper, Edgett and Kleinschmidt (1999) do not suggest specific methods, they conclude that multiple approaches are used by the benchmark companies. The companies, which Cooper refers to as benchmarks, are in this context the ones that have the highest quality in portfolio methods. High quality in this case refers to e.g. user-friendliness, a high level of recommendation and methods that are realistic. Moreover, the methods for benchmark companies should fit the organisation's management characteristics.

Portfolio management, as a field of study, implies that our empirical studies should involve different departments of the case study companies. However, other studies, like the ones conducted by the Product Development and Management Association (PDMA), argue that financial measurements are the most important ones (Markham & Hyunjung, 2013). In addition, Loch and Kavadias (2002) imply that managers in practice have a tendency to overlook strategic measurements as complements to financial ones. Studies too, like Cooper's (Cooper, 1985),

have received criticism by researchers such as Griffin & Page (1996) for not being simple enough in their managerial implications. Thus, this further suggests that a discrepancy between theory and practice exists.

Cooper, Edgett and Kleinschmidt (2001) list eight reasons why portfolio management is an essential aspect for companies' management:

1. Financial – to maximize return; to maximize R&D productivity; to achieve financial goals.
2. To maintain the competitive position of the business – to increase sales and market share.
3. To properly and efficiently allocate scarce resources.
4. To forge the link between project selection and business strategy: the portfolio is the expression of strategy; it must support the strategy.
5. To achieve focus – not doing too many projects for the limited resources available; and to resource the “great” projects.
6. To achieve balance – the right balance between long and short term projects, and high risk and low risk ones, consistent with the business’s goals.
7. To better communicate priorities within the organization, both vertically and horizontally.
8. To provide better objectivity in project selection – to weed out bad projects.

In addition to this list, Kahn, Barczak and Moss (2006) suggests that companies that are prominent within the area of portfolio management use a formal and methodical process. Further, these companies have an existing bank of ideas.

2.3.1 Strategic Portfolio Management

The strategy of a company determines to a large extent which projects that are suitable for its project portfolio (Cooper, Edgett & Kleinschmidt, 1999). Smith and Sonnenblick (2013) use a steakhouse menu allegory to describe the goals for strategic portfolio management. The authors describe how prioritized pieces of the menu, e.g. steak and prime ribs, simply do not fit into the same plate given their similarities. Instead of using highly prioritized items together, the composition of a plate or menu also needs to contain e.g. potatoes and vegetables, which have lower

individual priorities. To transfer the steakhouse allegory to portfolio management, the authors state: “the goal of strategic portfolio management is not to pick which projects are the best but to pick the best *set* of projects to achieve the organization's goals” (Smith & Sonnenblick, 2013, p. 47).

Table 3 provides an overview of the differences between a strategic- and an operational approach to portfolio management.

Table 3. Operational vs. Strategic Portfolio Management

	Operational	Strategic
Objective	Efficient allocation of staff to a fixed set of projects	Selection of superior set of projects to meet strategic objectives within staff and funding constraints
Decision Criteria	Staff flexibility, critical task paths	Project value, strategic goals for product/division/company
Planning Horizon	12-18 months	1-15 years
Planning Time Units	Day/Week	Quarter/Year
Resources Units	Individual staff members	Dollars, staff categories
Activity Units	Sub-task	Program/product/project

Source: Smith & Sonnenblick, 2013

Nevertheless, Bengtsson and Kärreman (2012) argue that there is a discrepancy between formulating a strategy and implementing it, viewed through a process perspective on strategy. Furthermore, the authors state that strategies are developed inside the organisations, rather than by analytics behind a desk. Even though some methods are described below, the strategic approach on project evaluation differs from organisation to organisation. According to Cooper, Edgett and Kleinschmidt (2001), a strategic perspective of portfolio management is a necessity. Without strategic criteria, the projects selected for new product development might not be aligned with the organisations overall strategy and the R&D focus becomes widely spread.

According to Griffin and Page (1996), in 1985 Cooper created one of the most comprehensive outlines for product innovation strategy and its connection to a firm's success. Cooper (1985) detected 19 key dimensions or factors that are underlying for NPD strategy. The two most distinguished dimensions concern a firm's technological capabilities. *Technological sophistication* aims at a firm's competences of developing highly technological and complex products. The second of those dimensions is *Production and technological synergy*, which refers to a company's internal ability to meet the technological requirements needed for the manufacturing of the products they develop.

Furthermore, Cooper describes seven strategic dimensions with the *market* as a common denominator. Even though this thesis has not touched upon a marketing context of NPD yet, it has been taken into consideration. Through the action research-inspired approach we have adopted, marketing aspects have been brought to the table by one of our case companies. However, as previously mentioned, Cooper's comprising study with all its dimensions and variables can be viewed as too complex for companies in reality (Griffin & Page, 1996). Nevertheless, similarities with one of our case companies' market concerns can be found in Griffin and Page's (1996) model for project strategy classification (see Table 4). According to these authors, their model is more convenient for management when they are categorising projects.

Table 4. Project Strategy Typology

		Newness to the Market	
		Low	High
Newness to the Firm	High	New-to-the-Company	New-to-the-World
		Product Improvements	Add to Existing Lines
	Low	Cost Reductions	Repositionings

Source: Griffin & Page, 1996

While describing what they call the *project portfolio process* (PPP), Meredith and Mantel (2012, p. 74) explain the benefits of categorising projects: "Identifying separate categories not only facilitates achievement of multiple organizational goals (e.g. long term, short term, internal, external, tactical, strategic) but also keeps projects from competing with each other on inappropriate categories". Furthermore, they believe that companies should apply different criteria for each project category and determine scales for each of these criteria in order to measure how projects score on them. The criteria in each category should then be given an appropriate weighting. Although some criteria might apply to several categories, their weights might differ depending on the category and change with the phases of a project's life cycle. These criteria should then be used to rank projects within their respective category. In this context, Meredith and Mantel (2012) suggest that some criteria, which are difficult to measure, might be applied to a subjective evaluation separately.

2.3.2 Strategic Bucket Approach

Cooper, Edgett and Kleinschmidt (2001) suggest the use of the strategic buckets approach for ranking and/or rating different kind of projects. The same authors describes this approach as being the dominant one within the different strategic approaches. Cooper (2011) states: “Many best-in-class companies use the concept of strategic buckets to help in the resource deployment decision” (p. 22). Further, Cooper (2011) suggest that strategic buckets is a tool to be used for increasing bold innovations within a company’s portfolio.

The purpose of the strategic buckets approach is to divide financial resources between different product lines, departments, project types and so forth, aligned with the organisation’s strategy. Strategic buckets can be implemented to create a balance between *incremental* and *radical* new product developments, in the company’s project portfolio. The balance of the portfolio will be different depending on environmental instability and complexity (Chao & Kavadias, 2008). Kahn, Barczak and Moss (2006) states that it is more favourable to commit to incremental projects in companies with a less refined portfolio method. This will be a consequence of poor resource allocation and poor portfolio balance. Moreover, the ranking of the projects within the different buckets or categories can be performed by using e.g. an NPV method such as the ECV (Cooper, Edgett & Kleinschmidt, 2001) (see 3.2.1 for ECV calculation).

2.3.3 Benchmark Companies and Best Practice

To be able to identify a benchmark company or a best practice of project evaluation within the manufacturing engineering industry, certain criteria for those needs to be established first. Cooper, Edgett and Kleinschmidt (1999) divides companies into four different categories based on *Overall Quality Rating* and *Management Fit* for project portfolio evaluation methods. These two factors in turn consist of multiple different variables listed below.

Overall quality rating:

1. The portfolio method is realistic, capturing key facets of the decision problem
2. Management would highly recommend their portfolio method to others
3. The method is rated as excellent by management
4. The method is truly used to make go/kill decisions on projects

5. The method is user-friendly
6. The portfolio method is understood by management
7. Management believes the method to be effective - makes the right decisions

Management fit:

1. The portfolio method fits management's decision-making style
2. Management rates the method to be efficient - is not laborious and does not waste time
3. Management sees it as effective (makes the right decisions)
4. The method is understood by management

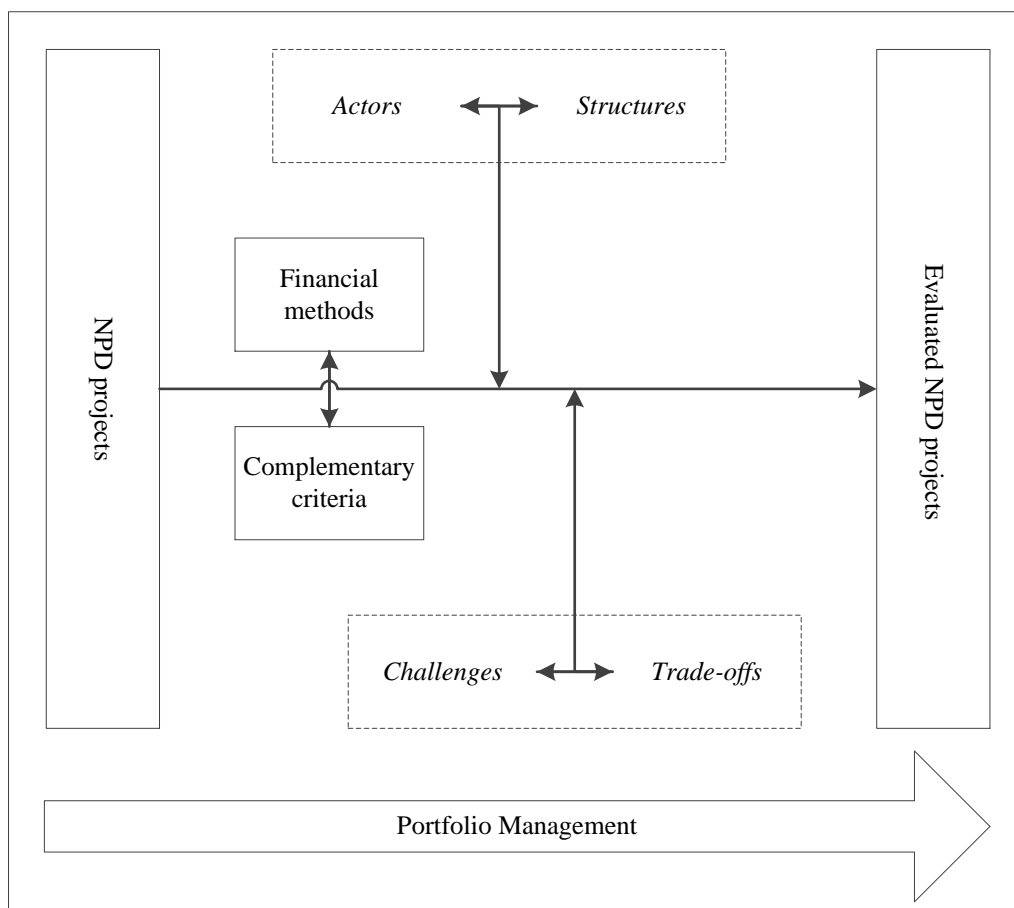
Cooper's work and studies within the project management/project portfolio field is considered by several to be in the forefront of the area of study. However, certain benchmark studies such as Cooper and Kleinschmidt (1995) and Cooper, Edgett and Kleinschmidt (1999) have a financial approach and a clear focus on measures and metrics. Griffin (1997) summarises previous studies of best practices of NPD. It is notable that the majority of those prior studies could not identify *how* the best companies separate themselves from others, even though numerous best practice findings were presented.

Kahn, Barczak and Moss (2006) provides an extensive framework for NPD, where the authors discusses different dimensions in a framework context. The dimensions are strategy, portfolio management, process, market research, people, metrics, and performance evaluation. By ranking the practice of each dimension (level one to four), the authors' purpose is to identify a best practice framework for NPD.

2.4 Conceptual Framework

In our thesis, we have relied on a conceptual framework (see Figure 3), which has served as a basis and guide for our study. It describes our understanding of the NPD project evaluation as a process in which financial methods and complementary criteria serve as evaluation methods. Furthermore, it shows how *actors* and *structures* affect the evaluation, and that companies face *challenges* and *trade-offs* in this process. Finally, the framework also shows that portfolio management is a process that involves all these aspects. While developing our framework, we were inspired by conceptual frameworks presented by Miles & Huberman (1994).

Figure 3. Conceptual Framework of NPD Project Evaluation



3 Methodology

This chapter describes how we conducted our empirical observations and what choices we have made regarding methodology in relation to the research problems, our research aims, research questions, and literature review. More precisely, we will argue for the choice of research design and philosophy, present our case companies, explain our data generation and analysis, and discuss criteria for assessing research quality.

3.1 Case Study Research Design

As previously mentioned, the manufacturing industry is in many cases characterized by complexity. Due to this complexity, we have relied on qualitative research methods in this thesis, as they enable a more detailed and enriched description of complex situations (Bryman & Bell, 2011; Gummesson, 2006). Furthermore, a focus within qualitative research is the interpretation of behaviour in a certain context, which is another reason to why we deemed that a qualitative approach was appropriate for our study, given our interest in the structures and actors involved in the project evaluation process (Gummesson, 2006).

More specifically, we chose a qualitative case study design. As Yin (2009) states: "the distinctive need for case studies arises out of the desire to understand complex social phenomena" (p. 4). The case study method permitted us to capture the characteristics of the organisational and managerial processes that we aimed to analyse (Yin, 2009). Moreover, a case study design allowed us to combine aspects of several methods in our research (Bryman & Bell, 2011). In addition, it is suitable given the explanatory nature of our thesis questions and the fact that we aimed at observing *contemporary* events where we *cannot* control the relevant behaviours of the persons involved in these events (Yin, 2009).

3.1.1 Research Philosophy

By conducting research, we inevitably must have a research philosophy that explains the nature of the phenomena that we study, *ontology*, and how we understand them, *epistemology*. A research philosophy was necessary in order for us to analyse the theories that we reviewed and the empirical observations that we made: what they mean; what their relations to each other

are; and their consequences (Van de Ven, 2007). Van de Ven (2007) argues that the knowledge of science and practice are different. However, this observation does not imply that they are opposites or substitutes; they are rather complements to each other. This notion has been important for us during the research process.

We have been inspired by a critical realist perspective and thus believe that our conceptualisation of reality merely represents an attempt to understand it rather than a direct reflection (Bryman & Bell, 2011). A foundation of critical realism is the notion that a reality exists, but that the researcher's ability to understand it is limited (Van de Ven, 2007). Furthermore, a critical realist position allows us to view "structural and cultural conditions to be seen as having an existence independent of social interactions" (Bryman & Bell, 2011, p. 616).

3.1.2 Multiple-Case Studies with Embedded Design

We have based our thesis on multiple-case studies with embedded design. As we were interested in scrutinizing the evaluation of NPD projects in practice, studying multiple cases provided us with a broader insight in the industry in question. Another reason for choosing a multiple-case study design is that it facilitates the testing of theories and the distinguishing of the cases' characteristics (Bryman & Bell, 2011). In other words, by studying several cases, we could identify differences between them.

The cases are represented by three companies in the manufacturing industry in Sweden. As previously explained, this industry was of particular interest to our study given its complexity. Sweden, too, was of particular interest due to the manufacturing industry's aforementioned importance for the country's economy. Upon choosing the cases, we predicted them to have similarities in the sense that they are all well-established companies in the manufacturing industry in Sweden. However, we predicted the results of the studies to be dissimilar, if not contrasting, for anticipatable reasons given their differences (Yin, 2009).

We chose to conduct multiple-case studies with embedded design, which provided several embedded units of analysis within each case (Yin, 2009). These embedded units of analysis were the interviewees at the case companies, with different tasks and functions in relation to the project evaluation methods and processes. Thereby, we could study several actors and functions within the case companies, and thus gain a deeper insight and understanding of the cases.

3.1.3 Inspirations from Action Research

Besides conducting multiple-case studies, we were influenced by *action research*. The reason was that our stated problem, purpose, and research questions arose from a concern from members of a company with whom we were involved. This company was one of our case companies, but differed from the others in the sense that our involvement with them was more extended. This type of involvement with members of an organisation regarding a matter that is of concern for them is a central aspect for action research (Eden & Huxham, 1996). Rowan & Reason (1981 cited in Eden & Huxham, 1996) and Whyte (1991 cited in Eden & Huxham, 1996) argue that action research provides a level of insight that cannot be gained through other means. The method brings together theory and practice by changing and reflecting over the organisation's concern (Avison, Lau, Myers & Nielsen 1999).

We were aware that action research has been associated with disordered and poor results (Eden & Huxham, 1996), but we would like to shield us from such associations. We were not conducting the research as part of a consultancy report for the company involved, but as a thesis with the aim to provide wider implications for the manufacturing industry as well as theoretical contributions. In other words, even though the interests of both academics and practitioners were at stake given the nature of this thesis, we intended to carry out a research with both theoretical and practical value. Another critique against action research is related to the researcher's level of bias (Benbasat, Goldstein & Mead, 1987; Bryman & Bell, 2011). Due to our inspiration from action research, the complexity of our research questions has developed along with the empirical gathering. Thereby, we have used an *iterative strategy* in the sense that our literature review has been under constant development throughout our empirical gathering, (Bryman & Bell, 2011).

3.2 Case Companies

The case companies that we studied were interesting for our research in the sense that they are all large, well established, companies in the manufacturing industry in Sweden. Their histories, and thus their experience of being in this complex industry, span over a century. However, despite their somewhat similar heritage, the companies are different in their business areas,

products and solutions, and their organisational structures. Due to these dissimilarities, we expected their methods and processes for evaluating NPD projects to differ, which we considered interesting for our study. Table 5 provides an overview of the case companies on a corporate level, with the purpose to illustrate their historic heritage and core businesses. However, as specified in chapters 4-6, we would like to underline that we have only studied the subsidiaries and divisions included in our observations, and thus cannot claim to have studied the entire corporations.

Table 5. Overview of Case Companies

Company	Headquarter	History	Core Businesses
Alfa Laval	Lund, Sweden	Founded in 1883 as AB Separator.	Heat transfer, separation, and fluid handling. Main industries: Energy & Environment, Food & Pharma, and Marine.
Atlas Copco	Nacka, Sweden	Founded in 1873 as Aktiebolaget Atlas.	Compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems.
Trelleborg	Trelleborg, Sweden	Founded in 1905 as Trelleborgs Gum-mifabriks AB.	Coated Systems, Industrial Solutions, Offshore and Construction, Sealing Solutions, and Wheel Systems.

3.2.1 Alfa Laval

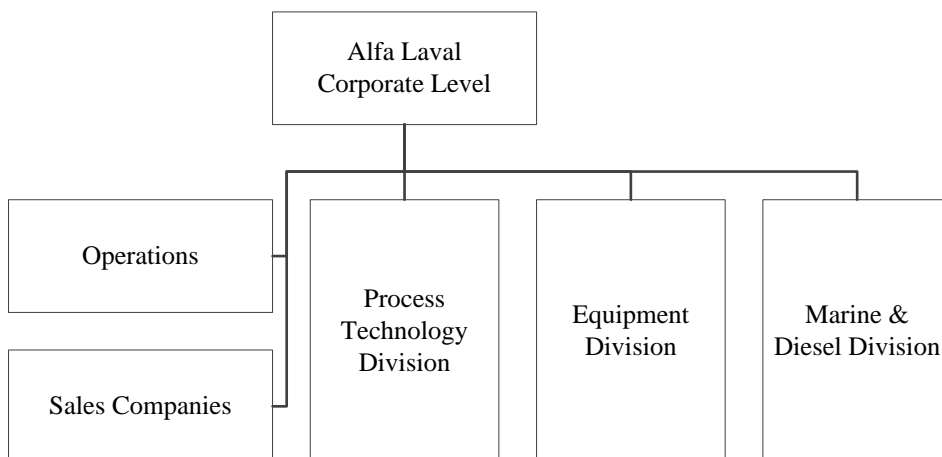
Alfa Laval's headquarters are located in Lund, Sweden, and the company operates in three main businesses: heat transfer, separation and fluid handling (Alfa Laval, 2015a). Heat exchangers can be used in systems for heating, cooling, freezing and air conditioning facilities, such as supermarkets and production plants. Alfa Laval's products are also used in the manufacturing industry, such as in the production of liquids, foods, and pharmaceuticals. Furthermore, the company's products and systems are used in oil and gas extraction, waste treatment, off-shore, in nuclear power, or in the mining industry (MarketLine, 2014). Its history dates back to 1883

and today the company has more than 17,500 employees worldwide. Alfa Laval provides equipment for the energy-, environment-, food-, pharma-, and marine industries (Alfa Laval, 2015a).

Mission: To optimize the performance of our customers' processes. Time and time again. (Alfa Laval, 2015b)

Alfa Laval has several customer segments, organised in three divisions: Process Technology Division, the Equipment Division, and the Marine & Diesel Division. In addition, the Operations and Sales Companies act parallel to these three divisions. Our empirical observations concern several of the customer segments. Despite acting in several different business areas, Alfa Laval is relatively centralised.

Figure 4. Alfa Laval's Organisational Structure



Alfa Laval has been engaged in our study as a collaborative actor in our action research-inspired approach. They showed a particular interest in how NPD projects are evaluated. In order to establish a deeper understanding of this, four formal and one informal (unrecorded) interview have been conducted with Alfa Laval managers. In addition, we have been granted access to internal documents and tools concerning NPD project evaluation, which have enhanced our own understanding of the subject. However, the content of those documents will not be disclosed or discussed in the thesis due to a confidentiality agreement.

Two of the four formal interviews have been conducted face-to-face at the Alfa Laval's headquarters in Lund. We also conducted the two other interviews at Alfa Laval, but via telephone as those interviewees were located abroad. The interviews had a clear focus on the methods and tools used for NPD project evaluation. Although some questions touched upon the subject of strategy and strategic fit, no distinct overview of the corporate strategy was presented. Therefore, we will not present a complete and accurate picture of the corporate strategy in our empirical findings.

3.2.2 Atlas Copco

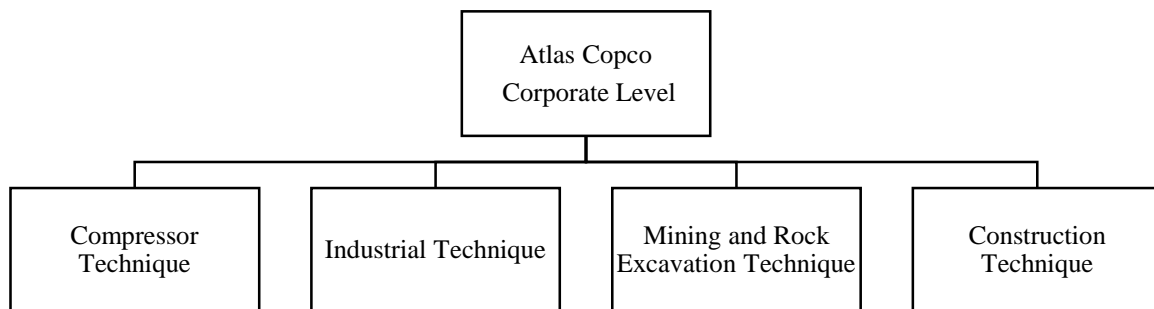
The Atlas Copco Group is a global provider of "compressors, vacuum solutions and air treatment systems, construction and mining equipment, power tools and assembly systems" (MarketLine, 2012). The compressors are used in several industries, such as air and gas treatment. Atlas Copco's equipment is e.g. used for drilling and rock excavation, and surface and underground mining, as well as different type of construction work (MarketLine, 2012). Its headquarters are located in Nacka, outside Stockholm, Sweden. The company was founded in 1873 and now has more than 44,000 employees worldwide. (Atlas Copco, 2015a)

Vision and goals: Atlas Copco's vision is to become and remain First in Mind—First in Choice® of its customers and other key stakeholders.

Mission: Atlas Copco's mission is to deliver sustainable profitable growth, which means that we do everything we can to ensure reliable, lasting results with responsible use of resources; human, natural and capital. (Atlas Copco, 2015b)

Atlas Copco is organised in four business areas: Compressor Technique, Industrial Technique, Mining and Rock Excavation Technique, and Construction Technique. These business areas are in turn organised in several divisions. Our empirical observations concern Atlas Copco Rock Drills - the business area Mining and Rock Excavation Technique - and specifically the divisions Underground Rock Excavation and Rocktec (see Figure 5). Atlas Copco is a relatively decentralised corporation.

Figure 5. Atlas Copco's Organisational Structure



After having established contact with Atlas Copco, we went to Örebro to conduct interviews face to face with managers at Atlas Copco Rock Drills, in order to receive a first-hand explanation of their methods and processes for evaluating NPD projects. We conducted three face-to-face interviews during our afternoon at the company. Furthermore, we were shown documents and tools used for evaluation, but out of discretion, they will not be revealed in this thesis. The interviewees at Atlas Copco had a long history at the company, but also experience from other Swedish manufacturing companies. The focus of the interviews was clearly on the methods of evaluation, and the structures and actors involved in this process.

3.2.3 Trelleborg

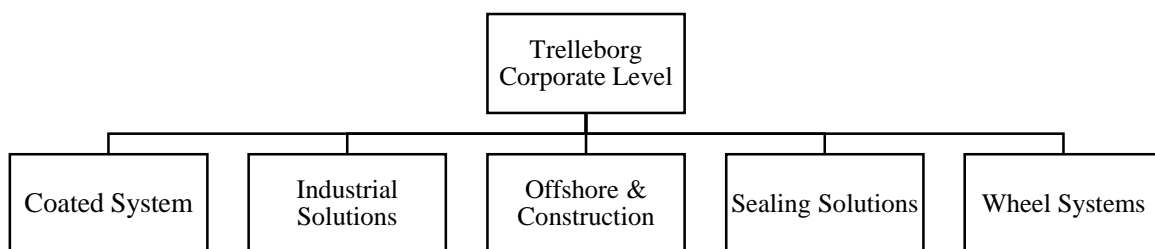
The Trelleborg Group is a global industrial group specialised in advanced polymer technology and solutions that "seal, damp and protect critical applications in demanding environments" (Trelleborg, 2015b). The company offers a range of products and solutions, including polymer solutions, polymer-based building products, solutions for infrastructure projects, engineered solutions, tires and complete wheel systems, and offset printing blankets. Trelleborg's markets include aerospace, automotive, construction, marine, oil and gas, as well as tires and wheels (MarketLine, 2015). Its headquarters are located in Trelleborg, Sweden, and the company has operations in more than 40 countries with around 16,500 employees worldwide. Founded in 1905, the company now operates in the following five business areas: Coated Systems, Industrial Solutions, Offshore and Construction, Sealing Solutions, and Wheel Systems. (Trelleborg, 2015a)

Vision: To be the customers' first choice in our selected market segments, creating value through high-performance solutions.

Strategy: To secure leading positions in selected segments. This means that we seek niches that – by virtue of our applications knowledge and range of advanced products and solutions – provide market leadership. (Trelleborg, 2015b)

As previously stated, Trelleborg consists of five business areas (see Figure 6). Each business area consists of separate business units. Our empirical gathering concerns the following business areas: Coated Systems and Industrial Solutions. The two business units concerned within Industrial Solutions are Anti-vibration and Insulation Solutions and Fluid Handling Solutions. The business unit within Coated Systems is Engineered Fabrics. It has been a rather difficult task for us to create a satisfactory overview of the corporate structure since several of the business areas and units are cross-functional. We were told that Trelleborg is a highly decentralised corporation: "Trelleborg is very decentralised. (...) Many companies claim to be, but actually few are as decentralised as we are" (Key Account Manager).

Figure 6. Trelleborg's Organisational Structure



During the writing of our thesis, we went to Trelleborg on three occasions to conduct face-to-face interviews with managers in different business areas. In connection to the interviews, internal documents were shown to us. One of those documents was an overview of the product development process, which we were allowed to keep in order to gain a deeper understanding of the project evaluation process. However, we will not present the content of that document in

our thesis, out of respect for confidentiality. The managers that we interviewed were all engineers, with varying career backgrounds in the sense that some of them had experience from other companies while others had worked at Trelleborg for a longer period.

3.3 Generating Qualitative Data

We have conducted *in-depth, semi-structured* interviews at the case companies (Bryman & Bell, 2011; Yin, 2009), with the purpose to interview managers who in various ways are involved in the process of evaluating NPD projects. With various ways, we mean that the managers work on different levels of the organisations and have different functions. Furthermore, depending on the terms used by the case companies, they represent different divisions, segments or business units. We have conducted ten interviews: four at Alfa Laval, three at Atlas Copco, and three at Trelleborg (see Table 6). The duration of the interview recordings varied between 45 minutes and an hour, except for one that lasted 30 min. However, our observations with the interviews also included informal conversations that were not recorded.

Our interviews focused on a number of questions (see Appendix 1) that we have summoned in an interview guide (Bryman & Bell, 2011). The interview guide was arranged in three parts: the first part was composed of questions about the interviewee; the second dealt with questions about methods for evaluating NPD project; and the third and last part brought up questions about actors involved in the evaluation process, and their roles and influence. The context of the interview guide and the sequence of the questions varied and were developed during our empirical observations when we identified and perceived factors of interest for our study. In other words, we made room for improvisations and adaptations. As Yin (2009) expresses: "The interviews will be guided conversations rather than structured queries" (p. 106). Data collection is inevitably a selective process (Miles & Huberman, 1994).

Our aim was to conduct face-to-face interviews when possible in order to enable the impressions that such observations can provide for the researchers. Thereby, we could obtain a deeper understanding of their evaluation by accessing internal documents and tools, which would have been impossible if only telephone interviews would have been conducted. Thus, eight out of ten interviews were conducted face-to-face, whereas two were conducted over the phone as these interviewees were stationed abroad (see Table 6).

Table 6. Overview of Interviewees

Organisation	Position/Title	Date
Alfa Laval AB	Product Manager A	2015-02-26
Alfa Laval AB	Product Centre Manager A	2015-02-26
Alfa Laval Copenhagen A/S	Product Manager B*	2015-03-02
Alfa Laval India Ltd	Product Centre Manager B*	2015-03-02
Atlas Copco Rock Drills AB	Divisional Controller	2015-04-08
Atlas Copco Rock Drills AB	Divisional Vice President	2015-04-08
Atlas Copco Rock Drills AB	R&D Manager	2015-04-08
Trelleborg AB	Key Account Manager	2015-03-10
Trelleborg AB	Sales Manager	2015-03-27
Trelleborg AB	R&D Manager	2015-04-28

*Telephone interviews

Before conducting the interviews, we sent our interview guide to all interviewees as a way to enable them to prepare for our questions. Moreover, before starting our interviews, we briefly informed the interviewees of our study and requested their permission before recording. As anonymity for the interviewees was requested by one of the case companies, we chose to keep all interviewees anonymous, only citing their positions in order to illustrate their roles. However, we perceive that this anonymity has not limited our research.

Furthermore, we have been granted access to internal documents and tools in order to enhance our understanding of the case companies' evaluation methods and processes. Moreover, we have used company profile reports to establish a better overview of the companies' background and business situations. The latter sources can be viewed as secondary data.

3.4 Qualitative Data Analysis

Qualitative data analysis implies challenges. As Bryman and Bell explain (2011, p. 571): "The researcher must guard against being captivated by the richness of the data collected, so that there is a failure to give the data wider significance for the business and management community". Therefore, we have categorised the content of our data in relation to the topics of our study and our conceptual framework. We have then dissected and fitted our data within the different categories in order to facilitate the analysis.

In our study, we relied on *cross-case analysis*. One important reason is that we wanted to increase our opportunities for *generalisations*, despite the fact that this has been deemed unsuitable for qualitative methods by Denzin (1983 cited in Miles & Huberman, 1994) and Guba and Lincoln (cited in Miles & Huberman, 1994). We perceive that by using cross-case analysis, there is a greater chance that our findings might have a relevance that extends beyond our specific cases (Miles & Huberman, 1994). There is in this context, as Silverstein explains (1988, cited in Miles & Huberman), a strain between the particular and the general. Moreover, we believe that a cross-case analysis would enhance our *understanding* and the possibilities to identify differences between the cases in our study (Miles & Huberman, 1994).

3.5 Criteria for Assessing Research Quality

Trustworthiness is judged by four criteria suggested to measure the quality of a case study (Bryman & Bell, 2011; (Guba, 1981). In our thesis, we will use what Guba (1981) refers to as the naturalistic terms for these criteria: *credibility*, *transferability*, *dependability*, and *confirmability*.

In order to increase the *credibility* of our research, we have recorded our interviews electronically, transcribed them in order to retain a high level of details (Yin, 2009), and included original quotes from our interviewees in the thesis to illustrate the subjects discussed. In this context, we have also showed if or when interviewees have provided contradictory explanations.

With the purpose to enhance the *transferability* of our studies, we provided background information about the case companies and their businesses (Bryman & Bell, 2011), as well as used the same interview guide during our semi-structured interviews (see Appendix 1). However,

given the fact that we have only studied three case companies, and that our observations of these cases have been restricted, the transferability of our findings was limited. Nevertheless, we have enhanced the transferability by pointing out the limitations of our study and suggested topics for future research (Miles & Huberman, 1994).

The *dependability* of our research was increased by constantly keeping records of our research process, such as our contact with the case companies and interviewees, and by involving our supervisor as a peer (Bryman & Bell, 2011). Furthermore, we have reviewed each other's notes and recording throughout the process.

During our research, we generated qualitative data by assessing relevant empirical material through in-depth interviews and observations. To test the researcher's level of bias, Yin (2009) suggests that his or her preliminary findings could be reviewed by critical colleagues. The scrutiny might offer different explanations and improvements for further data collection. Through the involvement of our supervisor and opponents, we exposed our findings to such critical reviews and thus the *confirmability* of our qualitative case studies was recurrently accounted for.

4 NPD Project Evaluation at Alfa Laval

4.1 Evaluation Methods and Criteria

Alfa Laval has a tool that serves as a basis for the evaluation and selection of product development projects. It is corporate in the sense that the same tool is used by all divisions in the company, irrespective of their functions or locations. More specifically, it is a CBA tool composed of several financial methods that takes into account the NPV and PP. Furthermore, the CBA also considers aspects of contingency related to the risk and complexity of NPD projects. A light version of the CBA tool is used for evaluating smaller and less complicated projects, as illustrated by the following quote:

We use a CBA template for new product development projects, which is a standard for Alfa Laval. (...) I know that for smaller development projects considering changes of an existing product, a simplified CBA has been developed. That one is used to overlook payback or half-life. (Product Manager A)

Although essentially one tool is used, Alfa Laval uses two internally developed Key Performance Indicators (KPIs) depending on the size of the projects: Time-to-Million and Time to 2 x Investment. Projects that exceed a certain amount of investments are measured in relation to a certain Time-to-Million target, while smaller projects are evaluated with regard to Time to 2 x Investment:

We have a CBA in the form of an Excel-file, in which data is filled in during the NPD process. It serves as a basis for decisions at different stage gates in the process and is evaluated afterwards. Since a few years back, we have two types of CBA, one could say. We measure two KPIs: Time-to-Million and Time to 2 x Investment. (Product Centre Manager A)

As previously mentioned in the literature review, financial methods such as CBAs are popular when project evaluation requires economic justification and because their numeric results are easily comparable and enable ranking of projects. This idea is shared by a project product manager at Alfa Laval, who describes an effect of having financial methods in the following way:

I think that you get a good view, especially when you need to compare and choose which projects you should have in a product line. So it makes decisions easier when you take them up in the board, especially when you supply to a lot of applications and organisations. Everybody needs development of new products, so then it is somehow easier when you take these calculations; instead of feelings

you have some figures to back up the decisions. So it makes it easier for people to accept a decision, which is not in accordance with what they wanted. In that way you avoid a lot of discussions that lead to nothing. (Product Manager B)

According to a couple of managers at Alfa Laval, another advantage of the CBA tool is that it is used by the whole corporation: "Everyone uses, approximately, the same CBA model. It is well distributed and established" (Product Centre Manager B). One of them also stated that this further allows for comparisons of projects from different departments worldwide, as well as facilitates decision-making and project selection:

The big advantage as I see it is that everybody does it the same way and you can see that the result is presented in a certain way. And this is important because there are a lot of departments and a lot of places where you develop and make investments, and at least what you have here is a common model and you have a common output, so it is easier to benchmark towards others. (...) So it is, I think, important in an organisation like ours where you could say that the managers in the top, who will take the decision eventually regarding which things that should be made, have the same picture, the same input. That way, it is easier for them, I think, to take the decision. (Product Manager B)

Regarding disadvantages of the CBA tool used by Alfa Laval, the managers we interviewed brought up several different aspects. An overall comment made by a product manager suggests that the CBA tool is inflexible and does not take into consideration the difference between projects:

I think that it is perceived as a bit rigid when you consider different types of projects, because they are different from one another. So you have to make a lot of assumptions, and guesses, and averages - that is work in other formats - and then paste the findings in the CBA. (Product Manager A)

Whereas some expressed a concern regarding the CBA tool's inflexibility, others tended to look past that limitation by simply using it differently depending on the type of project at hand. Upon receiving the question whether the tool considers the uniqueness or character of the project, one project manager explained:

You could say that somehow it does in the way we use it, because sometimes we are more detailed regarding which cost we will have for specific parts of the project. Sometimes we say "we don't care" because it does not matter. So you could say that what we do automatically depends on whether the project goes more or less into details. So if you have a project with high costs, then we will be more detailed. (...) We will put more or less work into making a CBA depending on the character of the project. (Product Manager B)

However, the above quote contradicts a comment made by another manager who underlined the importance that everyone should use the tool in the same way: "Actually, the important thing would be that everyone works in the same way in order for us to compare different projects" (Product Centre Manager A). One manager argued that a CBA is not an ideal method to use for evaluating NPD projects, as the projects might be very different from one another. "One might ask oneself: are we comparing apples with apples?" (Product Centre Manager A). It is important to specify in this context that there are different types of NPD projects. There are *radical projects*, which consist of developing a product with completely new technology or a product for a new market. There are also *semi-radical projects* and *incremental projects*. Another type of product or project is a *gap-filler*, which aims at complementing an already existing product range. Whereas the CBA might serve as a good measurement for some projects, it might not encompass some aspects that are important for other types of projects:

Sometimes it might be strategically important to come up with a new product. Then maybe a CBA should not always be the first method to use. Because if we have a new product which is new on the market and is innovative, then it is incredibly difficult to work with a CBA. Then a CBA is not, according to me, the right tool. Because in that case you have very high investment costs that you may never have in return within the period that you look at in the CBA. It is about taking steps onto a new market and it requires time, engagement, and activities on the market that we never capture. (...) We can deal with traditional projects and maybe when we add a gap-filler. But when we look at more radical - as we call products that are new for a market or an industry - it is difficult to use a CBA as a steering document. (Product Manager A)

Another manager argued that the CBA tool *per se* is not the only issue, but the targets set for the two KPIs, Time-to-Million and Time to 2 x Investment. The idea is that the size and type of projects need to be considered when setting the time target for the KPIs. The following quote illustrates this viewpoint:

The problem is: why did we set the Time-to-Million target as three years? (...) We are talking about incremental development, semi-radical and radical. It depends on the type of product: is it new, a gap-filler, or a replacement product? In the latter case, perhaps the target should be three years, as we have an established supply chain and a sales organisation. If the product is new, perhaps Time-to-Million should be five years? I think that the target was set to unify the company. Right now we are looking into this field, as it might not be fair to compare a radical project with an incremental project and use the same target. (...) So I believe that we need to differentiate the requirements, these targets, and set them in relation to the character and type of project. (Product Centre Manager A)

Despite the limitations or inflexibility of the CBA tool, the managers seem to perceive that the challenge in evaluating NPD projects lie in understanding one's products and markets:

A CBA is a forecast and you have to consider that it is a best guess. My feeling is that the CBA is about understanding both the product and market well in order to be able to make a good CBA. A lot of experience is required to make a good CBA. (Product Manager A)

This also highlights the importance and difficulties related to the quality of the input to the CBA. As discussed in the literature review, bad input creates bad output. Essentially, the issue can be linked to market intelligence, as explained by a manager in the quote below:

The quality of the input is important. How have the figures been acquired and what scenarios are they based on? I believe that we need to improve the quality of the input. (...) That is a field that we need to look closer at: forecasts, global potential, market attractiveness and size. Are the figures realistic? (...) The size of the market, specifically, is something that we still discuss and sometimes we purchase reports made by external actors, but they do not always match each other or our perception. Eventually, an appreciation of the market is still subjective, which leads to difficulties. I have no simple answer as to how we could obtain qualitative input. A lot is based on historic data. (Product Centre Manager A)

All managers seem to agree on one notion: financial methods are not sufficient for evaluating NPD projects. When evaluating, ranking and prioritising projects, decisions are not only made based on financial criteria. Strategic fit is a criterion that several of the managers we interviewed pinpointed: "How well does this product or project comply with our market strategy, our manufacturing strategy, and development strategy" (Product Centre Manager A)? Despite not being a criterion included in the CBA tool, strategic fit is taken into consideration when a project is evaluated at the board:

The product boards take soft decision criteria into consideration, which you can explain in your product pitch. A strategic view is added, so it is not all about the numbers. In fact, we have decided upon product projects that have long payback periods or Time-to-Million periods. This was done deliberately, since it was considered to be the right strategic move. (Product Centre Manager B)

Alternatively, as expressed by another product manager:

You cannot just use a mathematic model and then make decisions based on that. Because it is also a question about looking at other things. (...) Sometimes a decision is a strategic decision that we need to make: if we should be in the market, we need to do it. (Product Manager B)

In relation to strategic fit, portfolio balance was also raised as an important aspect to consider in project selection, as complements to the CBA:

Another aspect to consider is how much balance there is in the portfolio. (...) We cannot only have radical projects. We have to have balance, because projects require different resources and competences. You have to have some sort of portfolio balance. (...) Strategic fit and portfolio balance, those are aspects that we should look closer at as complements to the CBA model. The CBA is the dominant factor, but we would also need these other two criteria. (Product Centre Manager A)

Beside strategic fit and portfolio balance, some other criteria were highlighted during our interviews. The relation to competitors and customers were brought up as important aspects to take into consideration:

We cannot only develop products in order to face competitors, because then we are completely reactive. But if we see a window in the competitors' portfolio, pass them performance-wise, or develop a cheaper production method: those could be criteria. Another aspect is the customer. That aspect has pros and cons. Is the customer new or is it an existing customer that we sell a lot to? Is it a completely new customer group? Perhaps a criterion to describe and define the customer group. (Product Centre Manager B)

Moreover, competence and feasibility were also raised as criteria:

Do we believe that we have the organisation to take the product? Should anything be changed? And sometimes you should also take into consideration the risk that you have. What is the chance that you can actually develop the product as predicted? (Product Manager B)

However, all managers agreed that there should not be too many criteria involved in the evaluation of NPD projects, as the evaluation would then become too complicated:

You cannot make it too complex. It is a consideration. Would 40 more criteria make it better? (Product Centre Manager A)

4.2 Actors and Structures of the Evaluation Process

Two of the most common initiators for the NPD process are new market opportunities or requirements. R&D are also acting as initiators in some cases. The description of the process below is typical for a larger radical project. A stage gate procedure is used and the product manager, responsible for the concerned unit, formulates the basis for decision-making (a business case including the CBA). The business case is produced in consensus with stakeholders of

the project. The stakeholders could be the market-, sales-, production- and R&D departments, but also external clients. They have their opportunity to provide input.

The next step of the procedure is to involve the product centres, where the development resources are located. They will provide input on project costs and resource availability. There are several other actors involved in the NPD process as well - it is cross-functional. A global product board makes the approving decision for larger projects. The global product board consists of representatives of the corporate management, the three business divisions, as well as operations and sales companies (see Figure 3, Alfa Laval's organisational structure). Upon receiving the question how the project evaluation process could be improved, one of the product manager stated:

It functions very well. I think there could be less actors involved at certain times though. We are too many. But again, we are the largest product group at Alfa Laval, so we need multiple functions involved in the process. (Product Manager A)

The important role of individual actors in the project evaluation process is also something that was revealed during our interviews. For example, individual actors can use the CBA tool to their advantage with the purpose of increasing the attractiveness of their projects. However, individual actors can also be important sources of information and knowledge. Both these aspects are illustrated in the following quote:

We have realised that cases can be exaggerated in order to be prioritized, and when they are evaluated afterwards we might discover that they did not fulfil their targets. So there is some politics to it. It is interesting. How do we secure that we receive relevant input quality? (...) We are a business-to-business company and we do not have dedicated resources working only with market intelligence in the same way as companies might do with consumer products. In our case, we depend more on the knowledge of key people who can make mutual expectations. But it does not imply the same continuity and quality as if the task would have been outsourced or handled specifically by a team at the company. (Product Centre Manager A)

Upon the question if the interviewees perceived that all actors used the method in the same way, the answers opposed each other. One interviewee's answer was an explicit “no”; meanwhile another perceived that all actors did use it in the same way. A third interviewee told us that is was desirable, but implied that in the reality, it was not the case. During our informal meetings and observations, others have underlined this fact as well.

The foundation of Alfa Laval's corporate culture is its core values. All of the interviewees mentioned those core values at some point during the interviews. They also agree that the core values are very sound values and that they are in line with their own. As mentioned in the general observations, Alfa Laval seems to be the kind of company where employees want to stay for a long time, which is a good condition for a company culture to arise:

There are four core values within the company and the ones who have been employed for a long time understands the core. From time to time we deviate from the core - I have been employed here for 20 years - but mostly we get back on track. Sometimes we see that we are going down an undesired path, so then we return to our core values. The Alfa Laval culture consists of ownership (of processes); to drive the process and if you identify a problem, you should handle it in a constructive way. If you are committed to the issue you are very often the one who will drive the change as well. (Product Centre Manager B)

Upon being asked the question whether they have a formal decision process or not, the answers were inconsistent. The answers appeared to depend on the situation, and to a certain extent the location of the interviewee. A Product Centre Manager abroad gave us the following insight:

As a Swedish expatriate since seven-eight years, I have identified a gap between how we as Swedes think that things work and how it actually works, which cannot always be noticed when you are located in Sweden. The general picture is that decisions are made based on objective grounds in ruling forums, ruling committees or in product boards and so on. And that is the formal way of doing it. However, to really get things going you need some sort of lobbying activities, that you engage people in the decisions you want to make by the coffee machine before and after meetings. So you can say that the process is both formal and informal. (Product Centre Manager B)

However, this might not be general for the entire corporation. At the same time, all of the interviewees agreed upon that the decision process was in line with the corporate culture.

5 NPD Project Evaluation at Atlas Copco

5.1 Evaluation Methods and Criteria

At Atlas Copco, there is no single corporate evaluation tool for NPD projects. Instead, we were told that it is up to each division to use a method of their choice. We believe that this could be related to the fact that Atlas Copco is rather decentralised and that each business area and division has a high level of autonomy when it comes to handling its project evaluation. When speaking to a divisional controller regarding their methods for evaluating NPD projects, we asked whether their evaluation model was used by the whole Atlas Copco corporation:

No, but locally in Örebro. It is not a global model; we developed it here. It is used by the technology side, the market side and by the accountants. (...) Then our sister division also adopted our model, so they use the same one. But it is not something that has been decided by Atlas Copco. (Divisional Controller)

There seems to be no expressed desire to use a common model either. The model referred to in the above quote is a CBA tool combining several financial methods, including NPV and IRR. We asked a divisional controller whether a payback method was used as well:

Actually, we do not calculate payback time. (...) We look at: when do we believe that revenues will come? Then we calculate the present value with an internal rate of return that we use within the corporation. (Divisional Controller)

There is a consensus that the evaluation method should not include too many aspects; instead, it should remain simple enough for the users to effectively understand it:

The more you add, the more complicated it becomes to work with it. It should be as simple as possible. I would prefer deleting some functions in that case. (...) Because it is only a tool for prioritising between different projects. (Divisional Vice President)

The above and below quotes touch upon the antagonism of having a simple model and yet a model that captures the complexity of NPD projects. When asked whether the method used is user-friendly, the divisional controller replied in the following way:

Yes, I think so. It is quite easy to understand. It has to be. If it becomes too complex, it will be difficult to gain responsibility taking. It cannot be something that only a certain person or economists understand and which would be too difficult to understand for those who actually are responsible

for the project. They have to understand it and be able to update it themselves. (Divisional Controller)

User-friendly and perspicuous were two words used to describe the advantages of the evaluation model. Regarding its disadvantages, the issue with the tool used is that projects cannot properly be compared and prioritised by using it. But then, the tool was not developed for comparing projects:

The model is not built for comparing projects. You use it for each project, but there is no comparison between projects in the model. It is made for evaluating projects individually. I think that another tool is needed in order to make a prioritisation assessment - to compare projects. (Divisional Controller)

We perceived some frustration regarding the lack of a method for prioritisation of projects:

Prioritisation is something that we are not that good at, I believe. We do not have a clear and good model - should we run a project or not? There are many opinions. The opinion of the market is most important. Where the deal is - that is the driver. Which project, if you have to prioritize, can deliver most to our result? There is no good articulate model. (Divisional Controller)

Another highlighted problem with the CBA used is that it only partly captures the key aspects of the decision problem. It does not include aspects of contingency related to the risk and complexity of NPD projects, although those aspects were brought up as important criteria to consider. The below quote illustrates the limitations of financial methods for evaluating this type of projects:

It captures the economic aspect of the project. It does not capture its technological complexity, that is, the risks of the project. (...) It is a financial view of the project, but it does not capture the technological risks. (Divisional Controller)

When we asked our interviewees about criteria, strategic fit was also highlighted as an important criterion, closely connected to the importance of knowing the market and customers, as well as future trends:

Strategic fit. (...) We are in a position where products have been rather similar for a long time, but now we see a technology change, with automation and electrifications. (...) If you should get into that then, in the short term, it is not a good business case, or it is extremely uncertain. It could be a "land of milk and honey" or it could be nil or minus. Strategic fit, because it is also about knowing the market and customers, the trends. We look a lot at long-term trends and try to take decisions based on them, and they are difficult to quantify sometimes. (R&D Manager)

At Atlas Copco in Örebro, there was a general notion among the interviewees that profitability is an obvious criterion to include in the evaluation of NPD projects:

They have to be profitable. Because after certain phases, we capitalise some of our development projects - unbelievable costs - and then it is evident that they have to be profitable, because if the conditions change - competitors appear or the technology changes, and the product dies - then we have legally to take all costs at the same time. (R&D Manager)

The aspect of margins is important, although, as a manager admitted: "It is extremely important for us. (...) For an engineer, it is not pleasant, but it really is" (R&D Manager). Besides the general understanding among the managers that a profitability calculation is necessary, the idea that other criteria have to be taken into consideration was just as strong. Strategic fit and importance are examples of criteria used, but they also consider whether a project is time critical. Feasibility is another important criterion that can act as a type of gatekeeper:

Sometimes you want to manage a smaller project faster. Unfortunately, it is not as profitable, but with a smaller input you will finish fast. Maybe it is more connected with the capacity. You might have a project with shorter time-to-market; in the long term it might now be profitable, but in the short term it might be necessary. (R&D Manager)

However, these criteria are not included in the CBA model; they are not part of the calculation. Instead, these criteria are taken into consideration as parameters on a list of columns, where the financial aspect only represents one column. The others columns are composed of complementary criteria, such as strategic fit and technological trends. Furthermore, the type of project has to be contemplated; whether a project is radical, semi-radical, incremental, or a gap-filler:

You have to include other parameters. You could have a project that you must manage in order to launch another product. Sometimes, we have to launch a project because we must have a complementary assortment to be able to sell the whole package to a customer. (R&D Manager)

Other aspects to consider when evaluating NPD projects are the demands of the market and customers. Whether a project is deemed profitable by actors involved in the evaluation is irrelevant if no customer is actually willing to pay for the product:

One thing is to be sure of what the market demands; that we are certain of that before we initiate a project and that you have made a thorough background job in relation to the market, our customers, and our sales companies. (...) Furthermore, it is not only about capturing the requests of the customer, but also knowing what the customer wants. Because there is no point in developing a great product that costs a lot if nobody wants to pay for it. It is more interesting to work with that type of

projects, but sometimes we might surpass the targets regarding the technology of the products. There are many markets in the world where there is no demand for high-technological products. (...) So it is important to know that the customers is willing to pay for the product that we develop. Otherwise, the business case will not stand, that is just the way it is. (Divisional Controller)

Time was also raised as an important aspect to consider. There is a risk in starting and having too many ongoing projects at the same time, as it "leads to their becoming very long" (Divisional Controller) in a time perspective. The market development could change as well as the actions of competitors. The technology could take a leap. Furthermore, "the customers could change their minds: they no longer are in need of what they thought they needed previously" (Divisional Controller). Prioritisations are necessary:

There is a danger in keeping up too many projects at the same time. The resources are not unlimited. You have a certain number of people, a certain amount of hours, and a certain amount of money that you can spend. The more projects you drive, the less resources per project. (Divisional Controller)

5.2 Actors and Structures of the Evaluation Process

Atlas Copco in Örebro uses a stage gate process when evaluation NPD projects, but it does not look the same at every division. However, in order to facilitate comparisons, the same stage terms are used in most cases. A local Product Board or Global Product Board, depending on the size of the project, acts as a decision forum regarding NPD project. All functions are represented in the boards - they are cross-functionally organised - and the Global Product Board is composed of the divisional management. The Global Product Board is summoned at least three times per year and the local Product Boards meet every month. The actors involved in the Global Product Board in one of Atlas Copco's divisions in Örebro are listed below:

If we look at those in the Global Product Board, then we have the divisional management; the local R&D managers for our product companies; our person in charge of the product portfolio; after sales. We have a separate division responsible for sales of spare parts and service, and they should be involved in all projects. Furthermore, people from the technology side and market side are represented, and those are often the project managers. (Divisional Controller)

The NPD projects are managed by project managers, who are part of local project office, but the initiators of are often the market or R&D departments. There are three local Product Boards, one for each product line. Previously, there were also three forums, but they were categorized

according to project types: one for new development projects, one for technology development, and one for product keeping. "All new development projects were managed in one forum. It was a bit complex because we fought for the same resources" (R&D Manager). According to the divisional controller, it is important to involve actors from different departments in the evaluation process, as evaluation always is subjective and based on perceptions of the future:

In the end, it is about evaluation and assessment. It is the evaluations and assessments you make that have a lot of influence. Nobody can say anything else than what they *believe* regarding our future market for products. Therefore, it is very important to involve many different parties in such a project when you make the evaluation. So both the market and technology departments are involved. The technology department should provide answers to: How much will it cost? Within which time span should the project be managed? The market should answer the questions: What will we earn with these products? What will be the average profit for such a machine? How many of this product do we expect to sell within the next four to five years? (Divisional Controller)

Individual actors also play an important role in the evaluation process, as they can have vital experience and knowledge. However, such aspects are qualitative and cannot be measured: "Experience - what can it provide? It is not something quantifiable, but rather a feeling" (Divisional Vice President). We were also told that the company was very engineer-influenced and that conflicts of interest can arise when different departments evaluate a project together, especially now that more emphasis has been put on economic requirements:

We are a very technology-weighted company. R&D has almost been a protected part of the business. We can change a lot, but the technology side has been very protected. So now when we stop some projects due to the business situation, those decisions are received badly by the technology side. They cannot understand, because it has never happened before. Engineers are highly valued, generally. (Divisional Controller)

All interviewees agreed upon that the actors conducting the bases for evaluation used the methods in the same way. Still, they were only able to evaluate how the actors of their own division performed, in this context.

Yes, there are only a few who uses the tool, one, two or maximum three persons. They work very closely. (R&D Manager)

Given the rather flat and cross-functional organisation of the process, all interviewees at Atlas Copco believed that it was easy for them to influence the process. The NPD process at Atlas

Copco in Örebro has undergone several changes in the past according to a manager we interviewed. These have resulted in organisational changes and thus affected the structures and actors involved in the process:

We have made some organisational changes. We made one three years ago, where we created a more function-based organisation. (...) We had a continuously occurring cross-functional forum. A list of products and projects was reviewed, changes were checked, and projects were prioritised. We reviewed their value, their benefits, available resources and feasibility. But in the new organisation, we have aligned the market department, technology department, the service part, and to a certain extent the production; instead of having one large function, we have moved them down on a product line level. (...) So you push down the decisions a level, you could say, and thus are closer to the product. (R&D Manager)

6 NPD Project Evaluation at Trelleborg

6.1 Evaluation Methods and Criteria

Trelleborg does not use a standardised method or combination of methods for project evaluation on a corporate level. The business unit concerned decides upon their project cost calculation method of choice. There is a clear focus on the entire development process rather than specific evaluation methods. However, some sort of cost estimate is always made, at least for projects above a specific size or amount of money:

Of course we can identify how much each cost centre costs in my team, how much my resources cost, what our expenses are, and the cost of testing at another location. The core issue is to get a complete overview of how much *each* project really costs. This is where experience is important. At the initial phase, we make an estimate of expected sales of each project. Based on that, we decide upon if we should continue or not. (R&D Manager)

No specific Excel tool or similar was used for investment appraisal at the Engineered Fabrics business unit. However, the necessity of developing such a tool has been identified at the business unit in question. One of the interviewees at Trelleborg, a sales manager at Industrial Solutions, mentioned that a feasibility study is performed to determine the value of a new product. No standardised or pronounced method is used to calculate the value, but every NPD project is documented from the initial phase. However, the value of projects might appear very differently across Trelleborg's business units. The value could consist of the savings their clients could make by using Trelleborg products:

Then there are savings around €80 to €120 million to be made for our clients. That is our ballpark. They get that cost saving, then we split the cake. That is very often how we work: to show the client where savings can be made. Then you have to sit down and see what is fair. (Key Account Manager)

The absence of a standardised project evaluation method might largely be explained by the fact that the business units (the ones concerned in this thesis) commit themselves to customer-specific projects. The requirements for a more detailed and overall evaluation method has not existed internally. The costs for some NPD projects are carried by, or divided between, Trelleborg's clients and themselves. Nevertheless, there is a need for some strategic fit or a portfolio balance for a new product:

We are working quite hard with complementing our product portfolio. It is not likely that we come up with a completely new product and target completely new customers. It is within our portfolio that we can make sharper or improved products. We are perhaps not calculating return on investment, since we have relatively low development costs. But there should be a value in entering a market: of monetary, profitability or complementary character. So we are working a lot with a portfolio management mind-set. (Sales Manager)

While discussing project evaluation follow-ups with an R&D manager, goals and targets for NPD projects were mentioned. On the question whether they had specific targets to follow up the cost of the projects, we were provided with the following answer:

No, not really. We have some Key Performance Indicators (KPI): the number of development projects we are committed to; the number of projects for each developer; win/loss ratio, thus, how many projects turned out successful and not so successful. We also have one combined KPI we call *value creation*. It takes the size, the duration and the win/loss into consideration. Before, we used to only look at the duration - time-to-market - how long time it took to develop a new product. It does not provide a fair comparison for larger projects with maybe a five years' time horizon. The time-to-market KPI results in that it is more favourable to commit to small easy-fix projects than actually working with the large ones that take a longer time but have potential of a higher revenue in the end. (R&D Manager)

Rather than having specific evaluation methods, it is clear to us that the NPD process is the main focus at Trelleborg. Close collaboration with clients, using internal competence and experience, and having a product portfolio mind-set, make up the Trelleborg way of committing themselves to the right NPD projects. However, the close collaboration can also be associated with challenges:

What complicate things a bit for us is the divergence of our end customers. We seldom make two, three, four, five product launches for the same client. We cannot compare them and take lessons. It is a bit of a dilemma for us. (...) We are having difficulties of amassing our experiences. (Key Account Manager)

During our interviews, the interviewees identified other areas of improvement concerning the project evaluation method. As an example, a sales manager implied that they could improve and standardise their evaluation process. The reason was that they considered themselves very good at innovating new products, but struggled with the actual launch of the products. The sales manager was referring to their way of communicating innovations and new products to their customers. Furthermore, he reasoned that they conducted market research and market analyses,

but they did not have a standardised process or method for it. When we asked about important criteria to consider when evaluating NPD projects, we received the following answer:

Some form of success rate, what is the probability of success? It has to be the most important. If it is something we have made previously, then we have a customer and keep contact with them, and then there is a certain probability that we know what we are doing. If it is a completely new business that we do not have knowledge about, then the contingency factors are larger. Secondly, do we have the internal resources? We judge that we have the technical probability, but do we have the internal resources to manage it? (Key Account Manager)

During our interview with a R&D manager, we were provided with a documented overview of the NPD process. The criteria mentioned in this document largely concerned market aspects, competition, trends and strategic fit. However, we will not reveal the specific content of this document.

6.2 Actors and Structures of the Evaluation Process

A representative of one of Trelleborg's sales companies usually initiates NPD projects. It could e.g. be a sales manager or a key account manager who together with their clients have identified a need. Yet, whether a project is started or not could depend on other factors as well:

It would be relatively easy to implement a sale support system that provides more input – combining the output, which would be our case! Then just press send. I think that could be an advantage in the project selection. Because today, it is more about who has the greatest influence. Who is calling? Who is requesting something? If a colleague of mine asks the wrong person – then it is game over! He will never get through with his project, meanwhile I just have to pick up the phone and it is a done deal. So it would be beneficial to have a number of models for this, or combinations of them, to evaluate where we should allocate our resources. (Key Account Manager)

The process is, in a more formal sense, cross-functional and combines market and sales, clients and the R&D department. Thereby, the clients are viewed as actors in the project evaluation process as well. By viewing internal documents, it is clear which actors are involved at each step of the process. Some steps are more cross-functional than others are, but overall, the process can be seen as cross-functional. The sales managers are important in this process:

They are responsible for the first step and the third. It is their responsibility to collect as much information as possible from the client before we start. It is also their responsibility to engage the customers with quotation procedure and evaluate their interest, if it is a go or a no go. So we have an

extremely close dialogue with them, we do not have many sales persons. Some here and some in Italy. (R&D Manager)

Different directors/managers and/or clients functions as gatekeepers when it comes to the decision process at different gates. Each business unit creates their own product development process. There is no pronounced standard process within the Trelleborg Group. The initiators to a new product development project are in most cases Trelleborg's clients. At least, that is the case for the two different business areas we have studied. The other initiator could be a market need identified by either a sales unit or an R&D unit.

Most industrial organisations are slimmed today. There is not much room for brainstorming and to start with inside-out projects. Usually there is a need from the customer and it is our responsibility to come up with solutions. Therefore, in most projects we go through the development process together with our clients. (R&D Manager)

The new product development process is a close collaboration with the client. The interviewee at Engineered Fabrics believes that other business areas and units follow a similar structure. However, it is easier for some business units, with more standardised products, to work with inside-out projects. As we learned from a Key Account Manager, there are both formal and informal ways of starting NPD-projects. The more formal procedure at the Industrial Solutions business area is described below.

As explained by a manager at Trelleborg, a business case includes a project plan (identifying the problem) and acquiring of some sort of response from the client. If there is an intention to patent the product, some precautions need to be made and thus the client cannot be involved to a full extent. There are some cases where one does not want to sign a non-disclosure agreement. Furthermore, the business case includes a time plan. While making this report could be viewed as phase 0, phase 1 begins when a project starts to cost money. During this phase, the project is discussed with the clients, such as by signing an order for a prototype or general feedback, but as a rule of thumb, it should involve figures or measures.

A *Request for Quotation* (RFQ) is the following part of the project evaluation process at Industrial Solutions, for this concerned business unit. This document addresses specifics and costs of the project with highly detailed posts that need to be completed. The business case and the RFQ represent decision bases at the two first gates of the NPD process. However, we have learned that some issues might occur:

There is a standard, a form to be filled in for new products. We use a portal to forward it to our product manager. Maybe it is just me, but I do not always follow those standards. I think it is easy to get locked by format it is supposed to be delivered in. (...) I use it very seldom and I know these people well, so it is easier for me to send an email or pick up the phone and say: We have got something good going, let us do this! But that is not following the routine. My colleagues around the world follow the formal process with *request for quotation*. (Key Account Manager)

A sales manager provided us with his thoughts and concerns about the process:

When you are very process-driven, you loses some bases for innovation. Things do not move as quick and you drop some of your creativity somewhere. I think we worked a bit ad-hoc in this area before. It is of my belief that you had more freedom for introspection and try out different concepts, but that is not the case anymore. Now, we take a rather solid decision, if it is an idea that we should work with or reject. Then it is chewed into this protracted process. (Sales Manager)

Both managers cited above identified limitations with the way their processes were organised.

7 Analysis

Our aim in this chapter is to analyse our empirical material. By using a cross-case analysis, we will focus on comparing similarities and differences between our three case companies. First, we will analyse the methods or tools used by the companies, including criteria taken into consideration for evaluating NPD projects. Secondly, we will analyse how the structures and actors are organised in the evaluation process. We will save the comparison of our analysis and the literature review for the discussion in chapter 8. In the following analysis, we will return to our conceptual framework (see Figure 3, p. 32) as a guiding structure.

7.1 Project Evaluation Methods

Table 7 presents a summary of our empirical findings regarding methods for NPD project evaluation at Alfa Laval, Atlas Copco and Trelleborg.

Table 7. NPD Project Evaluation Methods

Corporation	Alfa Laval	Atlas Copco	Trelleborg
Evaluation Tools	CBA including NPV, IRR, and PP	CBA including NPV, and IRR; Separate Ranking Tool	Request for Quotation
Main Focus	Payback time; Profitability	Profitability; Strategic Fit	Customer Aspects and Customer Savings
Target	Time to 2 x Investment; Time-to-Million	Break Even	N/A
Level of Use	Corporate/Common	Separate/Divisional	Separate
Complementary Criteria	KPIs; Strategic Fit; Portfolio Balance; TTM; Market Aspects; Customers and Competition	KPIs; Strategic Fit; Market/ Customer demands; Product Durability; Energy Efficiency; Technical Feasibility; Time Critical	KPIs; Strategic Fit; Probability of Success; Technical Feasibility;

7.1.1 Evaluation Tools

Two out of our three case companies, Alfa Laval and Atlas Copco, used *financial methods* for NPD project evaluation. Their methods were similar, in the sense that both methods were CBAs, and that they included NPV and IRR. However, Alfa Laval also had a clear focus on PP as well. Trelleborg differed significantly from the other two in this aspect. They calculated project costs but could not specify any financial method. Instead, we had the impression that request for quotation played a more important role in the context, and that Trelleborg's absence of standardised and explicit methods was a consequence of their decentralised corporate structure and customer-specific projects. Besides using a CBA, Atlas Copco considered other criteria *separately* when ranking projects.

7.1.2 Focus and Target

We perceived that Alfa Laval's and Atlas Copco's use of financial methods also meant that they had a more distinct or outspoken focus on *profitability*, although profitability certainly was an important focal point for Trelleborg as well. Alfa Laval also emphasized the *time aspect* in the evaluation of NPD projects, in the sense that they measured Time to 2 x Investment and Time-to-Million. According to our observations, none of the other companies measured pay-back time to break-even or beyond. Atlas Copco, on the other hand, focused a lot on *strategic fit*, which they took into consideration beside the actual tool for evaluation. Trelleborg, on the other hand, primarily focused on *customer aspects* and *savings for customers*. We perceived that they had a more *interactive* contact with the customers when evaluating NPD projects. In addition, they did not commit themselves to many inside-out projects (innovation based on the company's internal core competences).

7.1.3 Level of Use

We observed another interesting aspect that we deemed necessary to bring up in this analysis. Alfa Laval, which we considered a relatively *centralised* corporation, had chosen to implement an evaluation tool meant to be used by the whole corporation: *one corporation, one tool*. Atlas Copco and Trelleborg, on the other hand, were perceived as much more *decentralised*. At these

two companies, there seemed to be no aspiration to implement one common tool for the corporations. Although a generalisation cannot be made based on three case companies, we still ask ourselves whether *organisational structures* have an implication on whether a corporation chooses to use a common tool for evaluation or if the choice of methods is delegated to individual business areas or divisions.

7.1.4 Complementary Criteria

All of our case companies used complementary criteria in order to present a strong and overall NPD project business case. When comparing the criteria proposed by the interviewees for evaluating NPD projects, we found both similarities and differences. All companies highlighted the importance of taking strategic fit into consideration as a complementary criterion to profitability, even though we did not obtain a complete overview of *how* the companies addressed the use of this criterion. They also stated that markets aspects should be considered: the customers and competitors. Furthermore, a common criterion raised by Atlas Copco and Trelleborg was technical feasibility.

Although portfolio balance was mentioned only by Alfa Laval, all three companies underlined the importance of considering the size and character of NPD projects in their evaluation. Trelleborg differed mostly among our three case companies regarding suggested criteria for NPD project evaluation. One reason could be that since they did not use a financial method, they might not have emphasised the same criteria as Alfa Laval and Atlas Copco. By using financial methods, the latter two might have highlighted criteria that were not included in these methods.

The use of *KPIs* was another important common pattern. However, the content of the KPIs differed between the companies. Atlas Copco used *energy efficiency* as an important indicator and they were alone in mentioning this as a part of NPD. Time-to-market (TTM) was a KPI used by Alfa Laval, Atlas Copco and previously used by Trelleborg. Alfa Laval pointed out that they were using two different measurements related to TTM since they had issues in comparing projects of different sizes and lengths. They were alone, we believe, to emphasise time measurements after sales. Trelleborg mentioned the same issue with TTM, and their replacement of the KPI time-to-market with *value creation* is an indicator that TTM is an insufficient KPI. The same indications were implied by Alfa Laval's split of their KPI. Although Atlas

Copco did not mention any disadvantages with TTM, they stressed the importance of the measurement. We find that the outcome of the TTM analysis is that *time* is a vital criterion, but at the same time, the TTM measurement causes issues when comparing different projects with one another.

7.2 Actors and Structures of the Evaluation Process

Table 8 presents an overview of our empirical findings regarding actors and structures at the case companies.

Table 8. Actors and Structures

Corporation	Alfa Laval	Atlas Copco	Trelleborg
Initiators	Market and R&D	Market and R&D	Clients, Sales, and R&D
Actors Responsible for Evaluation Basis	Product Managers	Project Managers	Sales Managers and/or R&D Managers
Decision Forums	Global Product Board and Product Council	Global Product Board and Product Board	Forum composed of Sales Manager and R&D Manager*
Organisation of Forums	Cross-functional	Cross-functional	Cross-functional

* For larger projects, senior manager/directors have to be involved.

7.2.1 Actors

We found general similarities in the roles of the actors in the NPD process at our case companies, even though there were also several differences. Product managers at Alfa Laval - who also managed the projects - and key account managers, sales managers and/or R&D managers at Trelleborg authored the business cases. At Atlas Copco, project managers from the technology and market departments managed the NPD projects. These were, as we call it, the actors responsible for the evaluation basis presented at the decision forums.

Another similarity between our case companies was their mentioning of the importance of key actors, whose knowledge and experience were viewed as paramount assets. Alfa Laval and

Atlas Copco specifically underlined this aspect, but we could also perceive the importance of individual actors at Trelleborg in their NPD project process. Furthermore, the involvement of actors from different functions had created some conflicts of interest

There are different views between the three companies regarding actors using their tools and methods in the same way. Alfa Laval implies that they are not, whereas Atlas Copco has the opposite impression of this matter. It is difficult to assess Trelleborg's position in this context. Besides the informal way of influencing project selection, is our perception that there are, to some degree, possibilities to choose how much information that should be included in a business case. This means that actors have an important influence on the evaluation of NPD projects.

7.2.2 Structures

We found similarities in the structuring of the NPD project evaluation at the case companies, in the sense that it was managed as a parallel process besides the managing of the projects. There was a common belief that structuring the evaluation process was important, and the dividing of the process into stages or gates was something that we observed at all companies.

Furthermore, the use of decision forums was very similar in the case of Alfa Laval and Atlas Copco. They both had two types of decision forums depending on the size and importance of the projects evaluated. Larger projects were decided upon by a global product boards at both companies, while Alfa Laval used the term product councils for smaller projects and Atlas Copco referred to them as product boards or local product boards. All decision forums are cross-functional. At Trelleborg, we were also introduced to a process, which was cross-functional and involved actors from different departments and functions in the evaluation and decision-making.

Regarding the presence of a formal decision process, an interesting notion was pointed out by a product centre manager abroad; the formal process could be viewed as a "Swedish way" of conducting things. We believe that the corporate culture is more tangible at a corporation's HQ than in its far away located subsidiaries. When it comes to informal structures, Trelleborg distinguished themselves. We had the impression that the company had the most informal culture of the three companies, which was reflected in an acceptance of informal decision-making.

7.3 Portfolio Management

The term *portfolio management* was not explicitly mentioned during our empirical gathering. The previously mentioned themes *financial methods, complementary criteria, actors and structures* can be summarised within the concept of portfolio management. The purpose was to obtain the interviewees' conceptions of each one of the different components of portfolio management. All three case companies practiced portfolio management in various ways.

Product portfolio was a term mentioned by several interviewees, but it should not be mistaken as being synonymous with portfolio management in this context. The fact that portfolio management was not mentioned by our interviewees can imply that neither of our case companies has a completely pronounced cross-functional portfolio management process. Based on our empirical findings it is difficult to assess to what degree our case companies commits themselves to a strategic perspective of portfolio management. All companies discuss the importance of strategic fit for projects however. It is of our belief that this area can be improved in terms of standardised and pronounced models and methods.

7.4 Challenges and Trade-offs

Table 9 presents an overview of our empirical findings regarding challenges and structures at the case companies.

Table 9. Challenges and Trade-offs

Corporation	Alfa Laval	Atlas Copco	Trelleborg
Challenges	Comparison and prioritisation of projects; Market input	Comparison and prioritisation of projects; Contingency to cover risks and complexity	Comparison and prioritisation of projects; Cost Follow-up/per Project; Inefficient overview
Trade-Offs	Sophisticated Tool/Comprehensible	Sophisticated Tool/Comprehensible	Customer Focus/Standardisation

The *challenge* of evaluating, comparing and prioritising projects of different size, character, budget and time horizon was primarily identified by Alfa Laval, even though this challenge was common for all three case companies. By acquiring detailed information about their evaluation methods, we were able to recognise that different methods represented different *trade-offs*, not just in terms of financial calculations but also in a user-receiver context. As Alfa Laval and Atlas Copco used a combination of different financial methods, they had to face the trade-off whether to use a relatively simple and comprehensible method, or a more sophisticated model, which to a greater extent took into consideration the complexity of NPD projects. Our observations revealed that there were many opinions presented on this matter, and thus showed that this trade-off is a key aspect to consider when choosing methods for evaluating NPD projects. Table 9 provides an overview of the challenges and trade-offs observed at the case companies.

8 Discussion

In the following discussion, we will address our most important findings in the light of previous research and existing theories. First, we will discuss the relevance of financial methods and the necessity of complementary criteria. Secondly, we will discuss the impact of actors and structures on the evaluation process. Thirdly, we will discuss the practical use of portfolio management and best practices, and specifically focus on portfolio balance, project selection and prioritisation, and best practices. Finally, we will discuss the challenges and trade-offs that companies face in the evaluation of NPD projects.

8.1 The Relevance of Financial Methods

In favour of quantitative methods, Markham and Hyunjung (2013) argue that financial measurements are the most important ones and that they are a characteristic of higher performing companies. They also discuss that this finding contradicts Cooper (2011) who claims that management that relies extensively on financial methods is restrained, especially when managing bold innovation projects. We believe based on our empirical study, that financial methods are a necessity as NPD projects need to be economically justifiable. Furthermore, we understand why these types of methods are popular, as Thamhain (2014) states, given their comparable results. However, we believe that NPD project evaluation cannot be made *solely* based on the results of financial methods.

We believe, as Thamhain (2014) underlines, that a combination of different financial methods is necessary in order to make up for their individual limitations. This is also a finding that we made at the case companies. It means that the methods used for evaluating NPD projects need to have a certain financial relevance and sophistication. At the same time, it is important that all users understand the methods. Furthermore, it is important that they can obtain the input and that the quality of the input can be guaranteed. Otherwise, the results cannot be reliable or comparable; bad input creates bad output.

Market input was discussed with several interviewees in the context of financial evaluation. Our impression was that factors such as probability of commercial success (Cooper, Edgett & Kleinschmidt, 2001) are perceived as arbitrary and difficult to motivate in a business case.

Whether this is a consequence of the complex nature of the manufacturing industry or the companies' issues of collecting the necessary data is not possible for us to answer. However, we consider this to be an interesting topic of discussion since the case companies mentioned it as an area in which they could improve.

We would like to emphasise our position in the discussion on financial methods. We believe that they should be purely *quantitative*. In other words, it is important that all input is *quantifiable* and leaves as little room as possible for subjective *interpretation*. Input that is not quantifiable or implies subjective interpretation should be considered as complementary criteria and hence be excluded from the financial methods or tools.

8.2 The Necessity of Complementary Criteria

As we judge that the evaluation of NPD projects cannot be made only with financial methods, we believe that it has to be complemented with relevant criteria. We found that there was a lack of focus on decision criteria, in literature, which could be used when selecting projects (Åstebro, 2004). Indeed, despite our case companies' use of criteria in the evaluation process, we observed some uncertainty regarding which criteria to consider. It is clear to us, based on previous research and our own findings, that strategic fit is a central aspect to consider when evaluating NPD projects. However, it is difficult to specify criteria that consider aspects that are difficult to define, such as strategic fit. Furthermore, as Blank and Tarquin (2012) underline, some criteria are difficult to quantify.

We believe that if companies rely on financial evaluation methods, it would become apparent to them that there are other relevant criteria to consider. These criteria would likely be related to factors which are difficult to include in a quantitative method and generally difficult to assess, such as contingencies or market and customer aspects.

Another important aspect to consider is the size and character of projects, as highlighted by our case companies. Thamhain (2005) states that the evaluation criteria depend on the type of project and business situation, and Hart et al. (2003) find that they also depend on the stage of the project. As our case companies suggested different important criteria to consider when evaluating NPD projects, we agree with Thamhain (2005) that the relevance of criteria is connected to the companies' individual situations in general, and to their individual projects in particular.

We believe that companies should use a *separate* tool, beside the financial tool, for comparison and ranking of projects where *unquantifiable* criteria should be considered. There are many such criteria, and we think that they are necessary to consider in order to capture the *complexity* of NPD projects.

8.3 The Practical Use of Portfolio Management and Best Practice

As Kahn, Barczak and Moss (2006) discuss, by not using a sophisticated portfolio management framework, problems such as portfolio balance will emerge. We discovered that Trelleborg used to struggle with this issue when the use of the TTM measurement made it more favourable to commit to small incremental projects instead of larger and more time-consuming projects. The importance of portfolio balance has been extensively highlighted in literature (Cooper, Edgett & Kleinschmidt, 1999; Cooper, Edgett & Kleinschmidt 2001; Chao & Kavadias, 2008; Smith & Sonnenblick, 2013).

Based on the discussion of a strategic perspective and the use of strategic buckets by Cooper, Edgett and Kleinschmidt (2001), and Cooper (2011) and Kahn, Barczak and Moss (2006), it is our opinion that the case companies could improve in this area. By implementing tools such as strategic buckets, project prioritising and resource allocation could be facilitated. However, according to our findings, project ranking and prioritisation cause practical issues. It is uncertain whether those issues are consequences of the limitations of the theoretical models or if our case companies are unaware of the theories in this field. We believe, based on our findings, that manufacturing industries are uncomfortable with project ranking as they consider it too subjective.

Furthermore, we reason that a standardised method for ranking and selection should be used by companies in practice. If a theoretical method does not comply with practical reality, it should be adapted to capture a company's internal resources, knowledge and experiences. Additionally, it is interesting to discuss whether a company should identify and adopt a “best practice” method, or if the company should develop a method based on its strategy, as Bengtsson and Kärreman (2012) suggest. A final question that comes to our minds regarding this topic is if an extensive focus on portfolio balance would limit bold innovations and radical projects, in the same way as Cooper (2011) suggests that an extensive financial focus does.

Much of the existing literature on NPD has a distinctive focus on best practices. During our empirical observations, we found a similar interest among the case companies. However, literature focuses on *how* best practice companies distinguish themselves in a more general sense, whereas the case companies showed a specific interest in our finding explicit best practice methods. Our idea is that companies and management should think a step further. They should ask themselves whether they want to adopt a well-working method externally or if an internally developed method would have greater potential. We believe that the complexity of NPD projects and the manufacturing industry points towards the latter alternative. One explanation of our companies' interest in explicit methods could be that project prioritisation is a relatively new issue for them, in the sense that the need of portfolio management has not existed to the same extent earlier. Our findings at Trelleborg, with customer specific projects, could imply this.

8.4 Impact of Actors and Structures

We find it particularly interesting to discuss actors in an *agency theory* perspective. As Akerlof (1970), Eisenhardt (1989), and Holmström (1979) propose, certain problems can be associated with asymmetrical information. In this thesis, it relates to the discrepancy between, on one side, actors managing the business cases and projects, and on the other, the project decision makers. The two problems of conflicting goals and desires and the verification of the agents' actions (Eisenhardt, 1989), are to a large extent applicable on the NPD project evaluation process.

In our empirical findings, we have found both examples of conflicts of interests and circumstance of asymmetrical information. There are many suggested solutions in literature to the issues related to the agency theory (Anderson & Oliver, 1987; Cravens, Ingram, LaForge & Young, 1993; Eisenhardt, 1985). However, those discussions and their implications on NPD project evaluation will not be examined within the scope of this thesis. We are content to establish that an agency theory perspective needs to be considered in NPD project evaluation, especially if there is an important information discrepancy between product/project managers and decision makers.

In relation to actors' use of evaluation tools, there is a specific issue that highlights their impact on the evaluation process. If a tool is difficult to understand and allows subjective interpretations, the users have a strong influence on its result. Furthermore, managers could have a selfish and deceptive motivation when assessing input for the evaluation of projects. By selfish and deceptive motives, we mean that individuals might desire to implement projects in which they have a self-interest rather than projects that are in line with the company's interests and strategy.

If an evaluation method is not (1) rated as excellent by the management; is not (2) user-friendly; is not (3) understood by the management; and if the management does not (4) believe that the method makes the right decisions (Cooper, Edgett & Kleinschmidt, 1999); then it is our belief that the evaluation method fails its purpose.

Based on our empirical findings, we perceive that companies struggle less with structuring the process of NPD project evaluation than making sure that actors use these structures and the evaluation methods in a similar way. The major impact of the structures is to make up a cross-functional framework for the evaluation process, while the most important impact of the actors is to represent the different functions involved in NPD as well as providing important experience and knowledge in the evaluation, comparison and prioritisation.

8.5 Challenges and Trade-Offs

The major challenge in NPD project evaluation is, based on our literature review and our own findings, the *comparing* and *prioritising* of projects. These projects are complex, as Hobday explains (1998), which makes it difficult to find appropriate evaluation methods and processes that consider their differences. It is difficult to compare and prioritise projects when their characteristics cannot easily be evaluated. On top of that, most evaluation methods have limitations (Remer & Nieto, 1995; Lin & Yang, 2015). Moreover, guaranteeing the quality of market input is an important challenge. Another challenge is that evaluation methods might be misunderstood or understood differently by different users and that there is no guarantee that actors use the methods in the same way (on purpose or not).

Furthermore, including criteria when ranking and prioritising projects is a challenge as they are often hard to quantify. Companies have to be aware of the fact that an evaluation based on

criteria might be very subjective, and that a complete evaluation of NPD projects cannot possibly be objective, especially given the influence of actors and structures in the process. Moreover, as Akhilesh (2014) concludes, combining relevant factors into a single evaluation is a challenge. The structures of an NPD project evaluation might create a framework to combine actors from different functions, but they are not a guarantee against conflicts of interests.

If and how different organisational structures could affect the practical implementations and use of portfolio management is not thoroughly discussed by the current literature. Even though our study only includes three case companies, their structures differ considerably. A decentralised organisational structure provides flexibility, but at the same time, it could represent issues. For example, it could limit a strategic overview. In the context of NPD, a lack of overview could result in overlapping projects or innovations; there is a risk that the wheel could be reinvented.

Former studies (Cooper & Kleinschmidt, 1995; Cooper, Edgett & Kleinschmidt, 2001; Griffin, 1997; Kahn, Barczak and Moss 2006) focus on identifying best practice methods and frameworks for NPD evaluation. However, the discussion on which trade-offs that different methods and approaches imply is less specific. Therefore, we would like to highlight this topic in our thesis. We believe that there is an important trade-off between (1) simple and comprehensible methods, which could be used and understood in the same way by all actors involved independently of their background and financial knowledge, and (2) more extensive and sophisticated methods, which aim at taking into consideration the complex nature of NPD projects.

The above observation highlights our finding that there is a *paradox* in the trade-off between a simple, comprehensible method and an extensive, sophisticated method that aims at taking into consideration more complex criteria. If a simple and comprehensible method would be chosen, the *reliability* of the output would likely be higher. However, its *relevance* might not be as high since it would not include complex criteria that are relevant for NPD projects. On the other hand, if an extensive method that includes such criteria would be chosen, the *relevance* of the output would be higher. However, the *reliability* of its output would likely be lower if the input cannot be quantified or properly measured.

The trade-off in the choice of evaluation method does not only concern whether to choose a simple or sophisticated method. A company should also decide whether to use a common evaluation tool for the whole corporation or whether to delegate the choice of evaluation methods to its business areas or divisions. We ask ourselves if a company's organisational structure has

implications on this second trade-off. Among our three case companies, we consider Alfa Laval to be the most centralised organisation. They have chosen to use a common evaluation tool for its entire corporation, whereas Atlas Copco and Trelleborg, which we perceive as more decentralised, have not made that choice. Instead, in their case, divisions or business units use different methods to evaluate NPD projects.

Another important trade-off concerns the criteria used in the evaluation. Due to the challenge of deciding which criteria to consider, companies also have to decide whether to use the same set of criteria for all projects or whether to use different criteria for different types of projects (e.g. radical and incremental). This trade-off could also be linked to the structures of the evaluation process. If the decision forums, or product boards, are organised in the sense that different forums manage different types of projects, then a set of criteria relevant for a certain type of project could be used by each forum. However, if the decision forums are based on e.g. different product lines, and each forum thus manages different types of projects, it could be more difficult to choose a set of criteria that takes into consideration the characteristics of every project type.

9 Conclusions and Contributions

In this chapter, we will conclude our findings, as well as outline our theoretical contributions and managerial implications. Finally, we will discuss the limitations of our findings and our recommendations for future research.

9.1 Conclusions

We will present our conclusion below in the form of answers to our research questions:

How can NPD projects be evaluated?

- Financial methods are essential, but should only include quantifiable data. However, NPD project evaluation cannot be made solely with financial methods.
- Complementary criteria that consider the complexity of NPD projects are necessary to include, but as they are not easily quantifiable, they should be considered in a separate tool.
- Portfolio management could be used as a process to combine financial methods with other relevant criteria in the evaluation to capture the complexity of NPD projects.

What impact do actors and structures have on the evaluation process?

- The impact of actors limits the objectivity of NPD projects evaluations.
- Actors provide important knowledge and experience in the evaluation, comparison and prioritisation.
- The structures serve as a cross-functional framework to guarantee the involvement of actors from different functions in the evaluation process.

What challenges and trade-offs do companies face when choosing evaluation methods and organising processes for evaluating NPD projects?

- Companies face the challenge of comparing and prioritising complex projects with characteristics that are difficult to evaluate.
- Companies face the challenge of involving actors with different interests in the evaluation process, who might use the evaluation methods differently.

- Companies face the challenge of guaranteeing the quality of market input.
- Companies face the challenge of involving criteria in the evaluation, which are often difficult to quantify and imply subjective interpretations.
- Companies have to choose between a simple, comprehensible method and an extensive, sophisticated one. However, this also means that they have to choose between a method with more reliable but less relevant results, and a method with more relevant but less reliable results.
- Companies have to choose between using a common method and letting business areas or divisions use their own methods.
- Companies have to choose between using the same set of criteria for all projects and using different sets of criteria depending on the type of project.

9.2 Theoretical Contributions

By researching how NPD projects can be evaluated, based on existing literature and a case study of three major manufacturing companies in Sweden, we have been able to shed new light on previous theories related to project evaluation. Furthermore, by studying financial methods and complementary criteria that consider the complexity of NPD projects, we have tried to increase the theoretical relevance of our thesis in relation to this type of projects. Furthermore, by studying what impacts actors and structures have on the evaluation process, we have not limited our research to investigating only evaluation *methods*, and have thus showed that the process of evaluating NPD projects is not static but *dynamic*. Finally, the most important theoretical contribution of our thesis is to study the challenges and trade-offs that companies face when choosing evaluation methods and organising processes for NPD project evaluation.

9.3 Managerial Implications

NPD projects and the concept of portfolio management are important features in order to maintain or improve a company's position in a competitive environment, such as the manufacturing industry. Our study implies that the evaluation of NPD projects is more difficult to standardise, implement, and manage in reality than in theory. The challenges and trade-offs become more substantial, and the actors and structures become more real. It is important that our conclusions

regarding the trade-offs that companies face are understood by management. The following questions could be used to identify a suitable method for evaluating NPD projects.

Choose one of the following two alternatives:

- Should the method be simple and comprehensible in order to ensure reliable results, but possibly miss relevant aspects?

or

Should the method be extensive and sophisticated and include relevant aspects, but thereby jeopardising the reliability of the results?

If the simple and comprehensible is chosen:

- Identify the limitations of the method in order to complement it with a framework of relevant criteria
- Based on the method and complementing criteria, is it possible to compare and rank projects with each other in order to make select and prioritise project?
- If not, identify a suitable method in order to compare and rank the projects

If the sophisticated approach is chosen:

- Does the company have the capacity to collect the necessary input that the method requires?
- Can the quality of the input be guaranteed?
- Can it be assured that the method is used in the same way by all its users or does it allow subjective interpretations?

9.4 Limitations and Recommendations for Future Research

An important limitation to underline regarding our study is that our observations only include three case companies, and that our observations of these cases have been restricted. Thereby, we cannot make generalisations of manufacturing companies in general or our cases companies in particular. However, we believe that it would be interesting to conduct a more extensive study of manufacturing companies that would include a larger number of companies.

Furthermore, given the fact that we have observed large manufacturing companies with a long history in the industry, it would be interesting to study whether newer companies evaluate NPD projects differently. Moreover, it would be interesting to include companies manufacturing fast moving consumer goods in order to identify if the evaluation of NPD projects is made in another way in "faster" industries.

Another interesting aspect that we discussed but upon which we could not make any conclusions is the importance of market input. We asked ourselves whether it was related to the complex nature of the manufacturing industry or companies' difficulties of collecting the data. We believe that this would be an interesting subject for future research.

Finally, whether a company's organisational structure has implications on its choice of evaluation methods and processes is another fascinating subject to study. As we were not able to make any conclusions on a potential causal relationship, we hope that it will be the topic of future research.

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Appendix 1: Interview Guide

Questions about the interviewee:

- What is your name and work title?
- In which department do you work and where is it located?
- Please tell us a little bit about yourself:
 - Background
 - Education
 - Have you worked in other industries?
- Please tell us about your position/daily work tasks.
- For how long have you been employed in the company?
- Are you currently involved in new product development/project evaluation?
- How long have you worked with new product development/project evaluation?

Questions about project evaluation/investment appraisal:

- Which method are you using for project evaluation/investment appraisal?
 - Why do you use this method?
- Have you or your organisation used any other method previously?
- Are you comfortable with the method/methods currently used by your organisation?
 - Why/why not?
 - Do you find it user friendly?
 - Do you find any advantages/disadvantages with the method/s?
 - Does it have practical relevance (realistic)?
 - Is there any discrepancy between the evaluation and the actual outcome? Please give us an example, discrepancy in estimated duration, payback, break even etc.
 - Do you have an example on a promising project during the evaluation stage that failed later on?
- Do you believe that project evaluation/investment appraisal can be made solely by using the method/methods used by your organisation?

- If no, is there anything missing?
- Would you recommend other companies in the manufacturing engineering industry to use the same method?
- Would you prefer to use another method for project evaluation/investment appraisal?
 - Which one?
- What criteria do you believe are important to include in project evaluation/investment appraisal?
- Does the method capture the key aspects of the decision problem?
- Would you recommend other companies to use the same method/process?

Questions about the process of project evaluation/investment appraisal:

- Who are involved in the process of project evaluation/investment appraisal?
 - Are there permanent actors?
 - Does it depend on the project/product category/segment?
- Who are responsible for the project evaluation/investment appraisal?
 - Are there permanent actors?
 - Does it depend on the project/product category/segment?
- Who decides upon the choice of projects/whether or not to accept a project?
 - Are there permanent actors?
 - Does it depend on the project/product category/segment?
- Do you think that your company commits to the right projects?
- Is there anything missing in the process of project evaluation/investment appraisal?
 - If yes, have you suggested any changes?
- Do you perceive that you can influence the process of project evaluation/investment appraisal?

- Do you perceive that you can influence the choice of projects/whether or not to accept a project?
- Do you perceive your company/organisation to have a distinguished corporate culture and/or management style?
 - If so, do you perceive the methods used for evaluation/investment appraisal to align with the corporate culture and management style?

Appendix 2: Article

NEWSLETTER FOR THE HVAC INDUSTRY ISSUE 6-2015

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EDITORIAL

The NPD landscape of today

NPD is the core of our business. Increased competition and a challenging economic climate result in our being more selective in the NPD process. Economists Ekbohm and Wrangé have conducted a comprehensive study of how we and our peers face the challenges that NPD project evaluation results in. Our industry is characterised by complex products, thus the evaluation of NPD projects becomes complex as well.

We need to understand the challenges, choices and trade-offs that we encounter in the evaluation. Besides those factors, there is a wide range of financial methods, complementary criteria and strategies we must consider to commit ourselves to the right projects.

We have a long journey ahead of us, but I am convinced that we will succeed.



SID E. BURNS

NPD Director, ALFA LAVAL

In Focus:

Evaluating NPD Projects

PHOTO: thenextweb.com

Committing to the right NPD projects is paramount. In this article two experts of the area tell you why and how.

The evaluation process of NPD projects is a challenge. A recent industry study by economists Ekbohm and Wrangé has examined how manufacturing companies in Sweden take on NPD project evaluation. Their research involves three manufacturing companies; Alfa Laval, Atlas Copco and Trelleborg. Through in-depth studies and analysis, the authors have scrutinized *how* NPD projects are evaluated and *what* challenges and trade-offs companies face when choosing evaluation methods and processes. Furthermore, the impact of actors and structures has been examined in this study. Their discussions concern how the financial appraisal of an NPD project should be conducted. They conclude that a financial method, e.g. a cost-benefit analysis, solely should contain quantifiable and objective figures. However, a quantitative method is not sufficient for evaluating projects. Complementary criteria, such as strategic fit, market aspects and project character need to be considered, separately. Furthermore, the authors discuss the different actors' roles and impact on NPD evaluation. Regarding the selection and implementation of evaluation methods and

filled by management. One important trade-off faced when choosing evaluation methods represents a *paradox*. As a manager, you will have to consider if an evaluation method should be simple and comprehensible or sophisticated and extensive. This is where the involvement of different actors becomes evident. If a simpler method is adapted, the *reliability* of the output will be higher, but the result could be less *relevant*. However, if a sophisticated approach is chosen, the *relevance* for a specific project will be higher, but the result is affected by subjectivity and thus the *reliability* could be questioned. In terms of managerial implications, there are a series of questions which must be reviewed by management in order to complete a successful implementation of an evaluation tool or method. This study can be regarded as an indication that the manufacturing industry has fallen behind when it comes to evaluating, selecting and committing to the right projects. By recognising this issue, we are now better equipped to be a competitor in the NPD struggle.

TEXT: SID E. BURNS