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Barriers to R&D project termination decisions

A case study at Volvo Group Trucks Technology

Master's thesis in Management and Economics of Innovation

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Abstract

In order to stay competitive, firms need to continuously innovate, and thus many firms undertake several R&D projects every year. Such projects are often risky and uncertain, which is why many R&D projects fail. Therefore, in order to not waste scarce resources, making a decision to terminate failing R&D projects as early as possible is of high importance for many firms. However, termination decisions are often taken too late, and therefore this study explores what barriers hinder termination decisions at Volvo Group Trucks Technology, as well as how the identified barriers can be handled.

The first part of the study identified barriers hindering termination decisions through a series of interviews conducted with representatives from different functions at Volvo GTT. The research showed that 16 different barriers exist that are either behavioural or organisational. The identified barriers were also rated by decision makers at Volvo through a questionnaire to be able to identify which barriers are the most prominent.

Combining the findings from the interviews and the questionnaire with previous research, an analysis of all the barriers was conducted. Apart from being either behavioural or structural, the barriers can also be divided accordingly to how they hinder the termination decision. Either the barrier has a direct effect on the decision maker, or the decision maker is affected by post-decisional effects of the termination decision, or the barrier affects the process of making the decision. In analysing how the barriers influence R&D project termination decisions, a framework that can aid in identifying and mapping of barriers was developed.

In conclusion, several reasons to why projects are terminated at Volvo GTT were found. Internal or external changes can cause an erosion of the business case, due to increased project cost or decreased feature performance, which often lead to affordability issues. Moreover, four barriers appear to be the most prominent in termination decisions. How termination is affecting other projects, together with considering sunk costs, and the ambiguity of the future, as well as considering the competitive position, appear to be the most hindering barriers. By changing the way projects are managed and evaluated as well as how decisions are framed these barriers can be either lowered or overcome.

Keywords: Project termination; project exit; escalation of commitment; sunk cost fallacy; project management; case study

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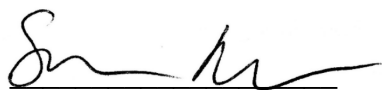


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1. Introduction

Firms need to continuously innovate, often by initiating R&D projects, in order to stay competitive. R&D projects tend to be associated with great uncertainties, namely technical, commercial and economical, and are economically burdening (Granstrand, 2010; Balachandra, Brockhoff, & Pearson, 1996). These uncertainties involved in innovation efforts means there are many risks of failure and unforeseen pitfalls along the way to project success. Lechler and Thomas (2015) found that more than 40% of R&D projects fail on average. If R&D projects are failing it would be in the utmost interest of managers to terminate such projects as early as possible (Balachandra et al., 1996). Thus, enabling them to minimise losses and relocate resources to projects with a higher probability of success and return on investment.

More than 87 % of R&D projects terminated are terminated too late (Lechler & Thomas, 2015). People tend to stick with the current situation or original position given to them even when presented with a superior alternative with negligible switching cost, known as being status quo biased (Kahneman, et al., 1991). Preferring the status quo is closely linked to escalation of commitment, that one can become increasingly tied to a course of action (Schmidt & Calantone, 2002). Previous studies have found a number of behavioural factors leading to escalation of commitment, such as the need for self-justification, sunk cost fallacy, cost of exit, and over optimism (Curseu et al., 2016; Ross & Staw, 1987; Steinkühler, Mahlendorf & Brettel, 2015; Biyalogorsky, Boulding & Staelin, 2000). One aspect of the escalation of commitment is the inability to not consider past economic investments, such as sunk costs (Curseu et al., 2016). Past investments tend to be seen as losses, which often makes the decision maker more risk seeking, due to further losses being perceived as less damaging while gains at this reference point are perceived as more valuable.

Moreover, the endowment effect, showing that people tend to demand more to sell an object in their possession than if they were asked to buy it, can cause managers to value projects already in their portfolio higher than if they had the option to acquire it (Kahneman, Knetsch & Thaler, 1991). Kahneman & Tversky (1979) have shown that people tend to value losses and gains differently depending on previous losses or gains. Hence, managers whose project have suffered previous setbacks or losses tend to be more risk seeking, by overvaluing potential future gains while undervaluing potential future losses.

Clearly, to make the decision to terminate an R&D project is proven to be difficult, both due to the complexity of evaluating projects as well as due to the influencing psychological effects at play. Thus, it is of high interest to find ways to improve managers' ability in making the decision to terminate unsuccessful R&D projects. Furthermore, difficulties in making the termination decision seem to be somewhat complex, containing both psychological and other influences. Thereby, a framework to identify and map these negative influences could be of value to both practitioners and for future research.

1.1 The case company Volvo Group

Aligned with the interest to find ways to improve the ability in making the decision to terminate unsuccessful R&D projects, this thesis explores R&D project termination at Volvo Group. Volvo Group is one of the world's leading firms within manufacturing of trucks, buses, marine, construction equipment, and industrial engines. The Volvo group include the brands Volvo, Volvo Penta, UD, Terex Trucks, Renault Trucks, Prevost, Nova Bus and Mack (Volvo, 2018a). This study was conducted at the division Volvo Group Trucks Technology, hereafter Volvo GTT, which is a centralised unit for new product development and technology supplying mainly the trucks business of Volvo Group with new products and technology.

Volvo Group needs to be innovative in order to keep their competitive position, deliver attractive market offerings, and fulfil legal requirements (Initial Interview). Hence, it is of high importance for Volvo Group to constantly update current products and services as well as developing new ones. This gives rise to several R&D projects each year and in 2018, Volvo GTT will have about 150 to 200 R&D projects operating (Interviewee 1).

Projects at Volvo GTT may be undertaken with different purposes in mind. Hence, there are three main types of projects at Volvo, namely new technology projects, new product projects, and product change projects (Volvo, 2017). The focus of this study is on the latter two, as they differ from new technology projects in terms of governance and evaluation structure. New product projects and product change projects are then divided into different sub-portfolios, namely Group Trucks, Buses, Construction Equipment, and Penta (Volvo, 2017).

The sub-portfolios in Volvo GTT are managed by different ranges, namely Heavy duty powertrain, Medium duty powertrain, Heavy duty vehicle, Medium duty vehicle, and Conventional. Heavy and Medium Duty represent the division of development in product scope, concerning loads and power output. Vehicle and Powertrain represent the division of development in product scope, concerning cab and base frame vs. engine, gears and axles. However, the powertrain range concern development globally whereas the vehicle range is more divided depending on application areas (Interviewee 1). The conventional range is market focused, targeting the US, consisting of heavy duty vehicle and medium duty vehicle. The larger functions involved in product development are, powertrain engineering, vehicle engineering and complete vehicle. Each function is contributing with their expertise to the development of new products or product changes.

Volvo Group consists of a number of brands, within trucks, construction equipment, buses, and marine. Central to all brands is the shared engine technology. Development of existing products as well as of new products is centralised to the entity Group Trucks Technology. Each brand within the Volvo Group reports its separate profitability and return on investment from R&D (Interviewee 9). Thereby, each brand supports and contributes with resources to projects it sees value in and wants to make use of.

1.2 Research problem

Both new product development- and existing product development projects are evaluated based on profitability calculations, project evaluation, as well as risk and opportunities, that all make up the business case, motivating investment in a project (Volvo, 2017). The core of the business case analysis consists of net present value, payback time and the internal rate of return (Volvo, 2016). Furthermore, project specific parameters central to its value are taken into account and emphasis is also put on the wanted future strategic position of Volvo, to ensure future profitability (Volvo, 2017).

The projects at Volvo GTT are governed according to the stage gate model. In order for a project to pass a gate and continue, the project has to fulfil prerequisites concerning time, product cost, project cost, as well as project profitability and risks (Volvo, 2017). Furthermore, R&D projects are also evaluated by the five aspects; quality, delivery, project cost, product cost and features, hereafter called QDCCF. Due to the highly technical nature of Volvo GTT's products the risk involved in R&D projects at Volvo GTT has always been significant.

When developing complex solutions and managing R&D projects the outcome can be predicted but not foreseen, much depending on the novelty of the project being undertaken (Maylor, 2010). Furthermore, as Volvo Group is acting on the global market they are influenced by ever changing external conditions, also creating uncertainties in the outcome of their R&D projects. Thus, R&D projects that seemed prominent initially may be devalued to the extent that the project should be terminated or better replaced by another. Since 40 % of R&D projects fail to reach its targets according to Lechler and Thomas (2015), it becomes evident that Volvo GTT needs to make decisions regarding project termination and continuation regularly. Moreover, if resources are allocated to unsuccessful or unwanted R&D projects the competitive position and future profitability of the Volvo GTT will most likely be negatively affected. Then, if 87 % of R&D projects terminated generally are terminated too late (Lechler & Thomas, 2015), and if some are never terminated, it seems of high importance to find out why and what can be done to improve this situation. Volvo GTT's interest in supporting this study would suggest they see value in identifying barriers to R&D project termination decisions, indicating there is room for improvement in this area.

1.3 Purpose and research questions

That many R&D projects are terminated too late raises interest to identify and map possible barriers that complicate or hinder the decision to terminate a project, as well as how these barriers could be handled. Thereby, the purpose of this master thesis is to explore how Volvo GTT comes to and takes the decision to terminate an R&D project and what might obstruct such a decision. Thus, the aim is to increase the understanding of the project termination decision process as well as to identify the most prominent barriers to R&D project termination.

The purpose gives rise to the following research questions:

1. How does Volvo GTT come to the decision to terminate an R&D project?
2. What barriers exist that obstruct R&D project termination and which barriers are the most prominent at Volvo GTT?

Inabilities in terminating R&D projects can be argued to lead to inefficient use of resources. Thus, giving rise to what can be done to improve, which leads to the last research question below.

3. How can the barriers to project termination be reduced or overcome?

1.4 Delimitations

The study is delimited by its specific context since the aim is to study this case in detail as well as to provide value to the partnering firm. Hence, contributions to the general perspective will be limited and application of the results to any situation other than the studied case needs to be done with careful consideration of the influence of context specific factors. One way to improve the generalisability would be to include more companies in the study to get a broader perspective and to identify which barriers are company specific and which are not. However, limitations in time and resources deemed it is best to study and understand one case properly rather than many but poorly.

Furthermore, this thesis focuses on one type of projects only, namely R&D projects. Another delimitation is that this study focuses on two of the ranges mentioned, namely Heavy duty vehicle and Heavy duty powertrain. Thus, the results and barriers identified can to some extent be biased due to this limited perspective. However, since the decision committee covers all ranges and since these ranges are the largest at Volvo, the barriers identified should be similar in all ranges.

Moreover, Volvo Group is a publicly listed company that needs to protect its shareholders' interest and abide to rules regarding sharing of information. Therefore, there is a risk that information is withheld and hence cannot be considered or published in the study. Furthermore, the signed non-disclosure agreements have led to some aspects having to be left out of the final report, due to being confidential information. However, that the authors signed a non-disclosure most likely also led to interviewees being more open to discuss sensitive aspects.

2. Theoretical framework

The following chapter presents and explains the theories used to analyse the research findings. The chapter initially focuses on concepts and models central to governing and managing R&D projects. The second part of the chapter focuses on different aspects of decision making.

2.1 Organising for R&D

The management of projects in order to achieve a particular task at hand can be described by four stages. First, the task and the goals are defined, second the project is designed and planned out, third the project is controlled and executed, and finally the project is completed and the result is reviewed in order to improve (Maylor, 2010). To complete a project, managers use the resources of the firm and usually involve members of different functions with specialised knowledge in order to achieve the best outcome. However, involving separate functions in a project can lead to issues in ensuring that functions actually collaborate on aspects of mutual interest. If such collaboration is not achieved and the separate solutions are not aligned the project may have trouble in reaching the common goals.

2.1.1 The stage gate model

The more common the task of a project the greater is the possibility to define rules and procedures that will ensure success (Maylor, 2010). However, there is no one best way to manage projects. As long as there is some variance in the external or internal context of the project actions are dependent on the specific situation. In order to catch growing issues early on opportunities to review the project can be created by dividing it into different stages and review points by using a stage-gate process.

A stage-gate process is a systematic way to move from idea to launch in new product development projects (Cooper, 2008). It maps out the road for managing the new product development process to improve effectiveness and efficiency. The model helps to break down the work needed to be done in stages, followed by gates, where go or terminate decisions are made. Thus, the investment decision is broken up, so that at each gate there is an option to continue to invest or to cut further losses. Furthermore, each stage should cost more than the preceding one, so that the commitment is increased as the uncertainties are decreasing, allowing for stable risk management. Each stage should define and map out the activities needed to progress the project to the next stage, with a clear goal and purpose. The stages should be designed to gather information, to reduce risks and uncertainties central to the project.

Cooper (2008) found that gates are rated as one of the weakest areas in product development. Gates are in many cases not doing their job, and are letting bad or troublesome projects to continue. The problem usually stems from that the initial go-decision means the project is now omitted into the financial plan and business roadmap, locking in the project. The following gates merely amount to update meetings, reviews, and milestone check-ups. Contrary to this,

gates should be where senior management meets to decide whether to continue to invest or to bail out based on the latest information. This group, called gatekeepers, should be a small cross functional group, consisting of key resource owners, making valid go or terminate decisions.

Some of the other problem examples brought up by Cooper (2008) are executive “pet projects” and excessive gate preparations. Projects being kept under the wing of an executive are subject to the terrible combination of getting special treatment at gates while having a higher failure rate. Bureaucracy and uncertainties in what information is required often lead to over-delivering, which forces gatekeepers to work through pages of material, much non-relevant to the decision. This in turn steals time from both the senior executive gatekeepers as well as the project team.

To make better go or terminate decisions at gates a number of firms, such as Johnson & Johnson, P&G, Emerson Electric, and ITT Industries, use scorecards (Cooper, 2008). The scorecards include key criteria for the project’s success and are used by the gatekeepers to make the right decision in a timely fashion. The six criteria used in a best practice case for the go to development decision, found by Cooper & Edgett (2006), are: strategic fit & importance, product & competitive advantage, market attractiveness, core competencies leverage, technical feasibility, and financial reward vs. risk. Each criterion is scored on a 0 to 10 scale. The scores are then displayed for a discussion, highlighting differences, while focusing on reaching an agreed upon group score for each criterion. The six criteria are weighted to add up to a total score of maximum 100. Usually a total of 60 out of 100 is required for a go decision. Cooper (2008) explains an effective scoring session should work something like the following. Initially the project is presented and questions about it are answered. Then each gatekeeper individually scores the project based on the key criteria. The scores are collected and summarised, showing an overall score of the project. Areas of disagreement are highlighted, discussed and explained. Finally, as the overall attractiveness of the project has been assessed an agreement is reached and the decision can be made.

The way of structuring a face to face meeting in this way, of separate individual work followed by sharing this work in a group discussion to finally vote or rank individually, is known as the nominal group method (Harvey & Holmes, 2012). The nominal group method is one of the most commonly used methods to reach group consensus and establish priorities for change. Moreover, this method has been argued to enhance the value of focus groups as sources of information and to improve the quality of a group’s judgement (Harvey & Holmes, 2012; Rohrbaugh, 1981).

2.1.2 Project evaluation

The monitoring of R&D projects is usually performed either formally by management or informally by the project manager and the project staff. In theory estimated future cash flows can be used to calculate if projects are economically worthwhile or not (Balachandra, et al., 1996). However, since future cash flows are difficult to assess and influenced by both internal and external changes decision makers tend to use alternative variables to assess the probability of project success.

Ryan and Ryan (2002) found that the capital budgeting tools that are most commonly used, more than 75% of the time, by the 1000 largest American companies, are net present value in 85.1% of firms, internal rate of return in 76.7% of firms, and payback time in 52.6% of firms. By the percentages it is clear most firms use multiple capital budgeting tools. All cash flows in these investment valuation methods are based on a forecast about the future (Granstrand, 2010). The probability of the forecasted cash flows may be calculated based on historical data and experiments, so called objective probability, or derive from individuals' beliefs about the future, so called subjective probability.

According to Majd & Pindyck (1985) projects of certain character can be incorrectly valued using traditional discounted cash flow (DCF) methods and neoclassical investment theory. Many investment projects have three main characteristics. Firstly, that the investment decisions, involving committing to cash expenditures and proceeding with development, is done sequentially over time. Second, there is a maximum rate at which the development can proceed. Third, the project will yield no cash return until it is completed. The fixed pattern of expenditure of discounted cash flow methods does not fit the sequential investments over time. The sequential investments also mean that managers can change the investment- and development rate or stop the project altogether as new information unfolds.

McMillian and Van Putten (2004) argue that DCF and Real Options theory should be used to complement each other, depending on where in the project development phase the evaluation is made. In the initial investment decision or in the early phases of a project, DCF methods, like net present value calculations, will lead to a too conservative investment policy. This is because the great uncertainties and risks involved will be captured in the calculation by the discount rate, however none of the potential opportunities and possibilities of increased cash flows are included. At late stages of a project, when uncertainty is low, DCF methods are argued to be more appropriate in evaluating the total expected value. This is because the number and value of other possible options available is low, letting DCF methods capture more of the total value. So, the total value of a project can be more fully captured by the sum of the net present value, the adjusted option value and the abandonment value of the project. Important to note is that the value of having alternative options in early stages of a project is contingent on the ability to terminate projects with low costs. Without this ability the option value is consistently outweighed by large switching costs, locking decision makers to the original project.

Real options theory shows that uncertainty of future prices makes firms more hesitant to both invest in a new project as well as to abandon an active project (Dixit & Pindyck. 1994). This is because of the increased flexibility of staying in the status quo and not taking an irreversible decision or locking up resources. Such flexibility becomes valuable with more volatile conditions and higher uncertainty. Real options models show that the value of abandoning a project is mainly determined by volatility of future prices, initial investments, and the termination cost. A larger isolated initial investment or a higher termination cost raises the threshold to terminate a project by decreasing resources left to be used and by increasing the switching cost. Volatility on the other hand changes the value of a project over a long period of time, while an initial investment and the cost of terminating a project is isolated. Therefore, initial investments and the cost of terminating does not affect the value of being able to terminate and switch to another option as much as decreased future cumulated cash flows will.

The organisational structure also affects how projects are managed and how decisions are made by setting the frames and rules that managers are expected to act within. In a highly formalised bureaucratic organisation decisions and strategic moves are restricted by standardised processes (Fredrickson, 1986). Thereby, decisions tend to only be made when a problem or crisis is detected by the formally monitored variables. Furthermore, action tends to be incremental due to restrictions of specified rules and procedures. Moreover, specialisation and separating functions tend to cause strategic action to only follow extensive political bargaining, which can be time consuming.

2.2 Influences on decision making

Taking decisions to terminate R&D projects are complex decisions that are influenced by a number of different factors such as psychological biases (Lechler & Thomas, 2015). In this section, different factors influencing how decisions are taken will be presented.

Research has shown that decision makers tend to persist and stay committed to courses of action even when new information and updated future return calculations deem it irrational to continue (Sandri et al., 2010; Staw 1981; Northcraft & Neale, 1986). This begs the question to what drives this persistence to continue and how decision makers may be skewed in their assessment, making continuing seem rational. Previous research has identified a number of effects skewing the assessment of an item's value (Kahneman et al., 1991). Two examples of effects doing so are the endowment effect and status quo bias, where the latter is closely linked to escalation of commitment.

2.2.1 The endowment effect

The endowment effect has been demonstrated by giving participants either two dollars or a lottery ticket and later giving them the option to trade (Kahneman et al., 1991). Even though the lottery tickets had a price of two dollars, and thus an objectively equal value, participants tended to stick with what they were initially given. Thereby, demonstrating an increased value for what is in one's possession versus if it were to be purchased.

Similar studies have been conducted in other settings proving the same effect (Kahneman et al., 1991). In a study at Simon Fraser University three groups of students were given the role as sellers, buyers or choosers meaning they either owned an item that was to be sold, were in the position to buy it, or had the option to choose between receiving the item or the amount of money it was worth. Hence, the sellers and choosers were positioned in the exact same situation. Even so the choosers behaved more like buyers than sellers and the reluctance to sell among the sellers was explained by their endowment. According to Kahneman et al. (1991) this can be explained by the pain of giving up on an item rather than enhance the appeal of what is owned.

2.2.2 Status quo bias & escalation of commitment

Status quo bias refers to the tendency that people prefer to stick with current states rather than changing to another option (Kahneman et al., 1991). The tendency has been proven by a study by Barry Staw where managers were given the task to allocate R&D funds to the organisation's

operational divisions. The managers then tended to continue to allocate resources to the division initially chosen even at a later stage. What is peculiar in this situation is the fact that the managers that had decided to invest in the division that turned out to perform the worst, were also the managers that showed the greatest tendency to continue to invest in the same division. Hence, they had a preference for the status quo causing them to get a lower return on their investment.

Fox, Bizman and Huberman (2009) argue that escalation decisions can be seen as maintaining the status quo. The decisions are often taken in groups to make the best usage of current knowledge and to make fully rational decisions (Curseu et al., 2016). However, previous studies have shown that these decisions tend to be biased and not completely rational. Escalation of commitment is one explanation to why. According to Ross & Staw (1987) an escalation situation is defined as a situation where money has been spent to a course of action, but where there is a choice whether to continue or to terminate and where the outcome of doing so is uncertain. In these situations, there is a tendency to overinvest resources into a failing course of action. Escalation situations occur in all types of circumstances, and when looking back organisations and individuals might wonder why they kept going for so long.

Considering that decisions should only be based on future consequences and not on past investments, this overinvestment of resources into a failing course of action is irrational (Curseu et al., 2016). Previous studies have found a number of determinants of escalation of commitment such as the need for self-justification, sunk cost fallacy, cost of exit, and over optimism (Curseu et al., 2016; Ross & Staw, 1987; Steinkühler et al.; Biyalogorsky, Boulding and Staelin, 2000).

2.2.2.1 Self-justification and learning from failure

According to Steinkühler et al. (2014) the need for self-justification is the reason for escalation of commitment being most supported by previous research. Self-justification can be defined as a process where decision makers continue to support a project by committing resources to rationalise previous decisions. Hence, people tend to bias their attitudes on information and tasks in order to justify previous behaviour (Staw, 1981). According to Biyalogorsky et al. (2000) the need for self-justification arises from managers wanting to preserve their image.

Furthermore, Staw (1981) means that two types of justification exist, internal and external. Most previous studies have focused on the internal justification process. Internal justification is when an individual chooses a certain action to protect his own self-image. However, Staw (1981) argues that external self-justification might even be stronger than the internal. That is, in some situations, especially when facing an evaluation or external threat, an individual might feel a need to prove that earlier decisions were correct. Thus, people might decide to continue with a course of action because they do not want to admit to others that they have made a mistake or failed (Ross & Staw, 1987).

Cannon and Edmondson (2005) mean that failure is often related to strong psychological reactions making individuals unwilling to admit a failure. The human desire to be admired by others, and the common belief that failing will negatively affect their image further contributes

to this. Moreover, the willingness to have a high self-esteem also makes people reluctant to admit failure to themselves. Commonly organisations penalise failure and reward success which further makes people try to avoid disclosing a failure. Hence, failures are often neither identified nor analysed.

Due to all these reasons, most organisations fail to learn from failure (Cannon & Edmondson, 2005). However, failure is an unavoidable aspect of operating in today's ever changing, complex world. Thus, a model for learning from failure can be of high-importance for all types of firms. Cannon and Edmondson (2005) have identified three organisational activities to undertake to learn from failure. Firstly, failure needs to be identified by the organisations. Small failures can be seen as early warning signals, but are often ignored and not examined thoroughly. Due to social and psychological reasons, such failures are often ignored which may give rise to larger, catastrophic failures later. One reason to why small failures can be difficult to identify is inaccessibility of data to identify it. Thus, organisations need to have systems and procedures to make the data available. Creating a feedback seeking environment, both from customers and employees can also help identifying failure. Moreover, it is also of high importance to create an open culture and a safe environment where people are not afraid of speaking up of failure. To do so, the leaders should act as role models and coach groups towards a more open environment.

Further, after having identified a failure another important activity is analysing why it occurred (Cannon & Edmondson, 2005). Individuals tend to be reluctant to analysing failure due to not wanting to affect their self-esteem and confidence. To ensure a proper analysis of failure, formal processes and forums for discussing and analysing are required. Experts should be put together in groups with individuals from different departments, with different skills and viewpoints. Moreover, using facilitators can also further contribute to the analysis by ensuring the discussions are learning-oriented. The third activity needed is what Canon and Edmondson (2005) refer to as deliberate experimentation. Experimentation is needed in a firm to innovate and failure should be seen as a necessary by-product of experimentation and not as something bad. Thus, it is important that both successes and failures are reported to others in the organisation.

2.2.2.2 Over optimism

Another driver of escalation of commitment is over optimism. Ross and Staw (1987) argue that over optimistic decision makers tend to terminate failing projects too late. Over optimism is when decision makers tend to underestimate probability of bad performance but overestimate probability of good performance (Steinkühler et al., 2014; Lovallo & Kahneman, 2003). Instead of rationally considering gains, losses, and probabilities decisions are taken based on optimistic illusions (Lovallo & Kahneman, 2003). According to Steinkühler et al., (2014) over optimism can be viewed from two different perspectives. One sees optimism as a personality trait whereas the other concerns optimisms regarding a specific project. Studies have shown that people being more optimistic than the average person tend to spend more resources on projects that were advised to be cancelled than others (Astebro, Jeffrey & Gordon, 2007).

Lovaglio & Kahneman (2003) state that over optimism arise both from organisational pressures and cognitive biases. Cognitive biases are errors in how the brain processes information. One reason to why people are over optimistic is attribution errors, which are that individuals tend to exaggerate their talents. This in combination with a tendency to misinterpret underlying reasons for certain events leads to people being prone to take credit for positive results whereas negative results are being attributed to factors in the environment.

Anchoring is one of the most common cognitive biases leading to over optimism and explains that the process of updating initial project plans during the execution of the project has serious drawbacks. Lovaglio & Kahneman (2003) mean that the original plan is favouring the positive in order to get the project started, and that this will lead to optimism during the following analysis. Executives are anchored to initial cost estimates and do not update them accordingly when problems arise. Competitor neglect is another cognitive bias that leads to over optimism. Instead of considering what negative effects competitors' moves could give rise to, executives tend to focus on their own company and what they can control.

2.2.2.3 The sunk cost effect

The sunk cost effect has been proven to be a determinant of escalation of commitment directly but also indirectly through the need for self-justification (Steinkühler et al., 2014; Biyalogorsky et al., 2000). It refers to that decision makers show a greater tendency to continue with a project once previous investment in terms of either money, effort or time, have been made. Hence, instead of evaluating the second decision from a neutral position, managers often consider previous investments when re-evaluating a project (Biyalogorsky et al., 2000). This behaviour is not rational according to traditional economy theory (Arkes & Blumer, 1985). Previous sunk costs should not be taken into consideration when making decisions.

Curseu et al. (2016) further add to this, stating that escalation of commitment can be seen as a risk seeking tendency that is started by viewing previous investments as losses. When an alternative is described in terms of losses instead of gains managers tend to be more risk seeking. Furthermore, decision makers might think in terms of losses after having made a decision for a course of action that did not achieve set objectives. Hence, the previous sunk costs are taken into account when making new decisions and the decision maker become more likely to take risks to improve the outcome.

One reason to why managers tend to become risk-seeking when considering sunk costs is explained by prospect theory, see Figure 1 below (Kahneman & Tversky, 1979). When a decision is to be taken regarding a new project the decision maker is at point a. No investment has been made. However, after having made some investments, the investor is instead at point b in the figure. At this point any further losses are perceived as smaller, as the change in perceived value is smaller for the same size of loss at point b, but small gains are perceived as large increases in value, as the perceived value function is exponentially increasing for gains at this point. Thus, when making a decision at point b, the decision maker perceives the possible further losses as smaller and is more likely to take risks in order to possibly gain large payoffs.

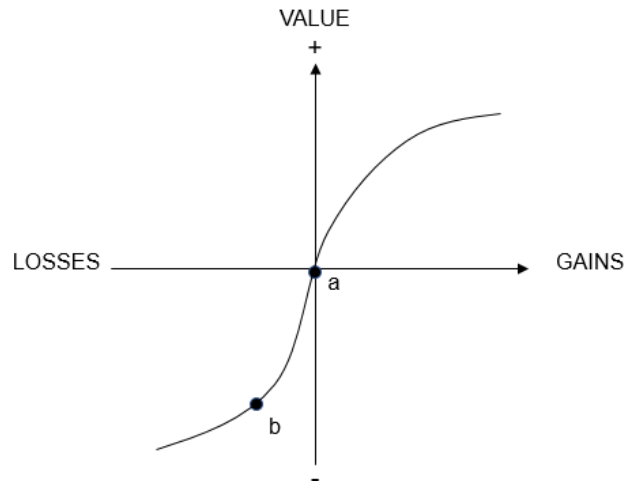


Figure 1 shows how people perceive losses and gains and maximise their utilization value due to personal utilisation functions. The function above is a general utility function as proposed by Kahneman and Tversky (1979).

Moreover, psychological aspects can also explain why sunk costs often are taken into consideration (Arkes & Blumer, 1985). One reason is that people do not want to admit that money has been spent on something that was not right. That is, people do not want to appear as wasteful, implying that this is also a driver of self-justification. Thus, by continuing to act as if the prior investment was correct, by investing more, makes people avoid this confession. Furthermore, the appearance of wastefulness seems to be of higher importance when it is one's own money at stake compared to when a previous investment has been done by a company or by someone else. In order to reduce commitment and become better at ignoring sunk costs people need to think less about maintaining responsibilities and avoiding loss, and instead focus on opportunities and promoting gains (Molden & Hui, 2011).

Northcraft & Neale (1986) have shown that in the decision to terminate a project, managers focus too much on the sunk costs and tend to overlook the opportunity costs. In cases of major project set-back, the option to terminate a project is viewed as a certain loss of initial costs while the option to continue is viewed as a high probability of large losses and small probability of no losses or small gains. Thus, the option with possibilities of salvation, even if small, is perceived more prosperous, due to the part of certain loss in the option to terminate. However, if the opportunity cost of resources is considered the decision to terminate would be presented as follows. Termination means a certain loss of initial costs and possible gains from investing of remaining resources in other opportunities, while continuing means high probability of large losses and a small probability of no losses or small gains as well as a certain loss of return from other opportunities. Thereby, both termination and continuation include certain loss, cancelling out the loss aversion bias. Thus, by highlighting the opportunity cost of the termination- versus continuation decision, managers become less persistent to continue.

2.2.2.4 Consequences of exit

Another economical aspect giving rise to becoming increasingly committed is the cost of terminating a project (Ross & Staw, 1987). However, when closing down, both costs of exit as well as the salvage value need to be taken into consideration. In some cases, investments in equipment can at least be partially retrieved due to their salvage value. Nevertheless, the costs of closing down can be very high when a project has been going on for a long time. Such costs may include the future salary payments to employees being terminated as well as losses from ending leases or penalties for breaking contracts.

This is further discussed by Havila, Medlin & Salmi (2012), who argue that managing the external stakeholders is a critical issue when closing down projects. Terminating a project can have consequences for the suppliers leading to a situation where compensation for redeployment of employees, materials and equipment has to be given. Thus, companies need to be proactive in handling the stakeholders.

When terminating a project, other issues also arise that needs to be taken care of. The project team often becomes disappointed when a project is terminated (Havila et al., 2012). Balachandra et al. (1996) also state that taking an employee perspective might be necessary when taking a decision to stop a project. Termination can cause demotivation of both project staff and members which in turn both can delay and hinder the decision to terminate. In addition to motivational problems, terminating also raises the issue of planning. The project team members need to be transferred to new projects which implies scheduling issues. Not only do new positions need to be found, but the positions also need to match the competence of the employee. When an individual is either under qualified or overqualified for the new task, the risk of demotivation is substantial.

2.2.3 De-escalation of commitment

De-escalation of commitment refers to a situation where decision makers reduce their commitment to a losing course of action (Moser, Wolff & Kraft, 2013; McNamara, 2002). De-escalation strategies can be based on either decreasing a determinant to escalation or by stimulating decision making to become more accurate (Simonson & Staw, 1992). Simonson and Staw (1992) argue that the perceived need for self-justification can be lowered by reducing the decision outcome when the manager's skills and abilities are assessed. Hence, reducing penalties for bad outcomes might lower the need for self-justification. One way to do so can be to assure confidentiality to ensure that the decision maker does not have to experience high social or psychological costs. The need can also be reduced by informing decision makers that the result of the decisions is not reflective of their true abilities. By highlighting what was out of the manager's control, managers are less likely to feel a need to defend previous mistakes. However, Boulding, Morgan and Staelin (1997) state that this might have negative consequences on the motivation of the project manager, which also needs to be taken into consideration.

Another possible solution to decrease the need for self-justification, is to design a reward system as to reward managers based on their decision processes instead of the outcomes of the decision (Simonson & Staw, 1992). The reason for this is that even though a good decision

is taken, there is no guarantee that the outcome will be positive due to uncertainties. Nevertheless, the assessment of the quality of the decision needs to be conducted before the result of the decision actually is shown, in order to avoid potential effects from biases.

One way to improve the decision-making process is to set a pre-determined stopping rule. According to a study by Boulding et al. (1997) this is the most effective way to reduce commitment. This is related to the suggestion of Simonson and Staw (1992) on providing specific minimum target levels that, if not achieved, lead to project termination. However, to give effect, the decision rule should be setup by an external source and not the manager self (Boulding et al., 1997). This since the effect of a predetermined rule set up by the manager self is not as strong, which is explained by the logic “I make the rules, I can break the rules”.

Furthermore, another possible strategy to reduce escalation of commitment is to replace the original decision maker (Ross & Staw, 1987). This is the second most effective method according to the study by Boulding et al. (1997). Introducing another decision maker lowers escalation of commitment since commitment of escalation arises because of one's own previous commitments and not others'. However, this approach is more time-consuming, than the other, since it requires new managers to get familiar with all relevant information.

2.2.4 Behaviour under uncertainty

Individuals making decisions under conditions of imprecise probabilities, or ambiguity, sometimes behave differently than under conditions of known probabilities, and prefer situations of known risks more than situations of ambiguity (Ellsberg, 1961). The way individuals are proposed to judge probability of a case or a situation is by using a rule of thumb to estimate the probability (Kahneman & Tversky, 1972). By matching and weighing how close a situation is to a known similar case, people predict the outcome.

Furthermore, Heath and Tversky (1991) found that individuals prefer ambiguity in contexts where they feel competent. This allows them to estimate the imprecise probability higher, based on their perceived higher than average competence, and turn the ambiguity to their favour. Hence, each individual is subject to over- or underestimate a gamble with imprecise probability, dependent on their recollection of similar situations as well as their perceived competence within the area.

Moreover, Keck et al. (2014) found that groups made ambiguity neutral choices more often than individuals, for different levels of probability and for different levels of ambiguity. Individuals making estimations before and later after a group discussion revised their attitudes the most and made a significantly more ambiguity neutral decision in the end. It is thought that this sequence makes the decision maker more aware of the differences in individual attitudes to the group attitude.

Keck et al. (2014) suggest that similar positive effects, like that of delegating important decisions to a group, should exist in situations of ambiguity. Hence, groups could make improved estimations and assessments of various risks and potential losses, when planning long-term in contexts of uncertainty. Especially, groups are thought to be able to improve decisions in ambiguous situations of low probability and high consequence.

2.3 Summary of the theoretical framework

Concluding this chapter, it becomes apparent that there are several aspects that influence the decision as well as the process of terminating R&D projects. In Figure 2 below the theories have been divided into three main areas of theory that have been used in this thesis. The first area of theory describes how organisations structure themselves to efficiently and effectively run, manage, and evaluate R&D projects. By organising in different ways firms strive to efficiently develop new technology or new product, while managing uncertainties and risks involved. Such organising also set the frames within which decision makers are expected to act and thereby influence how and when unsuccessful R&D projects are terminated.

The second area of theory describes how behavioural aspects influence decision makers in their ability to objectively evaluate R&D projects, assess the present situation, and take decisions. Several aspects show how decision makers may get attached to specific projects as well as get tied to a course of action and to continue. The third area of theory describes how most R&D projects involve uncertainties and risks that decision makers have to take into consideration. When decision makers judge probabilities of different future outcomes they are skewed by their personal background as well as their personal attitude towards risk and perceived skill within the area.

Summary of theoretical framework

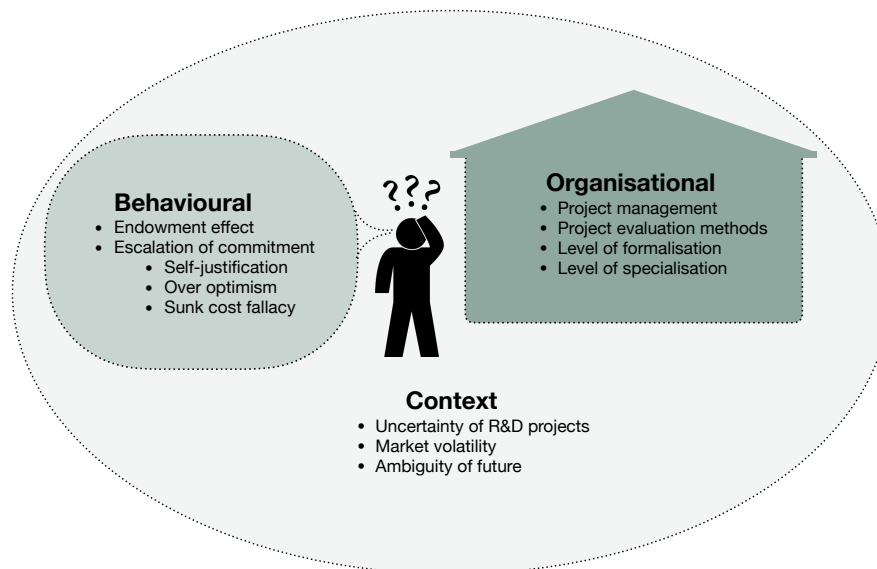


Figure 2 shows a summary of the theoretical framework. In the centre of the picture the decision maker is presented as a stick figure. The three main theoretical areas that in some way influence project termination or affect the decision maker when deciding to terminate a project are shown as bubbles in different shades.

3. Methodology

The design of the methodology is an important aspect when doing research and this chapter describes the methods used during the thesis work. Initially, the research approach is presented followed by a description of the literature study and data collection. Finally, a section about the quality of the research is presented which includes aspects such as validity, reliability and research ethics.

3.1 Research approach

The first step of this research was to formulate research questions providing a clear focus for the study. Bryman and Bell (2015) argue that the research questions should guide all parts of a research project, from the literature study to the data collection and the analysis. Thus, three initial research questions were formulated as follows. "How does Volvo determine when to terminate R&D projects?", "What are the most prominent barriers of timely project termination?", and "How should the barriers of timely project termination be handled?". When formulating the questions, several aspects were taken into consideration. Bryman and Bell mean (2015) that the questions should be clear, connected to established research, linked to each other and not too broad or too narrow. To achieve this, the research questions have been iterated and reformulated several times during the study leading up to the final three questions, presented in the introduction. Due to the explorative nature of the research questions, the study was initiated with an explorative approach within the area of termination of R&D projects and decision making by reviewing previous studies and existing literature.

Following, a mixed method approach has been used in this study in order to be able to discuss and examine barriers to project termination in detail during interviews as well as to get an overall assessment of which barriers are most prominent by conducting a questionnaire. A mixed method means that qualitative and quantitative methods are used together in the same study, which increases the validity and generalisability of the results (Easterby-Smith, Thorpe, & Jackson, 2015). Bryman and Bell state that qualitative methods are beneficial when details of a phenomenon are studied and when people's beliefs and opinions are examined. The decisions being studied, regarding project termination, are often highly complex and to fully explore and understand the process and the barriers, a qualitative approach is suitable. However, to assess and compare the barriers' strength as well as to compare how the barriers are affected by size and project progression a quantitative approach is more appropriate since it is a time efficient way to reach many respondents, while minimising the interviewers influence of their responses.

Moreover, Easterby-Smith et al. (2015) state that there are two main considerations to reflect upon when using a mixed-methods approach, namely sequencing and dominance. Sequencing is whether one of the methods precedes the others, whereas dominance is whether one method is used more than the other. In this study, a master-servant design has been used which is when one method serves the needs of the other. In this case, the data from the interviews, which dominate this study, was later assessed and evaluated in a questionnaire.

Apart from having well formulated research questions, having a suitable research design is also crucial to do a high-quality research according to Easterby-Smith et al. (2015). Research design includes the organisation of the research, which in turn, includes the data collection in order to achieve the goal of it. For studying project termination at Volvo GTT, a case study design was appropriate. Case studies are suitable when the researcher wants to get an in-depth understanding of a specific case and can be based on both single cases and multiple cases. Yin (2003) further states that case studies are preferred when how or why questions are aimed to be answered.

Three main types of cases exist, the critical case, the unique case and the revelatory case (Easterby-Smith et al., 2015). As for this study, it can be labelled as a critical case. A critical case is when the researcher has a hypothesis and the case is used for creating a better understanding of that hypothesis. In this research, Volvo GTT was chosen due to the large number of projects they undertake each year implying that projects are terminated from time to time. Moreover, the focus of one company in detail is done in order to increase the over grasping understanding of the termination decision in a larger organisation.

In order to answer the different research questions, a combination of research methods was used during the study. Firstly, an understanding of the current processes at Volvo GTT was gained by combining observations of committee meetings with readings of internal corporate documents on their way of working. The observations were followed by interviews conducted with members from different functions, and with different roles at Volvo in order to get a deeper understanding of the processes and also to identify potential barriers that hinder decisions.

The barriers identified during the interviews were further studied through a questionnaire. The main aim of the questionnaire was to identify which barriers were the most prominent and under what conditions. How the research questions are linked to the different research methods can be seen in Table 1 below. However, the third and last research question regarding how actions can be taken to overcome these barriers was addressed mainly through a literature study. All methods will be further explained in the following sections of this chapter.

Table 1 illustrates how the first two research questions are related to the different data collection methods.

Research Method	1. How does Volvo GTT come to the decision to terminate an R&D project?	2. What barriers exist that obstruct R&D project termination and which barriers are the most prominent at Volvo GTT?
Observations	x	
Interviews with employees	x	x
Interviews with decision makers		x
Questionnaire		x

3.2 Literature review

The literature review was conducted in an iterative manner throughout the whole study. It was used not only to create an initial understanding of previous research but also to help to formulate the research questions and to show why the research questions are important as suggested by Bryman & Bell (2015). Initially, a general review of previous research on decision making regarding termination of projects was performed. Later on, the review was aimed at more specific topics within the area and a theoretic framework was formulated based on two main fields of theory, namely project management in general, and influences on decision making.

Mainly academic articles have been the source of information for the literature study. Such articles are considered as more reliable than other sources of information since they have been reviewed and accepted by a number of researchers according to Easterby-Smith et al. (2015). Google Scholar and Chalmers Library's search tool Summon, were used for finding the articles by searching for some main keywords, namely "project termination", "project exit", "project management", "stage gate", "decision making", "escalation of commitment" and "sunk cost".

In order to evaluate the articles, four aspects were considered as suggested by Easterby-Smith et al. (2015). Firstly, the purpose of the article was reflected upon, by reviewing the article's abstract. Furthermore, the authorship was considered by assessing and their credibility and recognisability. Moreover, the timeliness, meaning when the source was created, was also taken into consideration. Furthermore, the credibility and accuracy were evaluated by considering the number of citations of each article. However, for more recent research, the number of citations might be low due to the article's newness. In those cases, more emphasis was put on the other aspects.

3.3 Data collection

In order to fulfil the purpose of the study, the collection of data was performed using three different methods. Initially, data was collected by observations of different meetings at Volvo. Later, interviews with representatives from different positions were held and lastly a questionnaire was conducted. All methods contributed to the research of the study and are further explained in the following sections.

3.3.1 Observations

To get an initial picture of how Volvo evaluates and governs projects, observations of different decision bodies' meetings were performed at Volvo GTT, see Table 2. Four main types of observations exist, which are depending on the role of the observer (Easterby-Smith et al., 2015). During the observations at Volvo, the authors had the role that Easterby-Smith et al. refer to as "complete observers". This means that no interaction was made by the observers during the meetings, which is commonly how observations are made in management research. The main goal of these observations was to create an understanding of the decision-making process. Since Bryman and Bell (2015) points out that the risk of being complete observers is misunderstanding the situation, both of the observers took notes separately. The notes were also separated in facts and reflections in order to later be able to analyse the findings.

Table 2 shows which meetings that have been observed at Volvo GTT.

Meeting	Date
Group Finance Reference Group	2018-01-22
Group Finance Reference Group	2018-01-29
HDP Steering Committee	2018-01-30
HDV Steering Committee	2018-02-01
Product Decision Committee	2018-02-07

3.3.2 Interviews

To further examine how decisions to terminate projects are taken, but also to identify what might hinder such a decision, a series of 22 semi-structured interviews were conducted at Volvo GTT. Interviewing is one of the most common methods in a qualitative research according to Easterby-Smith et al. (2015). The main aim of conducting interviews is to create an understanding from another person's perspective, which is why interviewing was chosen as an appropriate main method of this study. Moreover, the semi-structured format was used since it allows for questions to be addressed without a pre-defined order which is useful when exploring new ideas (Bryman & Bell, 2015). Semi-structured interviews also allow for follow-up questions which is valuable when an interviewee brings up an interesting perspective requiring more discussion.

Furthermore, using a semi-structured approach made it possible to tailor the questions depending on the position of the interviewee even though the same interview template was used for several interviewees. The templates (see Appendix I) were formulated based on the research questions and organised into the three main sectors as suggested by Easterby-Smith et al. (2015). First, opening questions were asked to make the interviewees comfortable. Second, main questions regarding the key topics were focused upon, and lastly the closing questions were of a more informal character to conclude the interview, and thus, allow for other discussions and make the interviewee feel appreciated.

Bryman and Bell (2015) mean that when designing the interview template an important aspect to consider is to formulate the questions so that they are easily understood. Therefore, it is central to avoid theoretical, abstract concepts and instead use a more everyday language. Open-ended questions were formulated to allow for unexpected responses to fully explore the topic. To ensure that the questions were understandable to all respondents, the interview templates were discussed with both the supervisors at Volvo GTT and the supervisor at Chalmers prior to the interviews. Moreover, the template was sent in advance to all interviewees, this to allow them to reflect upon the questions before the interview, and thus increase the quality of it.

When interviewing, Easterby-Smith et al. (2015) state that two difficulties are to understand the interviewee's perspective as well as to avoid projecting own opinions on the interviewee. Therefore, all interviews were conducted with both authors present. The roles were always set before the interview, with one person being responsible for asking questions of the interview template while the other was responsible for administrative issues, such as recordings but also for asking more reflective follow-up questions.

Most interviews lasted about a half hour up to one hour and were done face to face to be able to read facial expressions and body language. Skype interviews were avoided when possible due to their lack of immediate contextualisation (Easterby-Smith et al., 2015). However, when no other option was available due to different work locations, conducting a Skype interview was preferred rather than to not interviewing the interviewee at all. Moreover, all interviewees were informed that the interviews were anonymous both when the invite was sent out, and at the start of the interview. The reasons for choosing to keep the interviews anonymous were to avoid making the interviewee feeling constrained and withholding information as well as to protect their integrity.

To be able to fully focus on the interviews, and to allow for a thorough analysis of data, all interviews were recorded and later transcribed, as suggested by Bryman and Bell (2015). Since the focus during the interviews was more on what was said rather than how, the transcripts were written without taking pauses and fillers such as uhm, eh, etcetera into account. When possible, the interviews were held in the primary language of the interviewee to allow them to communicate effectively and not to miss out on possible data. However, some interviews were held in the interviewees second language English. Thereto, the transcripts of the interviews were written both in Swedish and English and to avoid distorting data, the transcripts were kept in their original language for the coding. Swedish quotes being used in the report were translated into English and then double-checked by the other author to be as correct as possible. To make it easier for the reader some quotes that were difficult to understand have been simplified by using clarifications in brackets.

Two main types of interviews were conducted considering the position of the interviewee. The first type of interviews was held with representatives from different functions with different relations to the decision-making process. Either they were members of the steering committees, or reporting to those, or chief project managers with experience from terminating projects. In common was the aim of broadening the authors' view on how the decision process actually proceeds, why projects are terminated, and also, why projects are not terminated. Thus, these interviews were of an explorative character. However, the interviews with the project managers focused on specific cases rather than the general case, why the questions were aimed at those specific projects. The specific cases were found and introduced to the authors by consulting with one steering committee member of the Heavy duty vehicle range as well as one from the Heavy duty powertrain range.

The second round of interviews, with the decision makers, followed what Easterby-Smith et al. (2015) refer to as the critical incident technique. This is an interviewing technique useful for going directly into a specific field instead of gathering large amounts of data. Instead of asking questions regarding the decision-making process in general, these interviews were solely focused on potential barriers. Easterby-Smith et al. (2015) suggest that this approach can be

used to detect behaviours leading to success or failure why the interviewees were asked to think of the processes of the termination of some specific projects. However, the risk of using this technique is related to the possible difficulty to recall happenings in the past. Therefore, when respondents showed tendencies to have difficulties in remembering the specific cases, the barriers were discussed more generally.

3.3.3 Sampling of interviews

Easterby-Smith et al. state that sampling is the first step in a data collection when conducting interviews and that it is important that the sample is purposeful and that the way the sample is chosen does not affect the research. In order to ensure this, a so called non-probabilistic approach to sampling should be used. Therefore, purposive sampling was used during the initiation of the interviews, meaning a list of possible future respondents was created, together with the supervisors at Volvo GTT. The potential interviewees were then considered based on their fit to the purpose of the study, meaning they should provide insight into the process of taking the termination decision. As an example, several steering committee members from different functions, were regarded as having a good overview of the projects under consideration as well as of the decision criteria and of the decision process, as they evaluate projects and provide recommendations to the product decision committee.

Later on, snowball sampling was used to identify new possible interviewees, that is that one interviewee recommends possible future interviewees. Bryman and Bell (2015) mean that this is preferable when a researcher's knowledge and/or network is restricted, as in this case. New possible interviewees were chosen to be interviewed if they would provide further insight or a new perspective on the process of taking the decision to terminate, in similarity to the sampling above. In order to generate a sample being representative of a larger population, interviews were conducted with representatives from different functions and with different roles. The sample size is case dependent but Easterby-Smith et al. (2015) argue that the process should continue up to the point when additional interviews appear less likely to reveal new information. Therefore, the interviews were conducted during a longer period of time, to allow for reflections in between and hence to be able to determine when all relevant information had been collected. In total, 22 interview objects were interviewed from different functions and with different roles, as can be seen in Table 3.

Table 3 shows the interviews that have been held with employees from different functions at Volvo GTT.

ID	Position	Date	Setting
1	Director Controlling & Strategy	2018-02-12	On-site
2	Chief Project Manager	2018-02-14	On-site
3	Chief Project Manager	2018-02-14	On-site
4	Director Controlling & Strategy	2018-02-15	On-site
5	Director Project Quality and Safety	2018-02-15	On-site
6	Director Controlling & Strategy	2018-02-15	On-site
7	Chief Project Manager	2018-02-19	On-site
8	Gate Auditor	2018-02-19	On-site
9	Product Decision Committee Member	2018-02-22	On-site
10	Director Controlling & Strategy	2018-02-22	On-site
11	Chief Project Manager	2018-02-26	Skype
12	Chief Project Manager	2018-02-28	On-site
13	Chief Project Manager	2018-02-28	On-site
14	Vice President	2018-03-01	Skype
15	Chief Project Manager	2018-03-07	Skype
16	Director Product Planning	2018-03-12	On-site
17	Product Decision Committee Member	2018-03-14	On-site
18	Vice President	2018-03-15	On-site
19	Vice President	2018-03-19	On-site
20	Product Decision Committee Member	2018-03-22	On-Site
21	Product Decision Committee Member	2018-03-22	On-site
22	Product Decision Committee Member	2018-03-22	On-site

3.3.4 Questionnaire

After having identified a number of barriers hindering termination decisions, a self-administered questionnaire was designed to assess the impact of the barriers. Having such a questionnaire means that the respondents answer the questions by themselves (Bryman & Bell, 2015). Moreover, the questionnaire was provided by e-mail to eliminate interviewer effects, as well as to lower the administrative efforts.

The questionnaire was sent to representatives with a possibility to terminate a project. That is, all members of the steering committees Heavy Duty Powertrain and Heavy Duty Vehicle as well as all members of the Product Decision Committees. All respondents got the same questionnaire, however attached to a personal email to make them more willing to fulfil the questionnaire by allowing the authors to explain why they had been selected to answer it. To access the questionnaire easily, the respondents got a hyperlink leading directly to the questionnaire. Out of 47 respondents, 24 answered the questionnaire, corresponding to about 51%. The study is largely based on qualitative data, used to explain and cross-check the result of the questionnaire. Thereby, the 51 % response rate was determined to be acceptable to represent the opinion of Volvo GTT's decision makers.

Bryman and Bell (2015) argue that when a questionnaire is filled in without intervention from the researchers, the formulation of the questions becomes of high importance. Therefore, the questionnaire did not include any open questions other than a final, optional question regarding whether the respondents had any other aspects they wanted to make the authors aware of. Instead, having closed questions makes it easy to process the answers, enhances comparability as well as eases display of variables relationships. All questions were constructed with rating scales, where the respondents selected the perceived impact of each identified barrier and whether the barrier got stronger or weaker during certain conditions. The complete questionnaire with questions can be found in Appendix II.

There is however a risk that questions get misunderstood when using self-administered questionnaires. Therefore, the questionnaire was pre-tested with one of the supervisors at Volvo GTT and the supervisor at Chalmers to ensure all questions, as well as the structure, were easily understandable. To make the questionnaire easier to follow, the whole questionnaire had the same format, with the same follow-up question after each barrier which minimises the risk that the respondent gets tired of answering before being finished.

3.3.5 Coding and analysis

Making sense of all the collected data is one of the most common issues when working with qualitative data according to Easterby-Smith et al. (2015). Data can be looked at, and framed, in many possible ways which requires the researcher to be both rigorous and flexible at the same time. No matter the approach, the framing of data should allow for theories to be developed and complexity to be reduced. For this matter, a content analysis was performed during this study.

The first step of coding when making a content analysis is to determine how relevant material is selected (Easterby-Smith et al., 2015). This was based on the formulated research questions. Depending on what research question the data could help answering, it was later given a certain colour code and coded into a separate document. To ensure that both authors coded the transcripts in the same way, a coding manual was set up. The coding was done in three steps. Initially three categories of major topics were coded, namely governing and evaluation of projects, termination process, and hindering the decision. The last category, hindering the decision, was later coded by clustering the identified hindering influence, on termination decisions. The clusters at this point were; employing and committing people, project dependencies and interconnections, organisational structure, customer and supplier relations, assessment bias, ambiguity of future, motivation, emotional connection, self-justification, prestige, and sunk cost. The clustering of the identified hindering influence was lastly coded in more detail. The detailed coding was done by matching quotes to theory, when possible, and otherwise by clustering quotes that contained similar descriptions of a hindering influence. Hence, the data were coded and analysed in several levels as suggested by Bryman and Bell (2015).

Moreover, Easterby-Smith et al. (2015) state that one possibility of having a mixed method approach is the possibility to conduct a cross-over analysis, where quantitative data can be analysed in qualitative ways and vice versa. In this study the quantitative questionnaire was analysed in combination with the interview findings to explain the results of the questionnaire. The data from the questionnaire have been analysed by calculating the mean value of the response to each question. That is, the mean rating of the strength of each barrier as well as the mean change in strength for each barrier by the two conditions project size and project progression. Following, the barriers have been sorted according to mean strength and mean increase in strength with project size and project progression. In addition, the barriers have also been sorted based on the number of times each barrier was rated as “no obstruction”. After grouping some barriers based on qualitative data and analysis, the mean of each group of barriers has also been calculated.

3.4 Research quality

In order to ensure high quality results and contributions, the choice of methods used in this study has been done with three major aspects in mind. That is, the validity, the reliability and the ethical aspects have all been considered. How these considerations have been integrated and affected the research design is presented below. Initially, how high validity and reliability have been achieved is explained. Finally, the ethical considerations are presented.

3.4.1 Validity

Internal validity is concerned with the match between the observations made and the theories developed based on those. In order to increase the internal validity a methodology suggested by Golden-Biddle and Locke (2007) has been used. Storylines have been created by telling, showing and telling. Initially what the finding will show is presented, then the qualitative data is presented, and finally an explanation to how the qualitative data has been interpreted is given. This allowed for total transparency of interpretations of the data and made sure the reader can assess if the interpretations are valid or not.

Moreover, triangulation has been used during the study which means that more than one data source is used to ensure the internal validity (Bryman & Bell, 2015). The interviewees at Volvo GTT were sampled as to give a nuanced view of the decision process, by representing different functions. Thereto, the interview results were also compared to findings from corporate documents to increase the internal validity.

External validity on the other hand, is concerned with the degree to which findings can be generalised beyond the study that has been performed (Easterby-Smith et al., 2015). Due to the nature of this study, being focused on one single company, the findings are also focused on their situation. However, large parts of the results may still be applicable to similar firms where R&D is a large part of their business model. Since the organisational barriers are more context specific than the behavioural, the latter are more likely to be similar to other firms and thus regarded as more generalizable and of interest for a wider audience. However, some organisational barriers should also be applicable to most companies, running more than one project and operating on a competitive market.

3.4.2 Reliability

Reliability of a study is concerned with whether a study can be repeated or not (Bryman & Bell, 2015). As with validity, reliability can be divided into external and internal reliability. Internal reliability is concerned with the degree to which members of the research teams agree upon what has been heard. Thus, to ensure internal reliability almost all interviews were conducted with both authors present. To avoid misinterpretations and allow for an objective assessment of the interview results, all interviews were recorded and later transcribed. Regarding internal reliability during the observations, notes were taken by both observers to avoid misinterpreting the situations. Thus, only observations noted by both of the authors were considered as valid enough to be included in the research.

Moreover, even though the questionnaire was not answered by all who received it, the response rate was considered acceptable. Since the respondents were given the option to remain anonymous, to allow them to fully express their feelings and thoughts, difficulties arose with sending reminders more than once which otherwise could have improved the response rate.

External reliability is related to whether a study can be replicated. Since many studies are focused on a specific social setting and specific circumstances difficult to freeze, external reliability can be difficult to ensure (Bryman & Bell, 2015). This is also the case with this research. However, to increase the external reliability a large number of interviews have been conducted to reduce the risk of having biased answers.

3.4.3 Ethical considerations

Research in business and management, like this study, does not give rise to the same ethical challenges as in other areas. Easterby-Smith et al. (2015) mean that one important difference between management and business research and other research within social science, is the role of the researcher. In this type of research, the researcher is many times the least powerful player. Thereby, the ethical challenges of this study are seemingly limited. However, as the

authors of this study strive to contribute to science, some precautions have been taken throughout this study. This is done in order to not cause harm or any negative effects due to the research, to either Volvo Group or Chalmers University of Technology, or any of the parties of said organisation taking part in the study.

Bryman and Bell (2015) have identified a number of principles in research ethics. Among them are principles protecting both the research participants, the integrity of the research community, included organisation and being honest and transparent in communication of the research. Two of the principles they discuss are to ensure that participants privacy is protected and ensuring that no harm comes to participants. Therefore, all interviewees and respondents of the questionnaire have been given the option to remain anonymous.

Furthermore, interviews were held at the interviewees' office to make them feel comfortable as well as to make it as easy as possible for the interviewee to attend. As the subject is of a sensitive matter to many, the questions were formulated in a way to not make the interviewee uncomfortable, by avoiding blame and not targeting any party. Another important aspect regarding research ethics is the confidentiality issue. In order to keep confidentiality agreements, several drafts have been sent to the partnering firm before final publication, for proofreading and double-checking company specific information. This is done in order to assure that no sensitive or wrongful information is publicised.

4. Findings

In this chapter the findings of this study will be presented. Initially Volvo GTT's internal governance and management of R&D projects is presented, based on internal documents and interviews. Next, the barriers to project termination are presented, identified through interviews at Volvo GTT. Next, the strength of each barrier as well as their change in strength due to project progression and project size is presented, determined mainly through the questionnaire.

4.1 Internal governance of projects

In this section the findings on how Volvo GTT manage, evaluate and make decisions regarding project continuation or termination will be presented. Furthermore, the most common reasons to R&D project termination and what options are most used to avoid R&D project termination are presented. These findings are from company documents, observations, and interviews at Volvo GTT.

4.1.1 Project management

R&D projects at Volvo GTT are divided into three different classes (Volvo, 2017). Which class a project belongs to is determined by the estimated budget, estimated time as well as the complexity of the project. The larger the budget, the longer the lead time, and the more complex the projects are, the higher the class. All R&D projects at Volvo GTT are being governed according to a pre-defined stage-gate model. However, depending on the class, the project is recommended to go through a different number of gates and decision points. Basically, the larger the project, the higher the class, and the more checkpoints the project needs to go through, which can be seen in Figure 3.

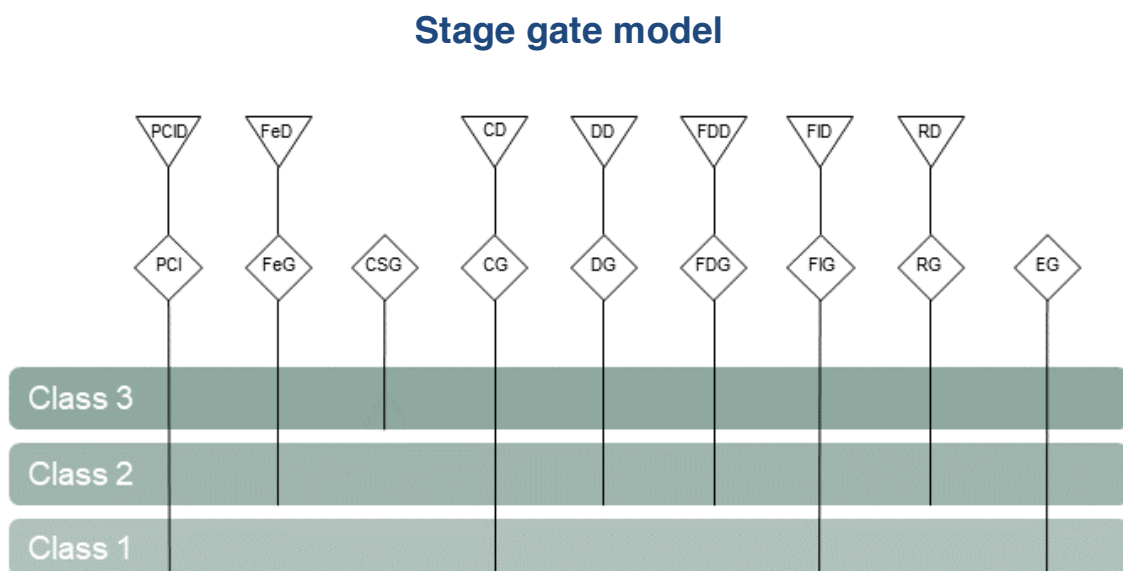


Figure 2 shows how projects are divided into three different classes depending on budget size at Volvo GTT. Depending on the class, the project goes through different stages and decision points.

To pass a checkpoint Volvo GTT uses a method they call predict, plan, prove (Volvo, 2017). Predict means predicting the final project delivery and requirement fulfilment in terms of QDCCF. QDCCF stands for quality, delivery, project cost, product cost and feature, which are what Volvo GTT sees as the most central aspects of project fulfilment. Quality refers to project quality and is measured by fulfilment of gate criteria. Delivery on the other hand concerns time and the ability to meet the planned start of production. Both the project cost and the product cost are evaluated based on predicted cost target fulfilment at production start. The last parameter, features, refers to expected additional customer value and is also evaluated on predicted feature target fulfilment at production start. The plan, in the predict, plan, prove, refers to getting ready for the following gate. The last P, prove, refers to proving fulfilment of the current gate criteria. Thus, in order to pass a gate, the project management needs to confirm that the project has achieved the deliverables for the gate, planned for the next gate as well as updated the project predictions and QDCCF fulfilment.

A project at Volvo GTT is managed by a number of project managers responsible for different functions as well as a chief project manager (Volvo, 2017). The chief project managers of larger R&D projects are supported by reference groups that exist for each large function, such as powertrain and vehicle engineering, finance, quality, and purchasing. The reference groups assess downstream consequences for the project and prepare the recommendations to be reported at the steering committee meeting. The aim is to efficiently get information from the project to the steering committee, as well as feedback from the steering committee to the project.

The steering committee steers, supports and shares ownership of R&D projects by endorsing project finance and operations plans, supporting and recommending actions, as well as helps to remove possible roadblocks preventing the project from reaching its objectives (Volvo, 2017). Furthermore, the steering committee appoints a gate auditor to independently inspect projects with focus on fulfilment of QDCCF and gate opening criteria. This is done to support the steering committee in making justified recommendations and to aid the decision-making process. Based on this and on information provided by the chief project manager the steering committee approves gate opening criteria and recommends a decision body to either open a gate, or to keep it closed. The steering committee's main responsibility however, is to assure technical feasibility, regarding technology as well as necessary resources (Interviewee 14).

The decision body approves or rejects recommended decisions, provided by the underlying steering committee, based on the project status report, the business case, the overall project portfolio, and the budget (Volvo, 2017). The decision body also approves the total project cost, the release of needed funds, as well as changes to the project scope or the solutions that are committed to be delivered. Members of the steering committees and the decision bodies represent a cross-functional perspective, each on different levels of the organisation, to consider the total impact of recommended actions and decisions. In contrast to the steering committee, the decision body looks more at the business aspects of the project, regarding both future benefits and future strategic position (Interviewee 14).

Projects can be aimed at achieving different goals and are therefore governed in different ways. Projects aimed to secure legal compliance are evaluated based on the same financial parameters as new product projects, however the profitability parameters are less considered.

However, project cost and product cost are still of major importance (Interviewee 1). The impact of not fulfilling legal requirements implies having to exit or not being able to operate in that market. This outweighs the financial parameters, almost making them irrelevant (Interviewee 1). Projects aiming to improve or add features to a product can be evaluated more on profitability and other financial parameters (Interviewee 1; 4). As these projects are justified more exclusively based on their business case, the financial parameters can consequently be used to more fully assess these projects.

4.1.2 Decision hierarchy

Evaluations of R&D projects and decisions regarding gate opening, release of financing, as well as decisions to terminate, follow a defined reporting path and hierarchy at Volvo GTT (Volvo, 2017). The R&D project team, consisting of people from different functions needed to execute the project, reports to a steering committee through their chief project manager. The steering committee, which is cross functional with representation on directorial level, evaluates, advises and recommends actions to the appropriate decision body. The larger and the more complex the R&D project is, the higher the decision is escalated. Furthermore, the decision may also be escalated if there is a cross-functional disagreement or when the impact of the decision or issue affects groups outside the decision body's responsibilities and authority.

R&D projects are governed and reported to different decision bodies dependent on the budget size, as can be seen in Figure 4 below. Maintenance projects of minor changes are governed by the maintenance decision body, which can act as both steering committee and decision body for small size projects (Volvo, 2017). Larger R&D projects are evaluated and governed by a steering committee as well as escalated to different levels of product decision committees. The steering committee makes a recommendation to a product decision committee, which makes the decisions. The next size of projects, are evaluated and governed by a steering committee that reports and makes recommendations to the product decision committee, who additionally report and make recommendations to the GTT executive management team, who takes the decision. Furthermore, if the size is even larger the decision point can be escalated to the executive board and to the AB Volvo board.

Escalation of decisions

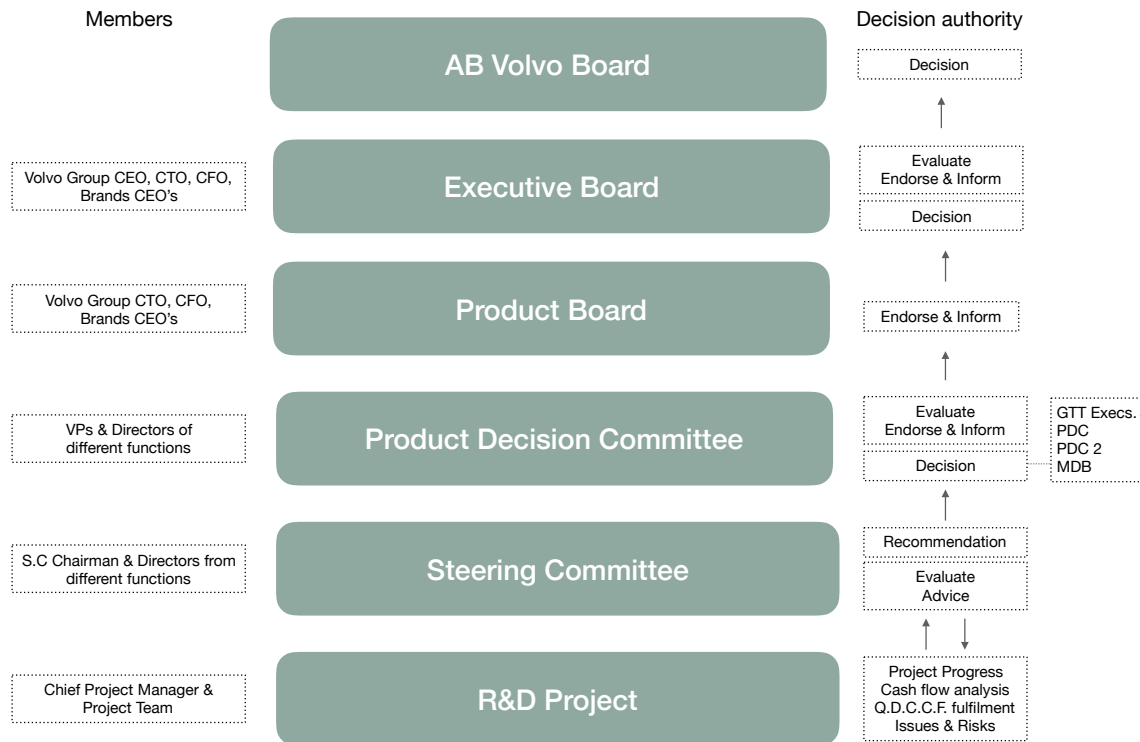


Figure 3 shows how decisions are escalated based on budget size to different decision bodies within Volvo GTT. To the left, the members represented in each body are roughly specified. In the middle, the hierarchy of governing entities is specified. To the right, a rough information flow is displayed as well as to what decision body the decision is allocated.

Moreover, during the last year, changes have been made regarding how Volvo GTT governs projects (Interviewee 1). Parallel tracks to handle emerging technologies have been added to their existing hierarchy. However, as of today most projects are still governed according to the decision hierarchy presented above.

4.1.3 Termination of projects

Termination of R&D projects at Volvo GTT can be based on a number of different reasons, and the alarming signals often have to be severe before the decision to terminate a project is taken (Interviewee 1; 4; 6). Common reasons to terminate are negative changes in the business case, most often in terms of decreasing profitability, or that the project is no longer affordable when there are not enough financial resources available (Interviewee 1; 4; 5; 9; 10; 13; 15; 17; 18). These two main reasons are then consequences of changes occurring internally or externally. Thereby, a current project can be made unattractive, de-prioritised, and eventually has to be terminated.

Internal changes mostly occur due to events in the project or in upper management. As the business case is often largely built on the QDCCF parameters, any negative changes to them due to what is discovered and developed by the project, will negatively impact the business case and erode the profitability of the project (Interviewee 6; 10; 11; 14; 18). Thus, input from

the project, or the different functions, of increasing project cost, final product cost, decreased quality, decreased feature improvement, or later delivery time will erode the project profitability. What seems to be the most common case is that the project cost increases as the predicted feature improvements decrease (Interviewee 9; 17). If several projects would increase on project cost, the total project portfolio does not longer fit into the R&D budget, which then causes project termination due to affordability issues. Moreover, short term affordability is indicated as the most common reason to reprioritise and terminate projects (Interviewee 17). In some cases, difficulties with the technical features can also lead to project termination (Interviewee 11).

External changes might also create changes in the business case. Predicted volumes are dependent on both reached feature improvements and customer preferences. The external changes mostly occur due to events in the market, dependent on competitors' moves, customer demand, and legislation (Interviewee 10; 14). Competitive moves can erode the current price position of Volvo GTT inducing a need for a strategic answer. If customers experience changes in what they require or if their purchasing power decreases, the volumes demanded of other or current features will change (Interviewee 1; 10).

To answer such moves or changes with R&D, Volvo GTT can improve their offering by increasing the performance of a specific feature or by adding more features, and thus motivate customers to choose Volvo. Furthermore, changes in the strategy, or in expectations of where the future market is heading, can cause upper management to choose new technical paths and therefore to terminate long term projects (Interviewee 1; 2; 14). In addition, external changes in legislation constrain Volvo GTT to comply with local and global laws if they want to stay in those markets (Interviewee 1; 4; 9; 14). The time to market of Volvo GTT's R&D projects aimed to meet legislation, is often longer than the time from which the law is set and to when it starts to apply. This causes projects to sometime become obsolete when legislations are changed prior to their planned application date and when there is no market value in the improvements (Interviewee 7).

In order for project termination to be considered, an insight in the organisation that a project is no longer feasible or needed, is required. This insight can mainly come from two directions, bottom up or top down. Changes to the estimated QDCCF can be detected by the project team, as they have an inside perspective on the progress and the expected outcome of the project (Interviewee 11; 13). Thus, they detect variations or gaps in the actual data compared with the project plan and targets. If such variations were to escalate, and it becomes obvious that the project will not reach the outcome predicted, the project team can recommend the steering committee to review the project, and possibly also recommend project termination (Interviewee 11; 13). However, such recommendations from the project team are very seldom, without it being initiated by a questioning from external functions or committees (Interviewee 14; 22). Such variations can also be detected by the reference groups of different functions and be reported to the steering committee, which then reviews the full picture and recommends the project to be terminated (Interviewee 1; 4; 14). Recommendations for project termination from the steering committee are, however, rarely the case (Interviewee 14). This, possibly due to that it is part of their duty to support the projects and remove road blocks to ensure successful completion.

The other main direction of initiating project termination, top down, is when a discussion of project termination is started in the product decision committee or higher. Here, the main concern is the business perspective of projects, which is discussed based on project reports and the business case, as well as on the projects' strategic fit to the total business perspective of the firm (Interviewee 14). Termination initiatives top down mainly concern affordability issues, due to that several or very large projects have increased in project cost exceeding the R&D budget (Interviewee 9; 14; 17). Furthermore, strategic changes concerning choosing technical paths or what products to be prioritised or introduced can also initiate termination decisions in this direction. However, no formal process to handle project termination after the decision has been taken exists (Interviewee 1).

4.1.4 Options to terminate projects

Planning and governance structures mean that Volvo GTT works proactively to predict foreseeable changes or difficulties that may obstruct the success of projects and takes action to prevent consequences such as project termination. That is, there are a number of options available, in cases of underperformance or negatively affecting circumstances, that are more preferred than terminating a project (Interviewee 8; 9). Options mentioned are to rebalance the project (Interviewee 2; 4; 5; 8; 9), in terms of project cost, product cost, and time, or to pause and push the delivery date (Interviewee 1; 9).

Rebalancing a project is the most common proactive action taken. In case the project or product cost increases, the project scope can be reduced to keep it within the set budget and to eliminate expensive add-ons that provide less customer value (Interviewee 2; 4; 5; 8; 9). In addition, if another more prioritised project increases in cost, less prioritised projects can be reduced in scope, and thereby also in cost. Similarly, the cost per year can be kept down by reducing the pace in a project and hence, pushing the delivery date, or by pausing it and restarting it at a later stage, often with a reduced scope as well (Interviewee 1; 9; 19). In addition, it is common that projects being closer to delivery date are given higher priority than the ones further ahead in the project plan (Interviewee 1). Another action to take can be to merge some projects that are all central to one specific product improvement in order to allow for synergies to reduce the overall cost (Interviewee 2).

4.2 Identified barriers to project termination

In this chapter, the barriers that prolong or block the decision to terminate R&D projects will be presented. Initially the barriers affecting the decision on a behavioural level are introduced. Next the structural and organisational barriers affecting the termination decision are presented. The behavioural barriers are more closely connected to the behaviour of the decision maker and less dependent on the specific organisational structure. In Figure 4, a summary of all identified barriers is displayed.

Identified barriers

<i>Behavioural</i>	<i>Organisational</i>
● Sunk cost fallacy	● Separate functions
● Social self-justification	● Separate brands
● Internal self-justification	● Separate ranges
● Emotional connection	● Hierarchic decision structure
● Fear of failure	● Demotivation of project team
● Future ambiguity	● Reallocation of project team
	● Losing key competencies
	● Effect on dependent projects
	● Relationship with supplier
	● Competitive position

Figure 4 shows the identified barriers that prolong or block a decision to terminate R&D projects. On the left side the behavioural barriers are listed and on the right side the organisational barriers are listed.

4.2.1 Behavioural barriers

Six different behavioural barriers were identified during the interviews. Those barriers are explained and supported by quotes below. Here behavioural barriers are defined as barriers obstructing the decision maker by behavioural instincts.

4.2.1.1 Sunk costs

A barrier causing projects to be continued rather than terminated is the internal view of sunk costs, causing it to be considered in the decision. The following quotes support these findings:

"[...] then there is no point in not continuing, because it is better to at least get the product, even if it won't be profitable, because otherwise you would just throw this money away." – Interviewee 6

"The time spent, and the money we have put in also matters. [...] If you only have to spend 20 % more to finalise, it is appealing to do so to get the product, and then hope that it will be better than what you actually believe." – Interviewee 3

"Usually we have spent quite some money. Why would we not finalise the project? If you have spent half of the cost of the project why should you stop it. Finalise the project and make as much money as you can with it. And to me this is the wrong approach." – Interviewee 14

Sunk costs seem to be viewed as a motivator to continue the project to get some return from the investments made. However, one interviewee also reflects upon that this is not the right way to think of sunk costs. Moreover, another interviewee also reflected upon how large investments in the early phases cause termination to not be considered as a viable option, as can be seen in the following quote:

“Actually my belief is, because of the front loading, we are putting a lot into the early phase of a project and then in the later phase the project is too super well prepared. And when we are getting at a point in time, I would say basically at the development decision, we have consumed about 30-40% of the total budget. So, if we stop at this level, then the sunk cost is already too big. So, we are always scratching our heads - ah we have spent so much money, we cannot stop it.” – Interviewee 20

Demands on preparation in early phases seem to quickly make the sunk costs so large that the projects are considered to have to continue. Moreover, postponing the decision can cause projects to be continued, as stated by the following interviewees:

“So very often, the time is taking the decision to continue [...] due to sunk costs. It is too late.” - Interviewee 20

“It hurts a lot more to stop a project that has been going on for a longer time, because we have invested more. Because, firstly, it has been going on for longer so that, what is possible to save by stopping the project is much more limited.” – Interviewee 16

Postponing the decision to terminate seems to cause the sunk cost fallacy to make the decision to continue the only viable option. Furthermore, postponing the decision to terminate also shrinks the remaining investments possible to keep from being sunk, which reduces the value of terminating. The following quote shows how sunk costs have to be justified upwards in the organisation:

“We have to justify [to upper management] what we have done for the money and it is compared with competitors” - Interviewee 18

It seems like pressure from upper management and shareholders can cause managers to consider the sunk cost. Moreover, the following quote shows how investments can be viewed from two perspectives:

“Do you want to use what has been spent and go to the end, even if it is not a marvellous project, at least you are doing something out of the money that you have invested. Or do you want to, let's say, protect the money that you will spend.” – Interviewee 21

Either the sunk cost is weighed into the decision to terminate which motivates continuing, or the future investments needed to finalise the project are considered. Moreover, the following quote shows how problems can occur with increasing costs in a later phase of a project:

"It has happened often with this project [that it has increased in costs] [...] So what can be done to finalise and to minimise the increasing costs?" [Another person responding]
"We don't have any choice, push for finish" – Observation in a steering committee meeting, 1/2-2018

It seems like even though there is a problem with increasing costs in this project, it is now so far gone that terminating the project is no longer an option.

4.2.1.2 Social self-justification

Social commitments, argumentation, and backing of different projects can cause managers to be tied to continue a project. This finding is supported by the following quotes:

"Usually there is a reason to why you terminate, and then you have to realise that somewhere you got something wrong or that you misinterpreted things wrong, which is purely human, but that can be hard to admit" – Interviewee 2

It seems like there is an unwillingness to admit earlier mistakes, which can cause people to continue to argue in course with their previous actions. The following quote shows how managers, similarly, can get tied in to a course of action:

"It is first, when for different reasons they have had to put a bunch of prestige into it, that is when it becomes difficult for them [steering committee members] too.[...] It can be a situation where the steering group members or others in the management have to step up, and take a step forward, and say this technical concept will hold and deliver what we should have. If you step up and say this is the way, and it then turns out there is a T-junction ahead, then of course under some circumstances it can be hard to say, ok I was wrong." – Interviewee 12

If it is uncertain how the company should move forward, the management may have to show leadership and support for what they believe in. Later, this causes managers to continue to back their earlier justifications, getting them more and more tied to the original path until they are forced to reconsider.

4.2.1.3 Internal self-justification

Another barrier making it difficult to change course and conclude to terminate a project is the inner conviction and belief that the project is valuable and the right way forward as can be seen in the quotes below:

"Everything is in the head, it is to bring yourself over this threshold, where you, at last, are able to draw the conclusion, that damn - let's skip this." – Interviewee 13

"People refuse to admit that they made a wrong estimation or assumption in the beginning. So it is better to continue. And then the machine is so big that nobody looks back" - Interviewee 22

It seems that first you have to convince yourself that a project has to be terminated. Furthermore, people seem to not want to admit when they got something wrong, which cause projects to continue. Moreover, early processes can add to the internal conviction of the project's importance as can be seen in the following quote:

"When we eventually have started a project [...] then it is in our plans, it is in our budget, and you have prioritised this and thought it is important. [...] And if you have started it, you and the ones involved think that this is so important, and are driving this, and want this." – Interviewee 17

Initial planning and early processes to get the project started seems to make people accustomed to arguing for the project's success. Thus, people's conviction of how important the project is, is increased along the way, making it more and more difficult for them to change their minds.

4.2.1.4 Emotional connection

When a project is started it is not looked at in the same way anymore, making it difficult for the people involved to come to the conclusion that the project should be terminated, as can be seen in the following quote:

"It is a hinder today that, when you are a project manager you have a very hard time to kill your project. It is not really happening today, project managers tend to try and keep their projects alive as long as possible. They try to make it good, until the end, even if it is not possible or needed." - Interviewee 14

"When you are a project member, the project is your baby, and that leads to conflicts because you have a hard time accepting the decision [to terminate]." – Interviewee 17

The managers and project members seem to develop attachment to the project causing them to try to keep the project going as long as they can. Additionally, the following quote indicates that it is difficult to remove products already in the portfolio:

"But it is very hard to remove products and to prioritise between them. Because then it is emotional. That this product we have to have. And when we have chosen what products we want on the market, then it affects what projects we must run." – Interviewee 17

It seems like emotions matter when products are selected and especially when it is regarding whether they should be removed or not. This, in turn, affects which projects to run and how to prioritise between them. The following quotes show how emotional connections to products and technical solutions may hinder.

"When each case can be equally backed by facts, it is the emotions that decide. [...] And it can be where you have your roots, where you have your base, what you believe in most" – Interviewee 1

“It is difficult to kill because it is a pet product. And then it is even more emotions into this. You can’t touch the [a prestige product]. Because it is needed. So, this one is extremely emotional.” – Interviewee 14

“Then there are of course special situations when people start to love their technical solutions, and that sort of stuff. Then it is of course difficult on another level.” – Interviewee 12

When objective data show no apparent correct decision, emotional connections and ties may be what control the decision. The emotional connections seem related to one’s background, personal ties to products, and earlier work in on developing certain products.

4.2.1.5 Fear of failure

The attitude to failure and project termination as a failure can also be a barrier to terminating projects. The following quote supports this:

“A couple of weeks ago I was discussing with one of my colleagues, we are so cautious not to fail, that in the end we are never stopping a single project, even if it is going directly into the wall” – Interviewee 20

The attitude to never fail seems to cause projects to be continued even if there are clear indications it is not going well. Being cautious not to fail leads to people always trying to find an option to continue the project as can be seen in the following quote:

“If it is the wrong technology we have been putting efforts into, [...] then the feelings come in again. Therefore, you want to avoid it and find all possible ways out to make it happen.” – Interviewee 5

When things do not go according to the plan there is an unwillingness to accept one’s mistakes or misinterpretations, causing people to try to continue the project in any way possible. Moreover, terminating a project may be taken as a personal offence:

“And then, as I said, you have spent a lot of money, there’s a bit of prestige in it. You don’t want to be the one to fail, that your project was terminated. Often this is taken personally.” – Interviewee 18

If people take pride in their work and really want to succeed this can cause personal stress and offence when a project they are connected to is terminated.

4.2.1.6 Future ambiguity

How people handle uncertainty and weigh data differently makes it hard to agree on a clear picture of the most probable outcome, which makes it more difficult to come to a decision as can be seen in the quote below:

[What do you believe is the main barrier to termination?] "Uncertainty in what you know about what the outcome will be. It can be differences in opinion in different parts of the organisation. When one part says that this won't add any value, while others say this will provide added value. In that case you have to find out what parts to trust in order to move on." – Interviewee 1

Differences in opinion, in cases of uncertainty, seems to make it difficult for decision makers to know what to listen to in order to get the most accurate picture and to be able to make the decision. The following quote illustrates how uncertainty changes as the project progresses and how that affects the decision:

"If you want to stop it you want to stop it as early as possible, because you have less sunk cost. So the dilemma is, the earlier you are, the more uncertainty you have. Then the less the decision is, let's say, based on facts that are very accurate"
– Interviewee 21

Either you stop early and are less certain about the probability of success, or you wait and gather more data to get more accuracy in your projections. However, waiting also means the sunk cost becomes larger which motivates the decision to terminate to be taken as early as possible. The following quote shows what one of the interviewees believes is the most deciding factor is regarding termination of projects:

"Then I think the most difficult part or the most deciding factor, regarding whether you should terminate a project or not, is connected to our estimate regarding the volumes of a specific product." – Interviewee 1

Accurately estimating the volumes to be sold of the project's outcome seems to be the most difficult, which plays a central role in the decision to terminate or not. Moreover, one interviewee discussed that there is value in learning about the uncertainties you have:

"But we don't know everything about everything. Sometimes you have to start, learn, realise that, hmm, no, we cannot go this way, we should rather go this way."
– Interviewee 18

Learning about things not possible to predict seems to be useful to move the project in the right direction. However, members and managers have to be open to take in new information and to change what was originally planned. Nevertheless, the following quote implies that uncertainty is not considered when making decisions to terminate:

"We cannot stop projects due to uncertainties in 2020/2022. [...] We move on like this and worry about 2020 another day" - Observation in a steering committee meeting, 30/1-2018

The decision maker seems to believe that uncertainties regarding the future should not be considered when discussing termination of a project. Instead problems are postponed to be addressed in the future.

4.2.2 Organisational barriers

Ten barriers were classified as organisational, meaning they are related to the way Volvo GTT is organised and structured. Organisational barriers are defined as barriers affecting the decision to terminate, due to structures, rules and processes as well as by operating in an open market.

4.2.2.1 Separate functions

That the organisation of Volvo GTT is divided into functions is in some cases causing difficulties regarding project termination. Several interviewees have reflected upon this aspect, which can be seen in the quotes below:

"It is also required that many people in the company believe it is bad, in order for it to be closed. It is not enough that only a certain part of the company believes it is not good, because then there might be others that still believe it is good and want to continue." – Interviewee 6

"It is a pretty difficult process [to prioritise and terminate] for us, because there are many functions that need to be involved." – Interviewee 19

The main concern seems to be that there is a large number of functions involved in the decision-making. From a more holistic perspective this functional division also leads to other dilemmas as illustrated by the following quote:

"And this barrier is important I think. We are asking people to execute business decisions or business skills but we are not asking people to continue to think about the business itself. [...] It's about how we have divided the work in the company. We have been facing a lot of constraints, new legislations, new expectations on the market. And then we have added functions, since we are organised in a traditional way. Instead of making sure that everyone understands the full picture we have divided it into smaller pieces" – Interviewee 22

Overall, the functional division increases the risk that the project team executing the project does not understand the complete picture of it. This is a risk also in decision-making, that representatives from the different functions are not completely familiarised with all aspects of the project.

4.2.2.2 Separate brands

The organisational structure with a portfolio of brands can in some cases also prolong the discussion regarding the termination of a project. A number of interviewees discussed this barrier during the interviews:

"The brands are definitely affecting. It happens often that we do not agree between the brands, and that prolongs the decisions." – Interviewee 17

[Regarding organisational barriers] "There might be a lack of a common view between our different brands. They have different markets and strategies, so sometimes there might be a conflict where you don't have same view." – Interviewee 4

Reaching an agreement when the brands have different strategies seems to be a barrier to project termination. One of the interviewees elaborates on why this might be the case:

"Every brand has its own responsibility for its results. And that leads to the effect that you all of a sudden get a very careful, regarding where you invest your R&D money. So, we have had situations sometimes where one brand believes that no, this is not interesting anymore while another brand thinks differently" – Interviewee 16

That the brands have their own accountability appears to give rise to conflicting opinions, due to the brands being really considerate about what projects to pursue or stop. Moreover, these conflicting opinions might block decisions due to the culture within Volvo GTT:

"The probability that everyone is agreeing is pretty low. So I see large difficulties in moving forward, getting right. It becomes a bit like the United Nations Security Council, it is always someone that puts in their veto. And then we get fully blocked." – Interviewee 16

"We have a consensus company, so the point is the consensus, you need a full yes from everyone. Then the no power – one no has the same power as all the yes combined – so it is blocking a lot of things. So we need to escalate, disagreements become a bit difficult." – Interviewee 22

"There are too many that can block or put in a veto against a decision. Even though, if you look at the main criteria to take such a decision, maybe it is three, four or five criteria, and then you might only need approximately five decision makers." – Interviewee 3

That all decisions need to be taken with 100% consensus seems to be a reason to why the decision-making process can be prolonged. This however regards all situations where opinions conflict, and not only due to having separate brands with their own accountability, but also functions.

4.2.2.3 Separate ranges

Another barrier to termination decisions regarding the way Volvo GTT is organised is the separation into different ranges. Especially the division into powertrain and vehicle has been subject to discussion during the interviews, as can be seen in the following quotes:

"Definitely we still have this old powertrain versus vehicle. And unfortunately, because I don't see the value of that... Here in Gothenburg, even when they are on the same site. Believe me it is like a citadel, no one can enter it. So, it is pretty difficult [to cooperate between ranges]." – Interviewee 20

"The organisational structure we have is not always smooth and efficient. Sometimes we see that powertrain have their own isolated race. [...] It varies a bit how it functions in different ranges, it [powertrain] is a bit more closed so to say, it is not open in the same way." – Interviewee 9

It looks like there is a lack of openness between the ranges which gives rise to cooperation difficulties. This issue is further complicated by the fact that the separate ranges is monitored by different steering committees:

"That is I still believe we could be better at cooperating across the borders, internally in GTT, between powertrain and vehicle. [...] We are organised in a vehicle and a powertrain range with different steering committees and governance structure. [...] Which leads to that one keeps up the poker face a bit too long, before you inspect the actual situation so to say which leads to one postponing the decisions."
– Interviewee 13

That one of the ranges appears to be more closed than the other, together with the different steering committees governing the ranges, leads to a prolonging of the decision process.

4.2.2.4 Hierarchic decision structure

That decisions are delegated into several decision bodies, before a final decision is taken, is seen as reason to why the decision process can be hindered. This finding is supported by the quote below:

"We do have so many forums today that need to decide. So, when it is large projects there are pretty many decision bodies it has to go through." – Interviewee 2

The number of decision bodies appears to prolong the decision process. However, the number of decision bodies and the number of members give rise to another possible hinder explained by the following quote:

"And what might be a large organisational barrier is that there are so many that are involved in the decision and governing, that it might take a very long time to realise, that no this is not a good project." – Interviewee 6.

The fact that there are plenty of different representatives involved in taking the decisions is also a difficulty. It seems to prolong the process by increasing the number of people that need to be convinced. This is further elaborated upon by one of the interviewees:

"[To make quicker decisions] if everyone would have been more agile, and had the opportunity or been ready to quickly re-plan. But it is not working like that here, we are following set schedules. And especially meetings and sessions involving upper management. So, it is not easy to arrange quickly there." – Interviewee 16

The pre-set time slots for the decision bodies' meetings appear to make the process of termination longer than necessary. The interviewee suggests a more agile approach to be able to cope with this issue.

4.2.2.5 Demotivation of project team

The motivation of project members will most likely be lowered if their project is terminated. The following quotes show how the motivation of project members may be weighed in to the decision to terminate:

"You sweat on your project, in order to make it happen. But we will stop it. This is not giving the strong momentum or strong motivation. So, in fact it is one of the obvious things why it is not so easy to stop projects" – Interviewee 21

After having worked for a long time on a project, termination will erode motivation, which makes it more difficult to take the decision. The following quote explains how erosion of motivation and handling negative effects of termination is easier in smaller projects.

"In a smaller project there are less people so it is much easier to talk with them face to face. ... If we have engaged 500 people it is much harder to reach the individual. And then it is also the group effect. That people talk, and don't understand the reasoning behind the decision, and then you get a negative effect that has to be counteracted, with a lot of explaining and a plan of what is next." – Interviewee 18

The ability to talk face to face and answering peoples' questions personally seems to be critical in counteracting demotivation and getting people to handle the transition better.

4.2.2.6 Reallocation of project team

When projects are terminated, the employees working on that project lose part of their current job. The need for reallocation of the employees might be taken into consideration during a decision process, as argued by the following interviewees:

"The longer you have come with the project the more people are involved. It is a so-called spending curve that is increasing. During a pre-study you are normally involving a few persons, but then, when you start getting into details, the number of people increases exponentially. And then, when you are in developing phase after concept gate. Then there are really plenty of people. And if you are at this stage and you have to stop, then it is extremely hard regarding the staffing of people. So that clearly makes it more difficult." – Interviewee 18

"It is always difficult to stop a project. Because it means that you have 15 people that are jobless. But it is not a big deal because we can utilise them for something else, it is not a big deal for me. We are not cutting jobs, we are cutting projects, it is completely different." – Interviewee 20

Having tied up employees is a factor that makes it more difficult to terminate an R&D project. The earlier the termination can be made, the less people are involved and hence, the easier it is. However, as argued by interviewee 20 it does not have to be a problem, as long as there are other projects to work on, since stopping a project is not equal to cutting jobs.

4.2.2.7 Losing key competences

Apart from the need of relocation of staff, another aspect of staffing may also be considered when determining whether to terminate a project, as stated by the following quotes:

"What matters then [when thinking of killing a project aiming at improving a star product] is that we will probably quite quickly lose a big part of that competence. And that means that if you want to start again later, then you do not have that key competence in the company anymore. [...] If you stop it, then it is a signal, and there is a big risk that we lose the competent people, that they look for a new position." – Interviewee 4

"Then you have to think twice [when making a decision to terminate] before you mess up. Because these types of resources, competences, those are not anything you pick up on the street. It is people with ambitions, and they will seek new positions if they notice that nothing is happening here, no fun projects." – Interviewee 16

The risk of losing key competences when terminating a project is also an aspect taken into consideration when terminating a project. The types of competences required for developing the technological products are not easily replaced, which is why this might also be a hinder for termination.

4.2.2.8 Effect on dependent projects

Naturally many projects at Volvo GTT are closely linked to each other which also might be a hinder to project termination. Closing down one might give an effect on another project, which is further argued by the following quote:

"The other [barrier] is that projects are tied together. That one project is delivering something that another project needs to have, and is expecting to get. And several projects are an extension of another project. Then some projects become very difficult to terminate. This is also a barrier to stop or adjust the scope of a project." – Interviewee 8

Many projects at Volvo GTT seem to be connected and linked to other projects. Terminating such a project would most likely lead to negative effects on other projects making it more difficult to terminate the actual project.

4.2.2.9 Relationship with supplier

Another aspect that might be hindering a termination decision is the contractual situation with a supplier. The quotes below support this finding:

“But we might have a situation where we have contractual obligations to suppliers, partners etcetera, that might be a structural hinder.” – Interviewee 4

“Quite some time is required [to terminate a project], because most often you have started investing. [...] You have made commitments to suppliers.” – Interviewee 1

To have made commitments to suppliers seems to be a barrier to why projects cannot be terminated. However, it is not just from a contractual perspective this matter is taken into account when considering termination:

“ [...] our projects and components and systems are also dealing with supplier contracts. When you have a business relationship, what kind of an engagement do we have? To whom? And what does it mean? Is it a new supplier? Is it a current one? Will he keep his business or what kind of effort has the supplier made to be part of the project?” – Interviewee 21

That the relationship might be damaged by an eventual termination is also an aspect that needs to be considered when making a termination decision. How this barrier effects termination seems to depend on whether it is a new supplier and how damaging it would be for the supplier's business if the project is to be terminated.

4.2.2.10 Competitive positioning

The want to stay in the current competitive position, or the need to get ahead of competitors, can also be a hinder to termination of R&D projects. The following quotes support that this type of reasoning exists:

“We were tied up there, we had to continue ... we were behind [Competitor X].”
– Interviewee 5

“[The decision to terminate] it is quite influenced by what our competitors do.”
– Interviewee 10

“So, maybe we do not see the profitability, but we just have to have it, to still be able to compete” – Interviewee 10

What the competitors of Volvo GTT do seems to be a hinder to terminate projects. Even unprofitable projects can be continued due to the competitive situation, indicating that Volvo GTT puts a lot of emphasis on what their competitors do.

4.3 Evaluation of identified barriers

In the following section the results based on the questionnaire are presented. Initially a brief overview of the strength of all barriers is displayed. Following, how the barriers are impacted by terminating a project in an early versus late phase is presented. Finally, the impact on barrier strength due to project size is shown.

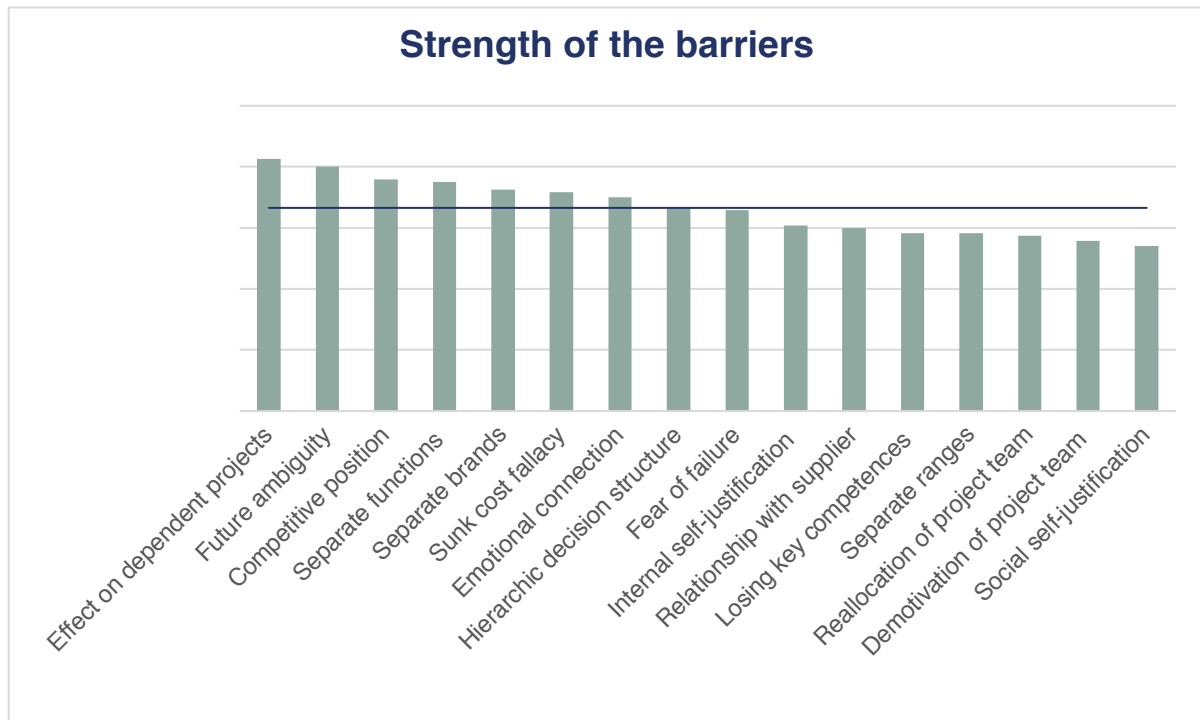


Figure 5 shows the strength of each barrier that has been identified previously by comparing the mean values of each. The mean value of all barriers' strength is shown by the blue line in the diagram to allow for comparison between the barriers.

The barriers to project termination were rated by the respondents of the questionnaire on a rating scale from one to five, where one corresponds to not obstructing the decision and five implies severe obstruction. All barriers that were identified during the interviews are considered to hinder termination decisions on average. As can be seen in Figure 5, the effect a termination decision has on other projects is rated as one of the strongest barriers together with future ambiguity, considering the competitive position and having separated the organisation into different functions. The least prominent identified barriers were social self-justification, demotivation of project team as well as considering reallocation of the project team.

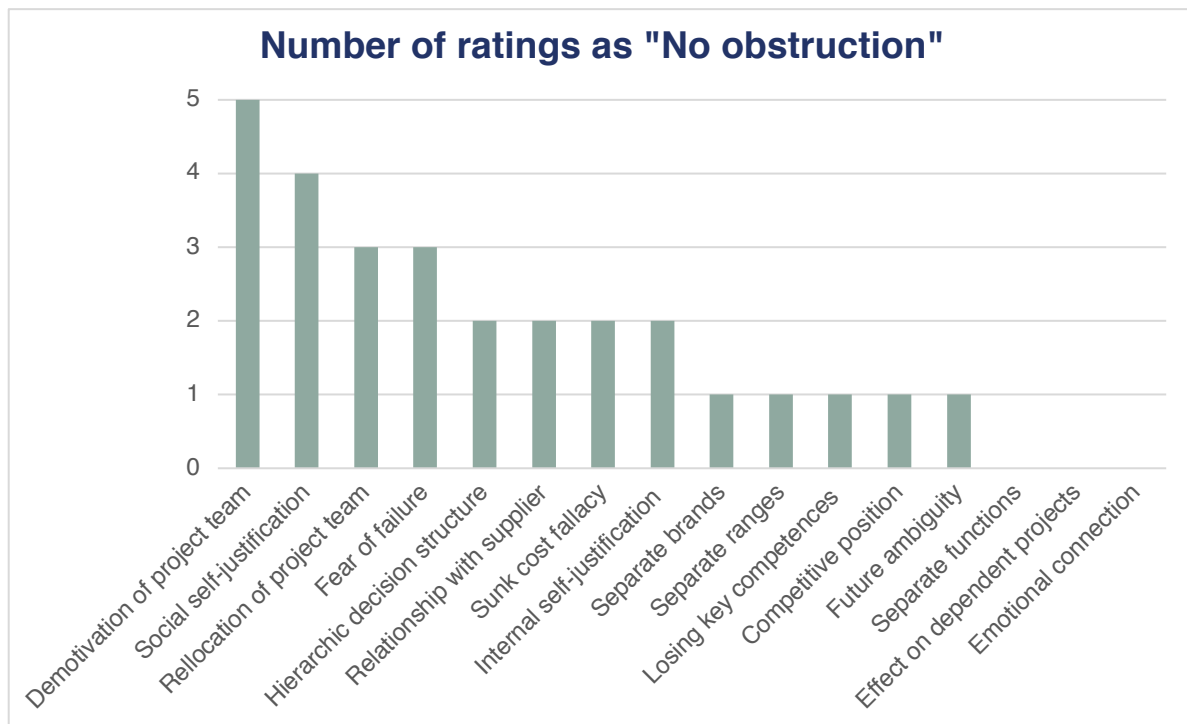


Figure 6 displays the number of respondents that have ranked each barrier as not obstructing the termination decision. On the left the number of times each barrier has been rated as "no obstruction" is displayed.

Even though all barriers seem to hinder the termination decision to some extent, some barriers were by a few respondents rated as not obstructing at all as seen in Figure 6. The barrier considered to not obstruct termination decisions at all by the most respondents was demotivation of project team, closely followed by social-self justification. Three of the barriers were considered to hinder termination by all respondents, namely, separate functions, effect on dependent projects, and emotional connection.

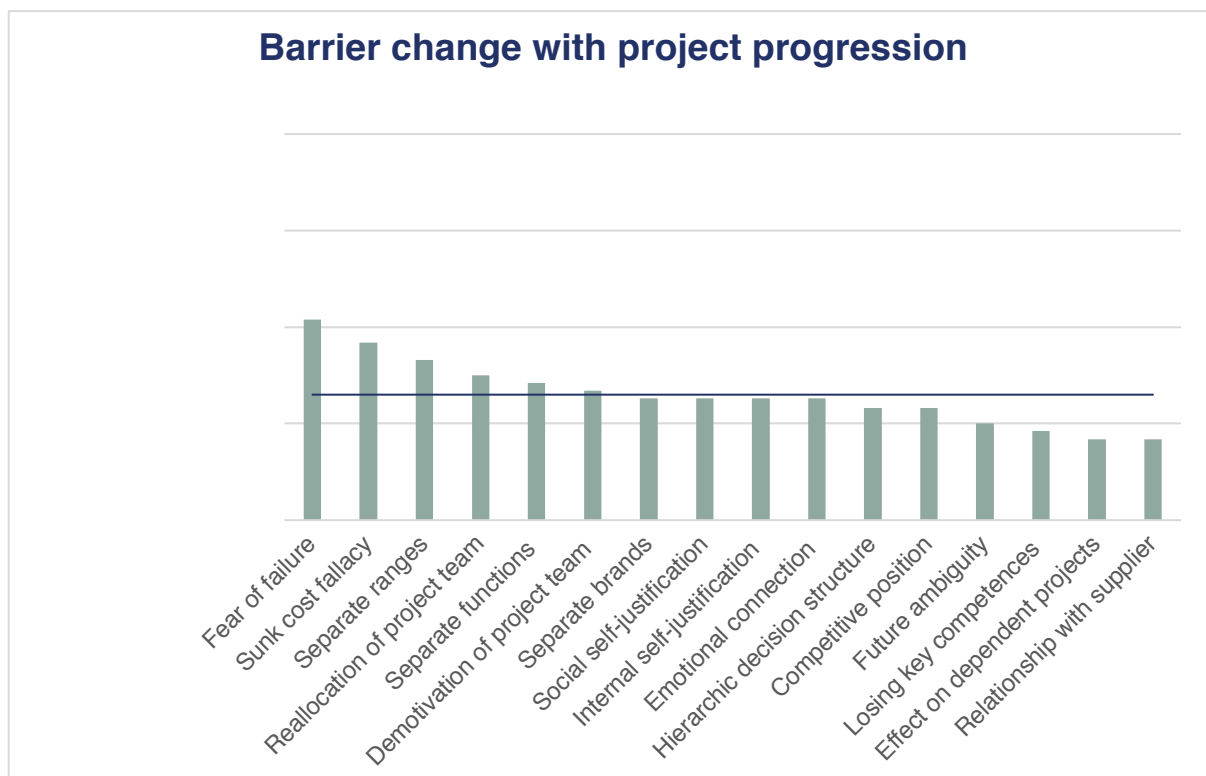


Figure 7 shows how the impact of each barrier changes with project progression. The blue line shows the mean value in changed impact. The change of impact, due to the project being in a later phase, for each barrier ranges from no change, to slightly stronger, to considerably stronger.

The barriers to project termination all change a bit in impact due to how far the project has progressed which can be seen in Figure 7. However, no barriers get more than slightly stronger for late project termination. The barrier that changes the most is fear of failure. Moreover, sunk cost fallacy, separate ranges and reallocation of project team get slightly stronger when the project is in a later phase. Barriers that change the least when the project is in a later phase are relationship with supplier, effect on dependent projects, losing key competences, and future ambiguity.

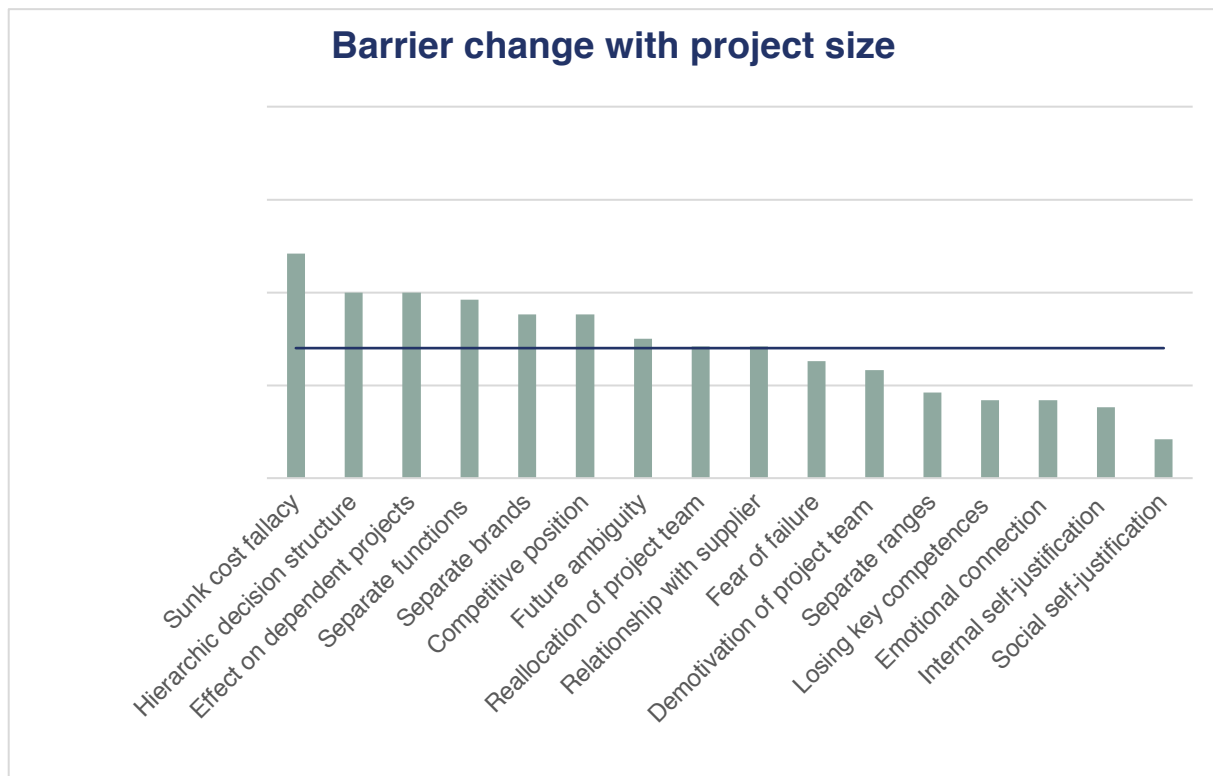


Figure 8 shows how the impact of each barrier is changed with project size. The blue line shows the mean value in changed impact. The change of impact for large projects ranges from no change, to slightly stronger, to considerably stronger, for larger projects.

The barriers to project termination all change in impact depending on the size of the project, as seen above in Figure 8. However, no barriers get much more than slightly stronger for large projects. The barrier that changes the most in impact is sunk cost fallacy, which gets slightly stronger for larger projects. Hierarchic decision structure, effect on dependent projects, and separation of functions also have a slightly stronger impact for large projects. Barriers that almost do not change in impact at all are, social self-justification, and internal self-justification.

5. Analysis

To analyse the results this chapter is divided into three major parts. Initially, how the barriers affect project termination is assessed and each barrier is analysed. Secondly, to further deepen the analysis, possible groupings of the barriers have been made and the overall effects of the barrier groupings are described and analysed. Finally, possible ways to overcome the identified barriers to project termination are presented.

5.1 Effect and dynamics of barriers

The framework in Figure 9 shows how barriers obstruct project termination in different ways, due to behavioural drives or organisational influences. Some barriers affect the decision maker directly, in the ability to take the decision to terminate. Other post decision effects also obstruct the decision maker's ability to terminate projects. Notable is that all these post decision effects are organisational. Lastly, some barriers obstruct the decision process that leads up to the decision to terminate.

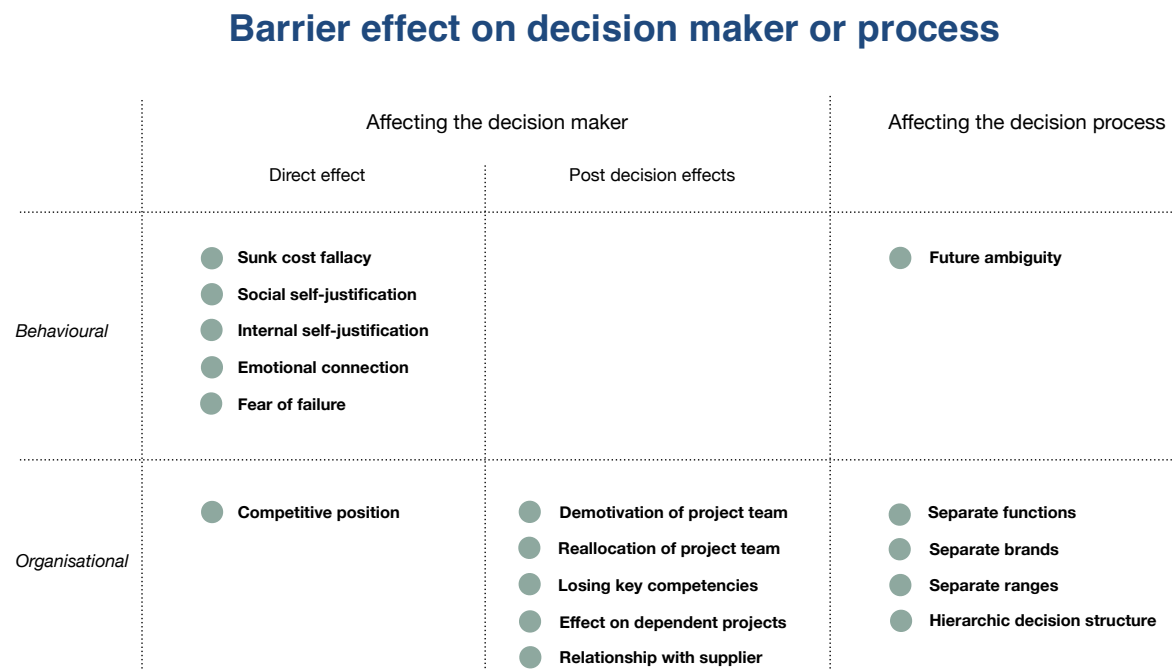


Figure 9 shows how the barriers affect either the decision maker or the decision process. In the left column the barriers that affect the decision maker directly are listed. In the middle column the barriers that affect the decision maker by their post decision effects are shown. Finally, the column to the right shows the barriers that affect the decision process. In the first row for each column the behavioural barriers are listed and in the second row for each column the organisational barriers are listed.

5.1.1 Barriers affecting the decision maker

The barriers affecting the decision maker can do so in two different ways. Either it affects the decision maker directly, or the decision maker becomes affected by post-decisional effects when making the decision. The direct effects are almost exclusively behavioural, and the post decision effects are exclusively organisational.

5.1.1.1 Barriers affecting the decision maker directly

Sunk cost fallacy

Sunk cost fallacy is considered to be one of the strongest barriers at Volvo GTT with regards to project termination, due to its relatively high rating and it being brought up in a large share of the interviews. It directly affects the decision maker since sunk costs are generally seen as a waste and decisions to continue are taken due to the want to get some result from past investments. However, taking sunk costs into account is not rational according to classic economic theory (Arkes & Blumer, 1985). Considering that only two respondents viewed the barrier as not obstructing the termination decision at all, it seems like most decision makers acknowledge its effect. The barrier sunk cost fallacy could also be an explanation to why short-term affordability is one of the most common reasons to project termination. Instead of termination due to a weakened business case, the project is continued to justify previous investments until it is no longer affordable.

Furthermore, if the decision is postponed the building up of sunk cost can cause time to take the decision to continue. Thus, it appears as the postponing of a termination decision cause increasingly negative influences to sunk costs. That the barrier is reinforced by project progression is also supported by the findings from the questionnaire. Moreover, it seems as the decision makers compare future required investments to those that have already been made. The further the project has progressed, the smaller is the remaining investment that can be kept from becoming sunk. This effect is further strengthened by the current way to manage projects at Volvo GTT. The front loading of projects due to demands on preparation results in large sunk costs early in the projects. Thus, the sunk cost barrier is strong even in the early phases.

In addition, as Kahneman and Tversky (1979) have shown, small gains at this reference point are perceived as more valuable whereas further losses at this reference point are perceived as less hurting. Moreover, people's aversion to certain loss cause decision makers, considering project termination and thus choosing between a certain sunk cost versus further investment, to become more prone to take risks in order to have a chance to obtain future gains and avoid certain losses.

The sunk cost fallacy is strongly related to the need for self-justification (Steinkühler et al., 2014; Biyalogorsky et al., 2000). Viewing sunk costs as a waste can cause decision makers to continue with the project in order to preserve their self-image, as productive and good decision makers. Furthermore, that sunk costs are considered might also be related to the barrier fear of failure at Volvo GTT. When past investments are seen as a waste, the motivation to continue might be even stronger to avoid having to admit a failure (Arkes & Blumer, 1985). Further, that interviewees reflected upon that the time sometimes takes the decision indicates that this barrier is linked to barriers prolonging the decision process.

Social and internal self-justification

Being tied to continue a project, in order to protect one's image by acting consistently to earlier social argumentation and commitments, affects the decision maker directly and are regarded as two of the weaker barriers to project termination. Contrastingly, social as well as internal self-justification are strong drivers of escalation of commitment according to Steinkühler et al. (2014) as well as Biyalogorsky et al. (2000). Moreover, self-justification should affect managers on all levels as well as decision makers, as they often need to vouch or bargain for a course of action. For example, steering committee members that have removed obstacles for a project, as part of their duty, can get tied to continue backing the project. Furthermore, social self-justification can be driven by the need to justify investments, and possible sunk investments, upwards in the organisation. Thereby, connecting the barrier social self-justification to the barrier sunk cost fallacy.

The weak rating of the barrier social self-justification could be caused by, either an inability to see the effect on one-self, due to it being so personally linked, or that there is an acceptance to change one's opinion in the company. The difference in rating of the barriers social- and internal self-justification is seemingly surprising as they are closely connected in theory (Staw, 1981). On the other hand, social- and internal self-justification's close rating in how they increase with project progression confirms how they both cause one to become increasingly committed.

The barrier internal self-justification is rated stronger than the barrier social self-justification, which contradicts Staw's (1981) findings, who found the opposite. This may indicate that the low rating of these two barriers should be met with caution. Moreover, the barrier internal self-justification can be closely linked to the barrier fear of failure, as internal self-justification provides one-self with the security of success according to previous actions and outcomes. However, the barrier fear of failure is consistently rated stronger than internal self-justification, which indicates that the barrier fear of failure may be easier to understand or to accept.

Fear of failure

As project termination seems to be seen as a failure, the barrier fear of failure naturally affects the decision maker directly. The barrier is moderately rated, while having relatively many ratings as "no obstruction" indicating opinions differ a lot regarding this barrier. Furthermore, fear of failure increases the most in strength of all barriers, with project progression. Thus, the barrier fear of failure seems connected to the barrier self-justification, which is aligned with Cannon and Edmondson's research (2005) that connects fear of failure to self-justification. On the other hand, the fear should decrease with project progression because of the decreasing uncertainty. However, as the project progresses, the investments and stakes involved increase. Thereby, fear of failure seems to be mostly based on earlier efforts and sunk cost rather than on the probability of failing.

One reason to why fear of failure hinders project termination is the lack of a formal process to termination. This since it may cause project termination to be less normalised and more of an exceptional case. By not having a concrete process, Volvo GTT might miss out on potential learnings arising from the termination. This is related to Cannon and Edmondson's (2005) study, where they found that being afraid of failing can cause organisations to not learn due to the unwillingness to dwell on past failures. Moreover, when learning is not prioritised, failing is seen as an even bigger waste, and the investments as lost, which connects this barrier to the barrier sunk cost fallacy.

Emotional connection

Having established an emotional connection to a certain project is regarded as a relatively strong barrier to termination. This seems to be the common view since no respondent sees the barrier as not obstructing at all. The barrier affects the decision maker directly by skewing the decision to continue due to personal ties. Moreover, background and belonging can make people value the same project differently. Likewise, attachment to a certain project or product can cause project managers as well as decision makers to be over optimistic and under-weigh negative information regarding a project. This can to some extent be explained by the endowment effect, that people tend to ask for more to sell an object that they already own, than if they were asked to buy it (Kahneman et al., 1991). Projects already started can thereby be valued higher than if there would be an option to start it.

In addition, some products that are referred to as "pet products", in the interviews and by Cooper (2008), can achieve a higher status than others. Thus, it seems such products earn an increased assessment and protection from managers. Furthermore, Cooper (2008) argue that the increased emotional connection to this type of products can lead to a poor combination of projects getting special treatment at gates while having a higher failure rate. Thereby, it seems important to note that the project should to be separated from the product, and that issues regarding a project should not be overlooked and no special treatment should be given projects just because of the connection to a certain product.

The size of the project does not seem to influence the barrier to the same extent as other barriers. Thereby, it seems the felt ownership of a project is not so affected by the project size, rather that it is the ownership itself that matters. However, the barrier gets stronger with project progression, most likely since that gives the decision makers time to develop an emotional connection to certain projects.

Competitive position

An organisational barrier affecting the decision maker directly is taking the firm's competitive position into account when evaluating a project. Considering that this is the third strongest barrier and that all respondents except for one viewed it as hindering termination, this barrier seems to be prominent. Comparing with other barriers, this barrier does not get much stronger with project progression. The logic of this can be viewed in two ways. As a project continues it is likely that more information regarding competitors is revealed. When the information reveals that competitors are ahead progression would increase the strength. On the other, hand if the

information reveals that competitors are not as far along as thought, progression would weaken the barrier. The barrier is considerably strengthened with project size compared to the other barriers. This seems logic as larger projects tend to be more strategic by nature, implying more focus is put on competitive reactions and the competitive landscape. Furthermore, due to the strategic component of this barrier, it is likely to obstruct termination the most if no alternative solution is available.

Strong focus on competitors and being committed to winning the development race on specific features can cause one to get locked in to R&D projects with decreasing payoff. Nevertheless, in order to not become over optimistic and be subject to competitor neglect, Lovallo and Kahneman (2003) argue that decision makers should take the competitive position into account. Solely taking own projects into consideration and ignoring competitive moves can be devastating for a company. Thus, bearing in mind the moves of the competitors can reduce the risk of Volvo GTT being over optimistic and might also help reduce escalation of commitment. However, in situations where the competitive landscape forces an upgrade or development of a certain product, lacking alternative solutions to the project can force the firm to continue with a project even when the business case is eroding.

5.1.1.2 Post decisional effects affecting the decision maker

Demotivation of project team

In order to keep up momentum and not erode motivation, decision makers may think twice about terminating a project, due to this post decision effect. As demotivation of project team has one of the lowest ratings in strength and the most number of ratings as “no obstruction”, this barrier is regarded as of having lower impact. However, the barrier does increase more than the mean with project progression, suggesting the barrier is largely based on sunk effort and commitment built over time.

This barrier can be connected to the barrier losing key competencies in the sense that it could be the loss of motivation and interest of people with key competencies that would lead them to seek employment elsewhere. However, demotivation of project team mainly regards the people who stay within the company. This is related to the finding by Balachandra et al. (1996) that it is important to find new positions for project members that match their skills in order to not erode motivation. Furthermore, that face to face communication and personally explaining the termination decision can ease the transition for the project team was reflected on in interviews. Hence, it seems rational to consider demotivation in the termination decision, however the barrier also seems possible to manage.

Reallocation of project team

When terminating a project, the project team lose their current task and thus the team members need to be relocated to other positions or projects. Balachandra et al. (1996) argue that this gives rise to issues with scheduling and planning and is further heightened by the issue of finding a position matching the competence level of the employee. If new positions cannot be found, some project team members might have to be fired, which can give rise to exit costs that are also taken into consideration when terminating a project (Havila et al., 2013).

Even though reallocation of the project team seems like a rational consideration, it appears as if it is not so strongly considered since this barrier is among the weakest identified. This indicates that reallocation is not an issue at Volvo GTT, most likely due to the large number of R&D projects being undertaken each year. However, the barrier gets stronger with both project size and progression. This seems natural because of the increasing number of people being involved in the project at later stages, as well as in larger projects. Thus, it becomes increasingly difficult to handle the transfer personally as well as finding a suitable position for all.

Losing key competencies

Ensuring that key competencies in the company are not lost due to project termination is a post decision effect that affects the decision maker. If people with key competencies cannot be reallocated to relevant projects and if they feel the company is not heading in a direction that is of interest for them, people may seek employment elsewhere. Thereby, key competencies built up over a longer period of time can be lost quickly and may be difficult to regain. As losing key competencies cannot be matched to theories found during this study, this barrier and its negative influence on R&D project termination can possibly be a newly identified barrier. However, as argued previously, there might be a link between this barrier and demotivation of project team. That this barrier has not been identified previously could however be explained by the highly technical nature of Volvo GTT's products, since specialised competences are required which are difficult to find.

This barrier should arguably increase for competencies closer to the company's core technologies. Moreover, competencies of decreasing importance due to technological shifts should be of less concern when terminating projects. Hence, the importance to consider losing key competencies would be highly dependent on the type of project under consideration. As losing key competencies is below the mean rating in strength and is not affected much by either project progression or project size the barrier is viewed as of having a lower impact in most cases.

Effect on dependent projects

The post-decision effect a termination has on other projects is the strongest of all barriers identified, and no respondent viewed it as not hindering, implying there is a consensus regarding it being a barrier to termination decisions. Often projects are supplying parts to other projects which makes them difficult to stop. Naturally, the larger the project, the stronger this barrier gets since large projects tend to be related to more projects, and hence the effect increases. As effect on dependent projects cannot be matched to theories found during this study, this barrier and its negative influence on R&D project termination can possibly be a newly identified barrier.

Comparing to the other barriers the effect on dependent projects is not considered to be affected to the same extent by project progression. Although it is strengthened, it is not strengthened much compared to the other barriers which appears odd since it is likely that more projects being related to the evaluated project are started at a later phase. Thereto, it should also be strengthened due to the fact that there is less time to find an alternative solution in the later phases.

Arguably, considering synergy consequences seems rational. However, projects might not only be linked to each other, but also merged and bundled together. In such cases, less successful projects may be hidden among others, due to difficulties in assessing the projects' separate business cases.

Relationship with supplier

Harm to the relationship- or breach of contract with suppliers is a post decision effect affecting the decision maker, which can hinder or block project termination. The strength of this barrier is rated relatively low. However, claims for breach of contract can be substantial, which in that case similarly increases the barrier to termination. Moreover, the change of the barrier strength with project progression is rated the lowest of all barriers, which contradicts the reasoning that more suppliers would be contracted the longer the project has progressed. The relative average increase in strength with project size may be caused by more suppliers being affected as well as larger commitments by and to suppliers.

Exiting a contract can directly add to the cost of terminating a project, in cases of contract exit fees and similar. This increase in termination cost can be connected to real options theory, which shows that an increased termination cost decreases the value of project termination (Dixit & Pindyck, 1994). Furthermore, Havila et al. Salmi (2012) argue that compensation for redeployment of both employees, materials and equipment should be considered when deciding about project termination. Thus, it seems rational that the relationship with suppliers may influence decision makers to continue a project. The existence of this barrier could be explained by not terminating early enough, causing suppliers to be tied up, thereby Volvo GTT has to consider supplier relationships when terminating R&D projects.

Generally, on the post decision effect barriers

As seen in Figure 9 all these post decision effects are organisational, which indicates they have a common source. This group of barriers can be argued to all trace back to how the organisation is set up to handle project termination. The barriers demotivation of team, reallocation of human resources, and losing key competencies, are all connected to how the organisation transitions people to new projects or other tasks. Furthermore, the barrier effect on dependent projects can be argued to depend on how clear the negative effects of termination will be on other projects and if there are methods in place to preserve the outcome of dependent projects in the event of termination. Moreover, the barrier relationship with suppliers can be connected to how contracts are written with the possibility of project termination or not and if actions are taken to preserve the relationship or not.

5.1.2 Barriers affecting the decision process

Future ambiguity

There seems to be two reasons to why future ambiguity is rated as the second strongest of all barriers. Firstly, the inability to fully predict outcomes means there is room for people to act on personal belief and try to convince the decision maker. This makes it difficult for the decision maker to accurately weigh the received information. Thereby, the barrier future ambiguity affects the decision process by causing longer discussions and evaluations. Additionally, Kahneman and Tversky (1972) as well as Heath and Tversky (1991) argue that people use their personal background and experience to judge future outcomes and handle ambiguity differently. Thus, this barrier could also be argued to affect the decision maker directly.

Moreover, two major sources of uncertainty can be distinguished from the interviews, namely product outcome and sales volumes. Considering these two major sources of uncertainty it seems logic that the barrier would increase with project size, as larger projects tend to have larger sales volume and the outcome having larger impact. Confirming this, the barrier future ambiguity is rated to increase about average in strength with project size. On the other hand, future ambiguity is rated to increase a bit with project progression, which is odd, due to that the uncertainty generally decreases as the project progresses. However, the investments and stakes increase with project progression. Thus, indicating future ambiguity is connected to the barrier sunk cost fallacy, and less to the actual probability of success.

Separate functions

Having an organisational structure with separate functions is seen as a relatively strong barrier, and is recognised by all respondents implying it is a quite important barrier. The large number of functions being involved when decisions are to be taken leads to long discussions and possibly also a delay of a termination decision. This can be connected to Fredrickson's (1989) findings that separation of functions causes political bargaining, which often is time consuming. Thus, having separated functions at Volvo GTT affects the process of taking the decision and even if all representatives, but one, believe a project should be terminated the project is continued due to the consensus culture. The influence of separate functions as a barrier to R&D project termination decisions was not found in theory, which may be explained by its close connection to the specific context and structuring of the organisation. Thus, the barrier separate function seems to be a newly identified barrier.

Following this reasoning, it becomes clear that the barrier is strengthened by project size as well as progression since more functions become involved in larger projects and at later stages. Involving several functions also gives rise to collaboration issues since the functions focus on different things. Thus, as Maylor (2010) states, it is of high importance that the functions involved in a project collaborate well in order to achieve the overall. Furthermore, there is also a risk that the representatives only look at project variables related to their specific function and not the overall picture.

Separate brands

Similar to having a functionally separated organisation, the division into separate brands also influences the decision process. The brand division is also considered as relatively strong, and is affected by project size in a similar manner as the barrier separate functions. This is because larger projects tend to involve more brands at Volvo GTT which can cause long discussions. Similarly to the barrier separate function's connection to the specific context, this barrier could not be found in theory, indicating it is a newly identified barrier.

Moreover, the brands' individual sunk cost could also be an explanation of why the barrier is strengthened by project size. This since the brands' separated accountability and performance metrics can spur conflicting opinions and consideration of sunk costs. Moreover, the barrier also seems to connect to the barrier hierarchic decision structure to some extent. Larger projects are escalated to decision boards where representatives from the brands are present, which can lock up discussions due to the consensus culture.

Separate ranges

Similar to the barriers separate functions and separate brands, dividing steering committees and having specialised ranges can obstruct the decision process and is a new barrier identified. This barrier mainly obstructs through the difficulties in cooperation between the separated ranges powertrain and vehicle. This in turn can cause decisions to be sub-optimised by failing to weigh in consequences in the other range. Furthermore, this can also be connected to Fredrickson (1989) who argue that separation of specialised knowledge can lead to political bargaining causing longer discussions before decisions can be made.

This barrier is relatively weak compared to other barriers and does not increase much with project size. This can to some extent be explained by the decision structure at Volvo GTT, that large projects are evaluated in the same decision body no matter which range it belongs to.

Hierarchic decision structure

That projects are evaluated and decided about in hierarchic steps can be time consuming due to set schedules for steering committees and decision bodies, causing projects to sometimes have to wait for the decision body of authority to meet. Both the number of decision bodies together with the number of people involved in the decision, can be seen as reasons to this being a barrier to project termination. However, its strength is only average compared to other barriers.

The barrier is not affected considerably by project progression, most likely since the decision bodies, and thus the number of hierarchical steps, are still the same regardless of how far the project has progressed. For larger projects the barrier increases in strength, probably due to the fact that larger projects need to pass several decision bodies before an actual decision can be taken.

5.2 Grouping of barriers

Some barriers seem to affect the termination decisions in similar ways, which is illustrated in Figure 10 below. Having structured the organisation in separate functions, brands and ranges causes long discussions and extensive bargaining regarding the decision, which prolongs the decision process. A further implication of this is that the prolonged decision process leads to increasing sunk costs, which in turn makes the decision even more difficult to make.

Furthermore, some of the barriers all cause skewed assessment of projects when considering termination due to decision biases. All barriers in this group increase the perceived value of continuing, or decrease the perceived value to terminate the project which causes the decision maker to postpone the decision to terminate. Moreover, these barriers all seem connected to one another. Thus, a decrease in one barrier would most likely cause the others to decrease as well. As an example, a decrease in sunk cost should partly also decrease the barriers fear of failure, as well as social and internal self-justification. This due to less fear of making earlier investments sunk as well as a decreased need to justify earlier investments made.

The last group of barriers concerns post decision effects that cause human resource management (HRM) issues. This group of barriers is thus dependent on how well project termination, and the relocation of team members, is managed. Comparing these groupings by looking at their mean strength it becomes clear that the strongest effect is longer discussions and bargaining, due to the organisational divisions.

Barrier group effects

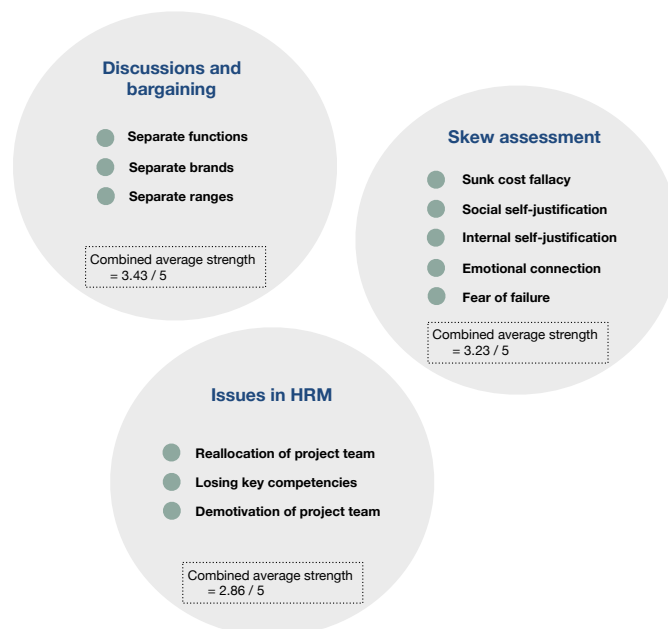


Figure 10 shows how some of the barriers can be grouped based on their effect on project termination. In each circle the barriers that cause similar effects are grouped and their combined average strength, is displayed in the bottom of each circle. In the top left circle, the barriers that cause long discussions and political bargaining before a decision to terminate can be taken are presented. In the middle right circle, the barriers that skew decision makers' assessment in the event of project termination are presented. Finally, in the bottom circle, the barriers that cause human resource management issues in the event of project termination are presented.

Considering what gives rise to the barriers, instead of the effect, the groupings made are still consistent. The discussion and bargaining grouping exists due to the organisational structure. The skew assessment grouping exists due to different cognitive errors. The issues in human resource management exist due to how project termination is managed. Analysing the other barriers, some additional patterns to what give rise to the barriers can be revealed. Both the barriers competitive position as well as effect on supplier relationships arise due to external circumstances of the project. The barriers hierarchical decision structure and effect on dependent projects both arise due to how projects are managed at Volvo GTT. The barrier future ambiguity on the other hand, arises mostly due to uncertainty regarding volumes and market changes.

Out of all the barriers, four barriers have been identified as the most obstructing barriers to project termination at Volvo GTT, which in the following order are; effect on dependent projects, future ambiguity, sunk cost fallacy and competitive position. The most prominent barrier appears to be the barrier effect on dependent projects. It has been rated as the most hindering barrier by the respondents, it increases relatively much with project size, and it can in some cases block project termination. The barrier future ambiguity is also regarded as one of the most obstructing barriers, due to its effect on both the decision maker as well as the decision process and its connection to the barriers sunk cost fallacy and fear of failure. Sunk cost fallacy is seen as a prominent barrier due to several reasons and not only due to its rating. Taking sunk costs into consideration when evaluating projects was one of the hindrances being brought up by the most interviewees. Furthermore, this barrier strengthens a number of other barriers, such as self-justification, fear of failure and separate brands. Lastly, the barrier competitive position is viewed as a highly obstructing barrier due to its high rating in strength and relatively strong increase with project size. Moreover, the enclosed strategic component of the barrier competitive position can be used as a strong argument against project termination.

5.3 Overview of solutions to overcome the barriers

By considering what barriers obstruct project termination the most, as well as what gives rise to the barriers, possible improvement efforts are suggested, as seen in Figure 11 below. The suggestions have been created based on the findings from the analysis in combination with theory to ensure high impact and suitability. However, since some barriers seem to be more rational than others, this has also been taken into consideration when evaluating where efforts should be focused. The possible solutions mainly regard changes to the existing way of managing projects, as well as to how projects are evaluated and how decisions are framed. That all barriers increased with project size and project progression indicates that the most elementary solution to decrease the barriers' strength would be to run smaller sized projects with shorter delivery time.

Suggested solutions

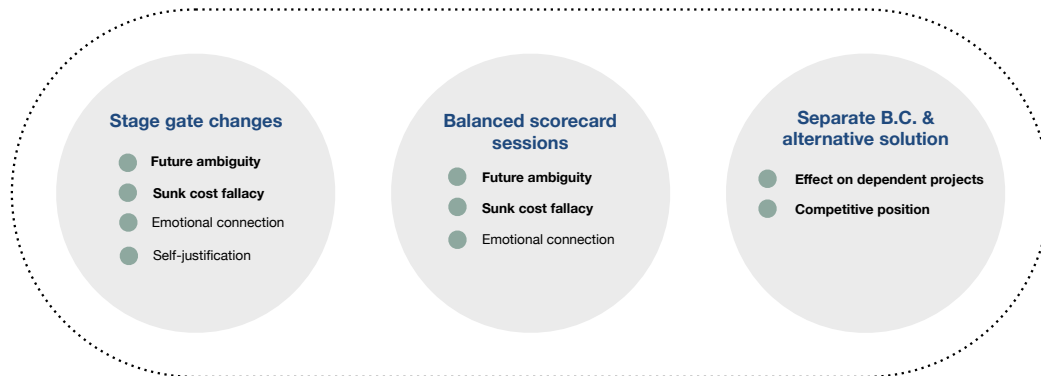


Figure 11 shows three main changes suggested that will help Volvo GTT to reduce the barriers. The most prominent barriers are marked in bold font and some additional barriers that can be reduced are marked in normal font. The left circle shows how changes to the stage gate and how having predetermined decision rules can reduce the barriers future ambiguity, sunk cost fallacy, emotional connection, and self-justification. The middle circle shows how changes to how decision making can be made using scorecards and the nominal group method can reduce the barriers future ambiguity, sunk cost fallacy, and emotional connection. The right circle shows how having separate business cases and alternative solutions can help reduce the barriers effect on dependent projects and competitive position.

5.3.1 Stage gate changes

Changes in the way projects are managed at Volvo GTT will have positive effects on several of the identified barriers. Modifications to the stage gate should be one of the first changes. Cooper (2008) points out that projects often are let through gates, without being stopped even in cases where the gates should not be opened. As this seems to also occur at Volvo GTT, some modifications to the stage gate model should be implemented, in order to lower the barriers sunk cost fallacy and future ambiguity, but also emotional connection and self-justification. First of all, initial investments and lump sum costs should be kept at a minimum followed by gradually increasing investments. Furthermore, the projects should be run in smaller iterations in early phases of the project, allowing for several review points and more opportunities to pivot. Thereby, sunk costs are minimised when uncertainty is high resulting in better risk management, as well as in an increased ability to pivot or terminate the project when needed (Cooper, 2008; Dixit & Pindyck. 1994).

Moreover, defining predetermined rules to when a project should be terminated is an initial step to making better and more timely decisions. Predetermined decision rules should however, as pointed out by Boulding et al. (1997), not be set up by the decision makers themselves. Instead, it is of high importance that these targets are specified by someone external to the final decision. By implementing a predetermined decision rule in this way for project termination, the barriers sunk cost fallacy and self-justification can be further reduced.

In addition to this, to enhance the decision making further, Volvo GTT could change who is taking the go or terminate decision as suggested by Ross and Staw (1987) as well as Boulding et al. (1997). To some extent Volvo GTT achieves this effect by their current structure of escalating decisions. However, as Volvo GTT keeps the same decision maker throughout the

whole project this effect, of changing decision makers, could be further improved. Thus, the barriers related to escalation of commitment, namely sunk cost fallacy, self-justification, emotional connection and fear of failure, could be lowered by implementing new decision makers for termination decisions. Since escalation of commitment is strongly linked to project progression, the shift of decision maker should only be implemented at later stages in the project. Comparing to implementing a predetermined termination rule, this suggestion however requires more time to be put in place. This since, the new decision maker needs to be fully informed about all aspects of the project.

5.3.2 Balanced scorecard sessions

To further lower the barriers to project termination, projects should be evaluated using balanced scorecards and the nominal group method at gate decisions and for project termination decisions. Projects should be evaluated on the six criteria; strategic fit & importance, product & competitive advantage, market attractiveness, core competencies leverage, technical feasibility, and financial reward vs. risk, as suggested by Cooper & Edgett (2006). Furthermore, the nominal group method lets decision group members first rate a project individually, followed by a group discussion about differences in the individual ratings, to finally let the decision makers rate the project individually again. Thereby, highlighting differences in members' assessment and focusing on letting decision makers converge to a similar rating. Thus, emotional connections and individually skewed assessments should be decreased, while allowing the group to reach consensus quicker. Furthermore, this method should allow for more ambiguity neutral- and improved high-risk decisions (Keck et al, 2014), thereby aiding to overcome the barrier future ambiguity. Furthermore, the current opportunity cost of continuing to invest should be highlighted when framing the decision to terminate, in order to overcome the aversion of certain sunk costs, and thus reduce the barrier sunk cost fallacy (Northcraft & Neale, 1986).

5.3.3 Separate business case and alternative solution

In addition, projects should strive to always be attached with a plan b or an alternative solution, increasing flexibility. Thereby, decision makers will not to the same extent be locked in to continue due to the barrier competitive position. From the earlier parts of the analysis it became clear that bad projects can get hidden among good projects and cause the barrier effect on dependent projects, found as the most prominent barrier, to hinder project termination. Thus, by always having separate business cases were synergy effects from dependent projects are specified the barrier effect on dependent projects should decrease. The complexity of Volvo GTT's final products implies that all parts need to be integrated and work as a system, thus projects will remain dependent and this barrier is difficult to overcome. Furthermore, considering the effect on dependent projects seems rational. However, as suggested earlier, having alternative solutions to consider can help reduce this barrier to some extent. Especially, if the only reason to continue a project is that it is critical to other projects.

6. Conclusion

In this chapter the research questions are answered. Thereby the purpose of the study, to explore how Volvo GTT comes to and takes the decision to terminate an R&D project and what might obstruct such a decision, can be fulfilled. Furthermore, this chapter presents how the study creates value for practitioners as well as suggests possible future research areas of interest.

6.1 Answers to the research questions

How does Volvo GTT come to the decision to terminate an R&D project?

Most commonly the termination process is initiated at one of the decision points in the stage gate model. In order for a decision to be taken, the project goes through several hierarchical steps to be escalated to the correct level of decision authority. The insight leading to project termination can either come bottom up, from the project team or top down, from the decision bodies, which was found most common. Moreover, several reasons to terminate an R&D projects have been identified. Negative internal or external changes can cause the business case of a project to erode, motivating project termination. Most commonly these changes lead to an increased project cost and decreased feature performance, which in turn leads to projects being terminated due to affordability issues. Furthermore, projects aimed specifically at meeting legislations can become undesirable due to legal changes. Several options to avoid project termination have also been identified. Most commonly projects are rebalanced, by adjusting the scope, in order to fit the overall budget. Other options to avoid project termination include slowing the pace of the project, pausing the project, or to merge projects in order to utilise synergies.

What barriers exist that obstruct R&D project termination and which barriers are the most prominent at Volvo GTT?

Several barriers hinder projects to be terminated at Volvo GTT. The barriers can be divided into barriers affecting the decision maker or affecting the decision process. Furthermore, the barriers that affect the decision maker can do so either by a direct effect or by a post decision effect. The barriers directly affecting the decision maker are sunk cost fallacy, social and internal self-justification, emotional connection, fear of failure and competitive position. The other type of barriers which affect the decision maker by post decision effects, include the barriers demotivation of project team, reallocation of human resources, losing key competencies, effect on dependent projects and relationship with supplier. Lastly, the barriers affecting the decision process are future ambiguity, separate brands, separate functions, separate ranges and hierarchic decision structure. All barriers to R&D project termination were found to increase with project size and project progression.

Out of all identified barriers four are considered to be the ones most prominent to project termination at Volvo GTT. The effect on dependent projects is seen as the barrier being the most hindering to terminate projects. In addition, future ambiguity is the second strongest

barrier to project termination. Thereto, considering sunk costs when evaluating a project seems to be the third strongest barrier, closely followed by feeling a need to continue due to the competitive position and competitor's moves.

How can the barriers to project termination be reduced or overcome?

Lowering or overcoming the barriers to R&D project termination can be achieved through changes to the existing way of managing projects, as well as to the way projects are evaluated, and how decisions are framed. The solutions are mainly aimed at overcoming the barriers identified as the most prominent. To enhance the decision-making ability regarding R&D project termination the following solutions are suggested. Early R&D project investments should be kept minimal and further investments should gradually increase. A level at which R&D projects are to be terminated should exist, as well as be predetermined by an external party. Moreover, new decision makers can be introduced in later phases of the project.

R&D projects should be evaluated using balanced scorecards and the nominal group method. Moreover, the opportunity cost, due to other investments available, should be highlighted in the framing of the termination decision. Furthermore, projects should strive to always have an alternative solution. Finally, projects should always have separate business cases where possible synergy effects to other projects are specified.

6.2 Implications for practitioners

The barriers sunk cost fallacy, future ambiguity, and emotional connection were found to be the three most prominent barriers of behavioural nature, and thereby less dependent on the specific context of the organisation. Furthermore, the most prominent organisational barriers, effect on dependent projects and competitive position, should apply to most companies that run more than one project and operate in a competitive market. Thus, these five barriers to R&D project termination should be of highest interest to identify and overcome for practitioners in general.

Clearly there are barriers tying decision makers to continue with a course of action that are both behavioural and organisational. In contexts of rapid change and high need for flexibility such barriers are expected to be increasingly detrimental. The framework, found in Appendix III, with behavioural and organisational barriers, of direct effect on the decision makers, post decision effects affecting the decision makers, and barriers affecting the decision process, could help practitioners and researchers to identify and map possible barriers. In doing so, they can get an overview of barriers to decision making, which should aid the process of overcoming said barriers in order to improve R&D resource allocation. Furthermore, as no similar framework was found in theory or previous research the developed framework is regarded as a scientific contribution.

6.3 Implications for future research

Since this study is focused on one single case company and the findings of this thesis most probably are affected by the context, the generalisability of the results and its applicability to other industries is to some extent limited. Thereby, future research could add to the scope of this report by examining project termination decision-making in other companies and industries. By exploring how similarities and differences between different contexts affect the identified barriers, central context variables could be highlighted, expanding the generalisability and application of this thesis. Specifically, the organisational barriers seem more likely to be context specific, which is why this area should be of most interest to expand the generalisability of this study.

Several previous studies have been focused on exploring escalation of commitment theory, while little is focused on the organisational influences on decision making and project termination. Thus, there seems to be a need for future research in the field of organisational influences that may aid or obstruct decision makers.

Since previous literature has focused mainly on some specific parts of the identified barriers, and not on generating an overall picture, further research could also be conducted regarding the relationship between barriers to decision making. Thereto, research could also be focused on analysing which barriers strengthens other barriers, to see if some barriers have a more central effect than others and give further insights to how improvement efforts should be focused.

Furthermore, using this thesis as a starting point, a future research topic could also be to try to identify and set up a framework on how a project termination process should be set up to minimise the risk of being hindered by the identified barriers. This should be of most interest for companies working with R&D projects.

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Appendix I – Interviews with Volvo Group

Interview template 1

This interview template regards all interviews held with representatives from different functions that have some relationship to the decision process

Background questions

- Could you shortly describe your role at Volvo?
- Could you shortly describe your relation to the decision process?

Questions asked regarding the decision process

- Could you describe the decision process regarding whether a project should be terminated or continued?
 - o What is required for a project to be terminated?
 - o Which parameters are used to determine whether to preserve or terminate a project?
 - How do these parameters differ between different types of projects?

Questions asked regarding barriers to terminate projects

- Which barriers do you believe can prolong the decision process or lead to projects not being terminated?
 - o What emotional and psychological barriers do you believe exist?
 - o What structural barriers do you believe exist?
 - How do you believe these affect the decision process?

Based on all the discussed barriers:

- o How do you think the barriers differ between class 1, class 2 and class 3 projects?
- o How do you think the barriers differ depending on how long the project has been undertaken?

Questions asked regarding terminated projects

- Have you been involved in any project that has been terminated and if so, which?
 - o Why was the decision to terminate the project taken?
 - o According to you, was the process to make the decision efficient?
- Based on your experience, can you think of any project that you believe should have been terminated that was not?
 - o If yes, which one?
 - o Why do you think it was not terminated?

Interview template 2

This interview template is the one used during all interviews with the chief project managers.

Background questions to the project

- Which type of project was it?
- How many persons were working on the project?
- What was the budget for the project?

Questions asked regarding the project termination

- Why was the project terminated?
- How did the discussion about termination start?
- To what extent were you involved in the decision to terminate the project?
- Did you have any additional information that you think may have affected the decision?

Questions asked regarding seen barriers during the termination

- Which underlying barriers do you think may have prolonged the decision to terminate a project?
 - o What emotional and psychological barriers do you believe exist?
 - o What structural barriers do you believe exist?

Based on all the discussed barriers:

- o How do you think the barriers differ between class 1, class 2 and class 3 projects?
 - o How do you think the barriers differ depending on how long the project has been undertaken?
- How did people in your surrounding react to the project being terminated?

Appendix II - Questionnaire

The questionnaire regarding the sixteen identified barriers was formulated in such a way that the same questions were asked repeatedly for all 16 barriers. Thus, the template presented below illustrates how the questions were formulated and in what order they were asked. The template was repeated for each barrier, and the only thing changing from barrier to barrier was the name and naturally also the explanation. Moreover, the questionnaire was divided into two parts, where the first focused on the structural barriers and the second on the behavioural barriers.

Questionnaire, 2018-03-27

“Barrier name”

“Explanation of the barrier”

- Please rank the strength of the barrier
 - 1 No obstruction
 - 2
 - 3
 - 4
 - 5 Severe obstruction

- How is the barrier affected during the following conditions:
 - Large project (compared to small)
 - -2 Considerably weaker
 - -1 Slightly weaker
 - No change
 - +1 Slightly stronger
 - +2 Considerably stronger

 - Late termination (compared to early)
 - -2 Considerably weaker
 - -1 Slightly weaker
 - No change
 - +1 Slightly stronger
 - +2 Considerably stronger

Appendix III – Framework to identify and map barriers

Affecting the decision maker			
Direct effect		Post decision effects	
<i>Behavioural</i>	<i>Barriers obstructing or hindering the decision maker by direct behavioural effects</i>	<i>Barriers obstructing or hindering the decision maker by post decision behavioural effects</i>	<i>Barriers obstructing or hindering the decision process by behavioural effects</i>
<i>Organisational</i>	<i>Barriers obstructing or hindering the decision maker by post decision behavioural effects</i>	<i>Barriers obstructing or hindering the decision maker by post decision organisational effects</i>	<i>Barriers obstructing or hindering the decision process by organisational effects</i>