CHALMERS
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Evaluating cross-border product development practices

A case study on resource deployment in problematic product development projects, and the effect of operations strategy on the resource deployment

Master's thesis in Quality and Operations Management

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CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2020
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Report No. E2020:024

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Abstract

This thesis aimed to evaluate the strengths, weaknesses, improvement-areas, and root-causes of the case company's product development practices. The case company had one product design office each in two European countries, and one shared location for manufacturing and materials sourcing in a third European country.

The thesis consists of a failure analysis case study of four problematic product development projects. The scope included analyzing the projects from three major perspectives: the influence of operations strategy, of organizational structure, and of early actions in the projects. The scope also included an analysis of a minor perspective: the communication of project information.

The study focused on experiences and information about the projects gathered from employees that were directly involved. Four interviews with representatives from upstream and downstream departments were conducted for each project. Conclusions were then drawn based on similarities and differences between the interviews and previous research into the main literature areas mentioned above.

The study found that the nature of the problems in the individual projects varied greatly, as expected, and that there were indications of similarities and differences based on in which country the development projects originated in. However, no evidence supports the notion that any cultural differences were a root-cause.

The researchers were able to conclude that the resource deployment had missed the target in the problematic projects, and that the formulation and communication of an operations strategy should assist the case company to avoid similar problems in the future. The study also concludes that the co-writing of project specifications should mitigate experienced uncertainties, and further recommends designing a new product development process to improve the execution of complex projects.

Keywords: *operations strategy, resource deployment, project organization, product development, project management*

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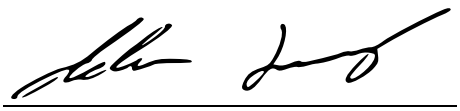
Acknowledgements

This thesis was conducted during the spring of 2020 at *Chalmers University of Technology* as the final part of the researcher's *Master of Science (M.Sc.)* degree in Q*uality and Operations Management*. We both agree that this thesis has been a worthy final assignment in our studies, and that the knowledge we've acquired during our time at this master's programme was invaluable for the thesis' completion.

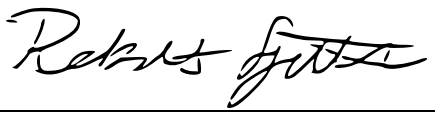
The researchers would like to especially acknowledge and thank all the individuals that were both involved and contributed to this thesis. First and formally, our challenging supervisor *Lars "LT" Trygg*, associate professor at *Chalmers University of Technology's* division *Innovation and R&D Management*, for his input and feedback throughout this thesis. Secondly, the case company's representative that initiated and supported this master's thesis. Thirdly, all of the participants from the case company that astonished us with their cooperative and transparent mindsets during both formal and informal interactions. Fourth, our friends and family that supported us throughout the thesis.

On an ending note, we are truly grateful for how both the case company and *Chalmers University of Technology* enabled us to conduct and complete this thesis, despite the current COVID-19 pandemic.



Adam Liljenberg

Gothenburg, June 3rd 2020



Robert Sjövall

Gothenburg, June 3rd 2020

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1 Introduction

This section contains an introduction to the research conducted as part of a master's thesis at the Chalmers University of Technology. The introduction was divided into several segments to simplify the understanding of the thesis's context. The segments are background, problem statement, scope, limitations, and a thesis outline.

1.1 Background

A senior manager from the European organization of the case company initiated the work on this thesis. The senior manager wanted to, with an academic perspective, gain a better understanding of the European organization and how it operates. The European organization had, in recent years, experienced potential differences in the operations' execution of projects. Obtaining new information and perspectives about the current organization of the European operations was seen as a way to base future improvement-decisions on facts. Therefore, the senior manager was interested in getting a current-state understanding of the European organization, including its strengths, weaknesses, improvement-areas, and root-causes.

Additional information about the case company, its context, and background is provided below in the next section *The case company*.

1.2 Problem statement

This thesis aimed to evaluate strengths, weaknesses, improvement-areas, and root-causes in product development practices in the case company. As the departments are collaborating through product development projects, a handful of recently executed projects became the basis for the research analysis. The analysis did, in four parts, analyze the product development practices and reviewed literature.

The approach of the analysis was to gain an understanding of the product development practices in general while focusing on a failure-analysis of recently executed projects deemed as '*problematic'*. The investigated projects were studied to determine why they were deemed problematic, and if the problems were unique for that project and/or location. The choice of problematic projects was predetermined by the organization. The analysis also considered how to deal with the identified causes. The research questions below were generated to reach the aim of the study:

RQ1. Why were there problems in the studied projects?
RQ2. How were the causes of the problems in the projects similar/different depending on the project's origin?
RQ3. How can these problems be avoided in the future?

1.3 Scope

This thesis includes a study of past product development projects in the case company. The authors analyzed the projects from three perspectives: influence of strategy on the projects,

influence on organizational structures on the project, and the influence of actions taken early in the projects. The scope also includes analysis of the communication of project information.

The study focused on information about the projects gathered from employees that were directly involved in the projects. Conclusions could then be drawn based on similarities and differences between the interviews and previous research in the areas described above.

1.3.1 Limitations

The research was limited to the European operations of the case company, more specifically to the locations in Sweden, Germany, and Poland. The study did not deal with data from non-European parts of the organization. The research did not investigate or analyze the dimensions of change management, organizational culture, and national cultures present within the European operations, as this would require a far too comprehensive and extensive scope, potentially affecting the research quality negatively. However, the emphasis is still placed on these dimensions, potentially affecting the European organization's business performance.

The research was also limited to studying only a handful of projects, focusing on projects considered, for any reason, by employees as problematic. The limit meant that researchers did, in fact, not conduct a project success/failure-analysis, but instead, limited it to a failure-analysis of projects exceeding deadline and/or cost target. Projects executed before the sweeping organizational changes to the European organization in 2008 were deemed irrelevant for the research. The research only studied projects were employees with direct experience of the project were available.

To keep some level of comparability between the projects, the researchers selected projects with an execution time of more than nine months and less than 36 months. The projects should also have been initiated within the last 36 months to avoid outdated findings. The study was also limited to new product development projects that involved upstream and downstream departments from two countries. In addition to this, projects were only studied if they had more than 8 people assigned to the project team, and less than 25 people actively involved at any time. The research was limited in terms of interviewee perspectives as no non-technical employee or individual outside the organization was interviewed.

Project management surfaced as a topic of interest during the exploratory phase. The researchers limited the study of project management practices to the first stages of project management. This is reflected in the frame of reference.

1.4 Thesis outline

This thesis is structured as follows:

- Section 1 (*Introduction*) describes what principles were used to guide the research, such as the problem statement and the limitations.
- Section 2 (*The case company*) presents the case company that was studied. This section includes information that will help the reader understand the context of the findings.
- Section 3 (*Methodology*) describes how the study was conducted and argues for the choice of methodology.

- Section 4 (*Frame of reference*) gives the theoretical framework needed for the analysis and discussions in this thesis.
- Section 5 (*Empirical findings*) presents the findings of the study. The section contains descriptions of four projects, the first two originating in Sweden, and the third and fourth originating in Germany. These are individually described in four sub-sections (5.2.1, 5.2.2, 5.3.1, and 5.3.2). The description of each project contains a general description, a description of the problems, followed by more findings grouped in specific areas for clarity.
- Section 6 (*Analysis and discussion of findings*) contains the answers for the first and second research questions. The analysis is divided into three sub-section. The first sub-section (6.1) contains an individual analysis for each of the two Swedish projects, followed by a common analysis of both projects. The next sub-section (6.2) has the same contents, but for the projects originating in Germany. The third sub-section (6.3) gives an analysis of the differences and similarities between projects from the two countries. The fourth sub-section (6.4) contains an analysis of all four projects on an aggregated level.
- Section 7 (*Further discussion and recommendations*) includes the answer for the third research question in the form of recommendations for the case company based on the analysis. It also includes a discussion on the methodology that was used, and on different perspectives of what constitutes a problematic project.
- Section 8 (*Conclusions*) concludes the thesis by giving summarized answers to the research questions and suggestions for further research.

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2 The case company

The case company is a multi-national organization with offices and manufacturing plants located in nine nations across the world. The case company is a developer and manufacturer of HVAC-systems (heating, ventilation, and air-conditioning), mostly dedicated to commercial vehicles in both the on-road and off-road segments, such as buses and construction equipment vehicles.

The case company is supplying a mix of small-, medium-, and large-sized enterprises. Products developed by the case company are usually highly customized, and the company supplies mostly lower-volume segments of these markets. It is worth noting that the European organization is not limited to only supplying the European market.

The information in Table 2.1 shows the locations of the European departments. Other departments exist within the European organization; however, these are outside of the scope of this study. Across the European organization, the Swedish and Germany sites collaborate with the Polish manufacturing plant through stage-gate processes with product development projects.

Table 2.1 - The case company's European sites and development departments

Location	*Poland*	*Germany*	*Sweden*
Development departments represented	Manufacturing engineering	Sales	Sales
	Production	Design engineering	Design engineering
	Sourcing	Senior management	Test and validation
	Customer Service		
	Quality		
	Sales (minor)		
	Design engineering (minor)		

The European organization went through a significant change in 2008, with the case company moving from having all European operations in Sweden, to build a manufacturing plant in Poland. Only the design engineering, sales, and testing departments were left to operate in Sweden after this event. The organization added and integrated a German design engineering department into the European organization in 2018. The purpose of the design engineering department in Germany was to supply the European on-road bus market. The development projects originated in Germany would focus on creating platforms that could then be customized for specific customers. The projects originated in Sweden differed from this since they usually had one customer per project.

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3 Methodology

The methodology section consists of the research strategy, research approach, chosen data collection methods, and ethical considerations deemed relevant for the thesis.

3.1 Research strategy

Given that the research questions were of a qualitative nature focused on the employee's experiences and perspectives regarding project execution, thus, data required characteristics of both descriptive and behavioral natures. Based on Yin (1994), a case study structure was chosen because of its ability to collect a broader set of data from interviews when contemporary events and behaviors are the main focus. Additionally, with qualitative research questions, it can be concluded that a qualitative research strategy approach was the best fit for this case study, because of how that research strategy is outlined towards collecting descriptive data (Taylor, Bogdan, & DeVault, 2016). Furthermore, the study was conducted mainly using inductive reasoning, meaning that qualitative empirical data was gathered, followed by a generalization and analysis of that empirical data with the reviewed literature (Taylor et al., 2016).

The research was primarily based on a failure-analysis of projects that were perceived, for any reason, as not being executed impeccably (i.e., 'problematic'). Before the acquired project data was aggregated to enable generalized conclusions in the case study, each project was treated as a sole entity.

3.2 Research approach

The study's research design was in a timeline divided into six phases, as presented below in Figure 3.1. A non-linear approach during the first three phases was valuable as reflective insights following the first interview phase necessitated additional literature reviewal. The initial rationale behind designing these initial three phases in a non-linear manner was to mitigate the risk of irrelevant data being collected during the more comprehensive second interview phase. Throughout all the interviews, the researchers were provided and supported by project-related documents.

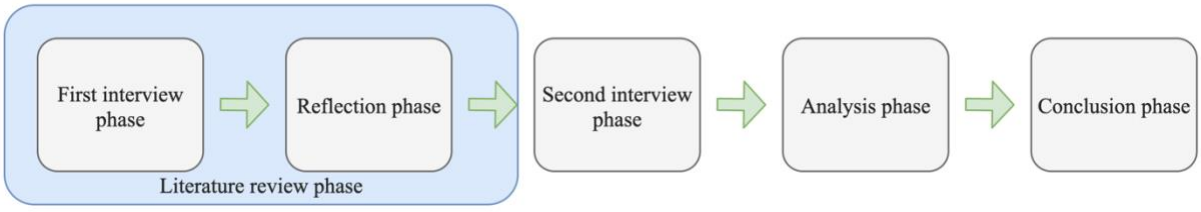

Figure 3.1 – Timeline visualization of the research approach (size does not represent resource allocation)

To further clarify the research approach before going into the phase's details below, the width of the focus changed throughout the research following a double diamond approach, as seen below in Figure 3.2. The focus widened in the phases that diverged, which allowed for an exploration of additional insights. The focus was narrowed in the convergent phases, allowing for comparability in data.

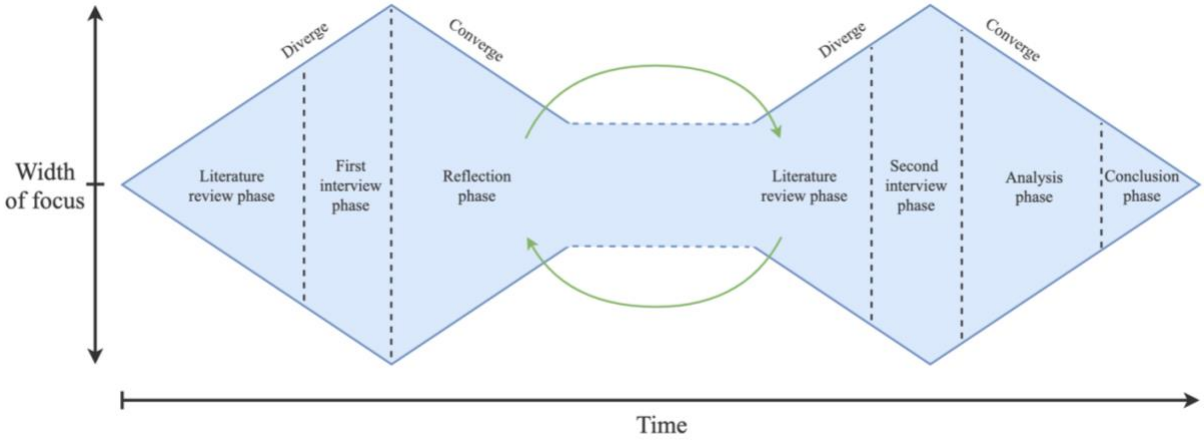

Figure 3.2 – Double diamond research approach

3.2.1 Literature review phase

Several literature publications related to the research area were reviewed throughout the duration of this phase. A spreadsheet has been used, in which information about each reviewed publication was inserted along with an abstract about its contents. A simple categorization of the publications into more general literature areas made the spreadsheet more coherent. This enabled the spreadsheet to act as a database, which provided the researchers with a comprehensive outline of the entire reviewed literature. All literature determined relevant for the research is found in *4 Frame of reference* below.

In preparation for the first interview phase and its interview template questions, the researchers focused on a broader exploratory approach reviewing several literature areas without going into too much depth. Additionally, the researchers emphasized an open-minded approach to each literature publication, as to not prematurely exclude its potential relevance regarding the research questions this early in the research. This enabled an opportunity to utilize pre-determined and standard interview templates found in reviewed literature areas. Therefore, the reviewed literature areas and the pre-determined interview templates became the basis in the creation of two interview templates, which was the initiating step of the first interview phase.

Following the first interview phase, the research had now advanced into the reflection phase. Here it was determined that additional literature reviewal was, as expected, required, both in terms of more publications from already reviewed areas as well as new areas. An iterative approach throughout this phase meant that the extent of new literature areas and the comprehensiveness of the already relevant literature areas could be increased, simultaneously, by continuously examining the relevance with the initial interview findings, as they were transcribed and easily accessible for both reading and discussing. Noteworthy, the researchers did not put the same emphasis on having an open-minded approach to each literature publication, as seen before the first interview phase. This was rationalized as the context of the company, and the research questions were more precise than before.

Resources remained available to this phase until the end of the reflection phase. Before the second interview phase, the researchers finalized and categorized all reviewed literature publications into both literature areas, which ended both the reflection and the literature review

phases, and therefore, initiated the first step of the second interview phase – the creation of the final interview template.

3.2.2 First interview phase

The purpose of this phase was both to explore the applicability of the initially reviewed literature and to gather general knowledge about the product development organization. Following the planning report, the first interview phase had two focus-orientations. One focused on exploring the general organization and provide insights into the employees of the product development practice, and one focused on providing insights by exploring the individual perspectives and experiences from the execution of the 'problematic' *Project 1* (company suggested this project to be researched first). Appropriately, the researchers deemed it suitable to create two separate interview templates, one per focus-orientation. The pre-determined templates found during the literature review phase were slightly modified to include influences from other, potentially relevant literature publications.

For the first interview round, the researchers conducted a total of eight one-hour interviews (four per template). The interviews were carried out with employees from both the Swedish site and the Polish site as these sites were both involved in *Project* 1. Each interview lasted about one hour. For the interviews regarding the general exploration of the organization and its context, the researchers had no prerequisites for whom to interview other than to have two interviewees from each of the mentioned sites. For the interviews regarding the execution of *Project 1*, the researchers had two prerequisites on whom to interview. Firstly, to have two interviewees from each of the mentioned sites. Secondly, having each site-specific pair of interviewees from two different (e.g., hierarchical) perspectives on the project.

Dividing up the interviews evenly between the sites was deemed rational as it provided the opportunity to gather insights from both activities up- and down-stream in the development process. The first four interviews were carried out according to the initial research approach, on-site in Sweden. Unfortunately, due to the COVID-19 outbreak, changes had to be made to the research approach, as with Poland closing their borders rendered traveling there impossible. Instead, the final four interviews were carried out, individually, via conference calls. Transcription of the interviews finalized this phase. These transcriptions will not be summarized or presented as part of the empirical findings.

3.2.3 Reflection phase

Reflection of the initial interview findings was conducted by the researchers verbally going through the transcriptions of the interviews while concurrently summarizing statements into groups of literature areas. This resulted in an instrumental reflection as the alignment between review literature areas, and initial interview findings created a clear picture of which areas to focus more on, which to drop, and in which new areas to further review literature. In some way, this phase acted as the calibration of the literature areas and their depth-levels, whether it was, e.g., non-existent or too deep. Throughout this iterative approach, the researchers informally informed and verified the current approach and progress with the supervisor.

The main goal of this phase was, therefore, to mitigate the risks of capturing data with insufficient quality (e.g., no comparable capabilities) in the more comprehensive second interview phase; thus, reducing the risk of rendering irrepresentable conclusions.

The final steps of the reflection phase were presenting and discussing the reflection progress with the supervisor, followed by updating the company contact about our progress and perspectives. After receiving positive feedback from both parties, the researchers advanced to the second interview phase. This implied the completion of both the reflection and the literature review phases. Additionally, the research questions could not anymore be modified.

3.2.4 Second interview phase

The purpose of this phase was to collect data relevant to the literature areas reviewed and determined relevant during the iterative reflection and literature reviewal phases. The interview in this phase solely focused on the execution of four 'problematic' projects. Therefore, one new interview template was created to accommodate and reflect the totality of the literature review output.

This interview round became the most comprehensive one as focusing on the execution of four 'problematic' projects resulted in a total of 16 interviews. Two of the projects originated at the Swedish site, two originated at the German site, and all four were later finalized at the Polish site. The researchers had similar prerequisites as in the project-oriented part of the first interview phase. Firstly, per project, to have two interviewees from each involved site. Secondly, per project, that each site-specific pair of interviewees had two different (e.g., hierarchical) perspectives on the project. This resulted in a total of 16 conducted interviews, four with the Swedish site, four with the German site, and eight with the Polish site. The interviews lasted 60 minutes each.

It seemed suitable to maintain the same division between the sites as done in the first interview phase, as the different perspectives it provided were valuable. Furthermore, due to the COVID-19 outbreak, all travels were banned. This unfortunate situation was solved by re-designing the research approach, as done in the first interview phase, to carry out all 16 interviews, individually, via conference calls. Transcription of the interviews finalized this phase.

After the first two interviews in this phase, the researchers evaluated the data gathered with the new interview template and found that an adequate level of comparability was conceived. Therefore, it was decided that the interview template was to remain in use throughout the remaining 14 interviews. Transcription of the interviews will finalize this phase.

3.2.5 Analysis phase

The researchers first had to make sure that each project, with four interviews each, were treated individually to enable a practical analysis of the findings from the second interview phase. This was done to mitigate the risk of prematurely generalize and synthesize an understanding without considering all perspectives, i.e., deemed rational as it had the potential of revealing individual project- and site-specific characteristics not representative in the entire observed organization. The transcriptions of the 16 interviews were grouped in their respective four projects, with four interviews per project.

The interview transcriptions from each project were then verbally discussed between the researchers while concurrently the answers and the contexts of each of the projects, both directly related to the research questions as well as additional non-direct and potentially valuable insights, were summarized. This provided the researchers with four project-specific summarized findings. The reasoning for also considering and summarizing the non-direct insights was that these insights could collectively be of value and relevance for the research questions.

Because of the different characteristics of the data, the researchers emphasized on having a very structured approach for this critical step in the study, as to maintain a certain aggregated and structured mindset without jumping to conclusions, focusing on specific details, or failing to realize critical factors. Therefore, in striving to reduce the oversight complexity and to increase relevance for the research questions, the analysis process in this phase was divided into four parts, as shown by the numbered overlapping areas in Figure 3.3 below. When finalizing each of the four parts, researcher consensus was established as a prerequisite before advancing.

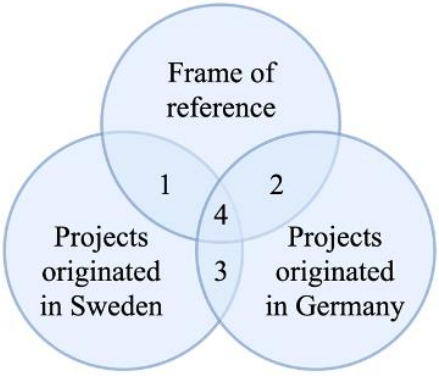

Figure 3.3 – The four overlapping areas indicate the four parts of the analysis

First, the researchers analyzed the findings from the two projects that originated in Sweden compared to reviewed literature and the research questions. The approach was to relate and analyze each of the two project-specific summarized findings with the reviewed literature and the research questions. After this was done two times, the researchers could generalize and summarize the 'projects originated in Sweden' concerning the reviewed literature, thus concluding the first part of the analysis as researcher consensus was also achieved.

Second, following the same setup as in the first part, this analysis was conducted with findings from the two projects originated in Germany compared to reviewed literature and the research questions. After this was done two times, the researchers could generalize and summarize the 'projects originated from Germany' concerning the reviewed literature, thus concluding the second part of the analysis as researcher consensus was also achieved.

Third, as one of the research questions was focused on the potentially different approaches between the Swedish and German sites, this analysis was conducted by comparing the findings from the first and the second parts of the analysis. This analysis was very straight-forward as the two site-specific findings already were generalized and summarized in the context of the review literature, thus allowing for a cross-examination utilizing the reviewed literature

context. When the findings from the specific cross-examination were completed and summarized, and the researchers had reached their consensus, this third part of the analysis was concluded.

Fourth, this analysis was conducted by utilizing and generalizing the findings from the third part and comparing those with the reviewed literature. This was the final, most generalized, and the most aggregated level of analysis in this study, aiming to identify significant characteristics (e.g., strengths, improvement areas) representative for the entire observed organization. This final part of the analysis was concluded once the findings were summarized, and the researches had reached consensus.

All the documentation of underlying arguments and summarized findings at each level was critical to enable effective finalization, as the analysis findings were discussed with the supervisor to reach a consensus. The entire analysis phase was finalized once a collective consensus was reached.

3.2.6 Conclusion phase

Using the findings from the analysis phase, the researchers could, in this phase, engage with answering the research questions. Once consensus was reached about the research questions being answered and underbuilt by sufficient arguments, the researchers could now deduce conclusions.

Specific deliverables, implications, and recommendations that are of relevance for the company are scheduled to be presented to them after the process for academia.

3.3 Data collection

Three data collection methods were chosen for this study, namely: literature review, documents, and interviews. The rationale behind this choice was that they, in combination, deemed suitable enough to enable the collection of an adequate level of data quality.

3.3.1 Literature review

The initial literature reviewal was focused on going through literature publications the researchers already had access to from the recent years studying, and the relevance of these initial publication was estimated based on the introduction to specifics of the master's thesis, and the company communication that led to that introduction. Additionally, the supervisor provided some additional valuable literature publications early-on to provide more perspectives. Later, during the reflection after the first interviews, a more concentrated and data-driven literature reviewal was deployed.

Throughout the study, a spreadsheet has been used, in which information about each reviewed publication was inserted along with an abstract about its contents. This enabled the spreadsheet to act as a database providing a comprehensive outline of the reviewed literature publications, while also simplifying returning and re-exploring certain literature publications. These publications were informally categorized into literature areas, which is the term mostly used by the researchers throughout the study, to make the entire spreadsheet more comprehensible.

Emphasizing on having this structured approach in the literature review was rationalized by the fact that the literature data will have a significant impact on the reliability of the study.

3.3.2 Documents

This method acted as the supporting method for the two other data collection methods. The purpose of this was to enable a better-generalized understanding of the contexts of organization, its process, and to provide additional perspectives of the project contexts. The company was very transparent towards the researchers, providing insights into the project-, process- and organization-related documents.

3.3.3 Interviews

Conducting on-site interviews in a synchronous audio-visual setting enabled the researchers to collect the additional behavioral data, as that setting made it possible to read unspoken cues, such as body language by the interviewee's (Waller, Farquharson, & Dempsey, 2016). According to Easterby-Smith, Thorpe, & Jackson (2015), being able to collect the additional behavioral data requires the researchers to be sensitive and skilled enough to both understand the perspectives of the interviewees, and to allow for individual reflection in their answers. However, because of borders closing due to the COVID-19 outbreak, trade-offs had to be made that led to the majority of the interviews being carried out off-site, while still being in a synchronous audio-visual setting but utilizing conference-call software. The researchers deemed that this alternative with off-site was still a suitable option for data collection. In an attempt to be both effective and efficient, the researchers decided that all interviews were moderated by the same researcher, while the other one was in charge of transcription and fill-in questions.

Easterby-Smith et al. (2015) emphasize that an interview setup approach needs to be decided before conducting any interviews. This decision was made through reviewing the type of research questions (e.g., qualitative, quantitative), how these questions are to be answered (e.g., use-cases, literature), and what requirements the collected data from the interviews had. The collected data required a level of comparability to answer the qualitative research questions, while also being exploratory, resulting in a semi-structured setup as the logical choice (Easterby-Smith et al., 2015; Waller et al., 2016).

Waller et al. (2016) state that determining the number of interviews required to collect sufficient data is a very complicated task, but with the two iterations of interviews in this study, the researchers were able to specify a more realistic total number of interviews required after the first iteration. Waller et al. (2016) continue by stating that it is essential to have a diverse range of interviewees in the data collection, as the more diverse the interviewees' perspective is, the smaller the number of required interviews will be. The research was designed so that four different perspectives per project would be investigated, which allowed the researchers to keep the number of interviews as low as possible. These perspectives were defined by the researchers as varying in both hierarchical position and project-role.

3.4 Ethical considerations

The ethical dimension of this study was essential to consider throughout the study, as with the involvement of external participants, such as interviewees, sharing their experiences and perspectives puts a responsibility on the researchers to act professionally and with integrity (Bryman, 2012). Bryman (2012) continues by discussing a handful of relevant ethical principles, in which the participants of the study should be treated with respect and any risks with participation in the study should be communicated clearly. Aligned with Bryman (2012), the researchers emphasized the meaning of informed consent to all participants, stating that the provided data and identities will be confidential, therefore, mitigating any risk of the study's result to harm their employment status or future opportunities. The consent form was based on a form presented by Taylor et al. (2016), and it can be found in Appendix A.

3.4.1 Environmental considerations

Conducting this study with the purposed approach, as seen above, across three European nations would put a strain on the environment due to the necessity of traveling. It could have been argued that the entire study should be conducted at the researcher's currently enrolled university, Chalmers University of Technology, in Gothenburg, Sweden, and therefore, reducing the total environmental impact of the study.

As the researchers considered both the environmental impacts and the complexity of the travel plan, the research approach, therefore, strived to minimize the amount of traveling by airplane, i.e., minimizing the number of visits for on-site interviews. Traveling domestically to visit the site in Sweden, was done by train. However, as previously stated, due to the COVID-19 outbreak, the research design had to be changed to no longer include any international traveling; therefore, significantly improving the study's environmental impact.

4 Frame of reference

This section consists of all the literature deemed relevant and applied in the research analysis. To make this substantial section more apprehensible, the researchers designed the layout to adhere to a general perspective of organizations, from top to bottom, going through the dimensions of the organization, its processes, and the methods and tools. The detail-level was also embodied within the layout, with it becoming more detailed as the reader progresses through this section.

4.1 Strategies in development organizations

In general, there are three different hierarchical levels of strategies, each with their unique scope, level of detail, and timeframe (Hofer & Schendel, 1978). Figure 4.1 below exemplifies the context of these three strategic levels. The functional strategies are the lowest, contain the most details, and has the shortest timeframe out of the strategies (Hofer & Schendel, 1978), and they should, apart from being a reflection of the more aggregated *business strategy*, also consider their interrelations to one another (Brown & Blackmon, 2005; Slack & Lewis (2017).

Figure 4.1 – Hierarchical example of strategies in an organization

Organizations can take different approaches (with varying levels of success) to development projects (Wheelwright & Clark, 1992). It is common to have a conventional approach to development projects where a *technology strategy* and a *market strategy* influence the projects directly in an unstructured way. However, Wheelwright & Clark (1992) presents the *development strategy framework* that illustrates a better approach that makes use of, for example, aggregate project plans that would more effectively enable e.g., decision-making and resource planning (Hayes & Wheelwright, 1984). Firms that strategically organize their development approach in such a way are likely to perform better in the *development*- and *performance objectives* (Slack & Lewis, 2017; Wheelwright & Clark, 1992); these objectives are later described more in detail. Based on the development strategy framework discussed by Wheelwright & Clark (1992) and *operations strategy* discussed by Slack & Lewis (2017), Figure 4.2 below suggests an illustration of how the business, technology, market, and operations strategies' contexts could be visualized in an organization that are, partly or solely, conducting development projects. The interrelations with other strategies are later described in more detail.

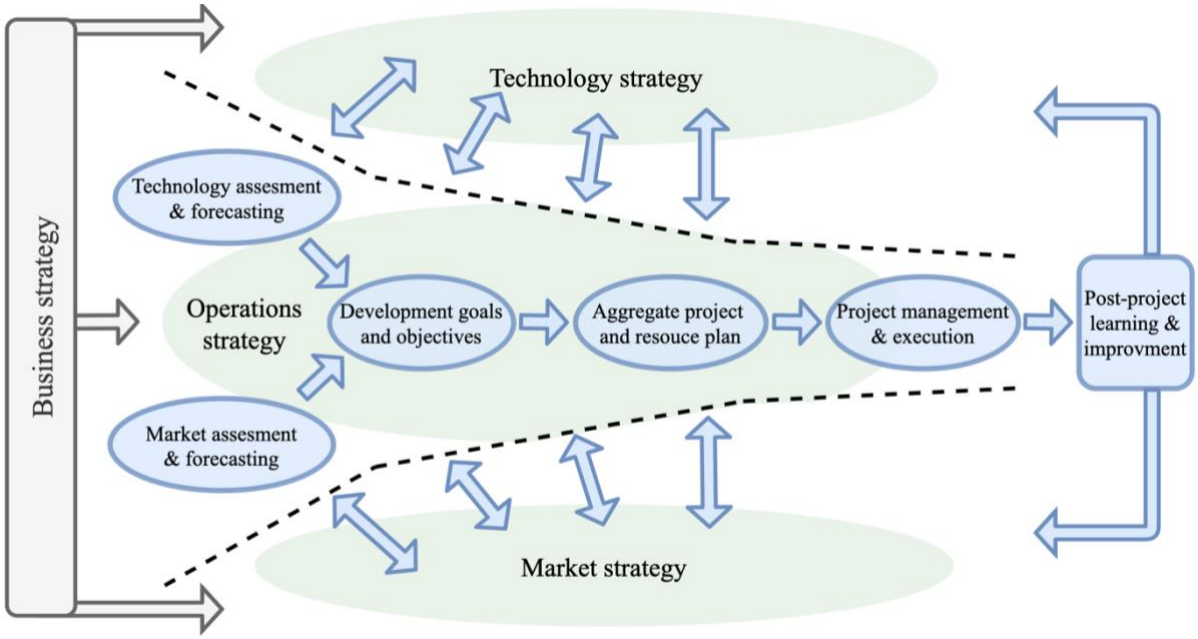

Figure 4.2 – Business, technology, market, and operations strategies' contexts in an organization

4.2 Operations strategy

This entire sub-section is devoted to describing what an operations strategy is, what it consists of, and its context in an organization and the interrelations to other strategies. In general, Slack & Lewis (2017) defines the concept of operations strategy as a means for organizations to manage their collective operations strategically for long-term, amongst others, competitive benefits (Hayes & Wheelwright, 1984; Skinner, 1969). This is supported by the operations' departments playing a significant role in the competitiveness as the customers'/markets' requirements are being satisfied by their activities. A formulated operations strategy can benefit all departments of any organization by minimizing the frustration that poor operational implementation has on the strategic direction. However, this does not guarantee that the operations' departments has any insight, strategic involvement, or considerations other than to their departments, subsequently acting as a supporting function (Hayes & Wheelwright, 1984). This is supported by traditional *operations management*, which refers to the short-term focus of managing resources and processes in a controlled and organized setting to create products and services without regarding any long-term strategic perspectives (Slack, Chambers, & Johnston, 2010). Therefore, a operations strategy aims to bridge the short-term focus and the long-term strategy.

4.2.1 Four perspectives

Slack & Lewis (2017) presents four perspectives on operations strategy, namely: *top-down*, *bottom-up*, *market requirements*, and *operations resources*, see Figure 4.3 below. Between the four perspectives, there are two connections called *process* and *content*. Each of these connections produces an output by reconciling its connected perspectives. With operations strategy, it is essential to consider all perspectives concurrently because of their strong interrelations. The criticality of considering more than one perspective is supported by Brown & Blackmon (2005).

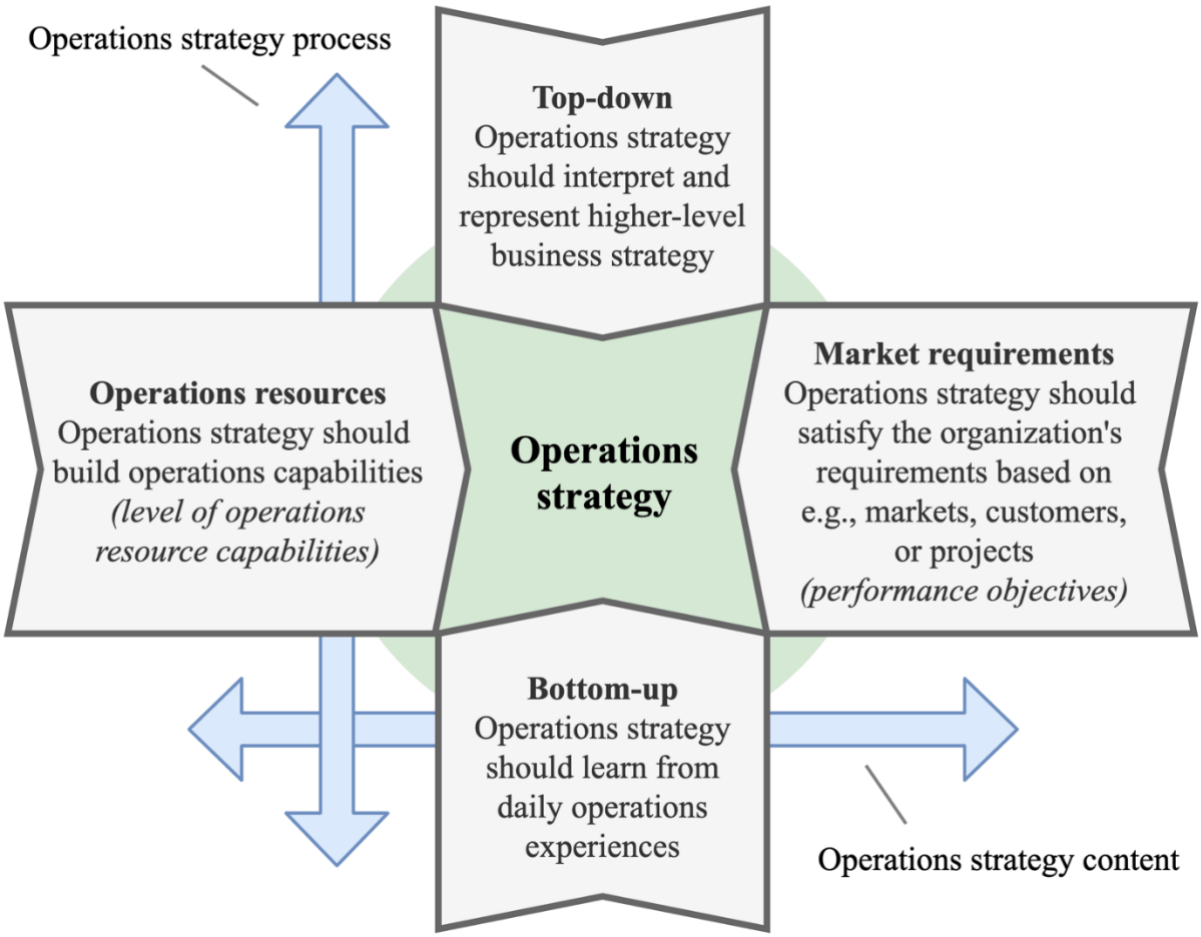

Figure 4.3 - Operations strategy's two connections and four perspectives

4.2.1.1 Operations strategy process perspectives

Slack & Lewis (2017) explains how the process connection yields a way of formulating operations strategies by reflecting on what operations and departments should do according to, e.g., the business strategy versus what they actually do.

The top-down perspective dictates that the direction of the operations strategy must reflect the business strategy, which in turn must reflect on the corporate strategy (Slack & Lewis, 2017). Therefore, by considering up-stream strategic objectives when developing the functional operations strategy, the risk of operations frustrating any strategic decisions is mitigated by ensuring that all departments are aware of strategic directions and decisions (Brown & Blackmon, 2005; Hayes & Wheelwright, 1984).

The bottom-up perspective dictates that by consulting each department in the organization, ideas, improvements, and suggestions deriving from experiences and know-how can be incorporated into new strategic directions and decisions (Slack & Lewis, 2017). Furthermore, this is called the *concept of emergent strategies*, and could assist managers in understanding why certain e.g., processes, tasks, or opportunities needs to be reviewed (Mintzberg & Quinn, 1990).

4.2.1.2 Operations strategy content perspectives

Slack & Lewis (2017) describes the content connection as containing the strategic direction of the operations strategy, which in this perspective refers to the reconciliation between the operations resource capabilities and the performance objectives based on requirements from e.g., a strategy, market, or project. This connection is a vital part of formulating and maintaining an operations strategy.

Understanding the operations and what it is capable of is, according to the operations resource perspective, called 'operations recourse capabilities' (Slack & Lewis, 2017). This is done by studying the interactions between the operations' resources and processes; including intangible resources, such as knowledge or know-how. Slack & Lewis (2017) presents a structured approach to analyze the interrelations and the capabilities, see Appendix B. These operations capabilities will vary greatly depending on in what manner the operations resources are deployed, as that will affect how the resources are interacting with each other and the processes; therefore, understanding how to affect the capabilities is a competitive advantage. Typically, the *resource deployment* is determined by considering the interrelationships and effects between the level of operations resource capabilities and the relative (e.g., competitive) importance of performance objectives based on requirements from the strategic direction/market position/project specifications (Hayes, 1985; Slack & Lewis, 2017).

The market requirements perspective emphasizes that the organization's market position must be reflected by the operations strategy, as it is the operations department's responsibility to support that market position (Slack & Lewis, 2017). As Figure 4.3 above indicates, the operations strategy requires understanding the specific requirements of a market position/customer/project to be able to align those requirements with the capabilities. Slack & Lewis (2017), and Slack et al., (2010) presents a set of five performance objectives used to understand and evaluate the requirements, and those will be explained in detail in 4.2.2 below.

4.2.2 Performance objectives

Slack & Lewis (2017) and Slack et al. (2010) underline that the five performance objectives presented in Table 4.1 below are general and different contexts will have different sets providing more/less insights. This set is generic enough to broadly differentiate competitive insights (Fine & Hax, 1985; Van Dierdonck & Miller, 1980; Wheelwright, 1984).

Table 4.1- Five performance objectives

Objectives	*Exemplified competitive importance*
Quality	Functionality, durability, performance, security, communication
Speed	Delivery time, lead time
Dependability	Delivery in time, as promised, according to specification
Flexibility	Ability to introduce new product/services, product variations, order volume flexibility
Cost	Cost sensitivity, focus on cost versus other objectives

The performance objectives are the enablers of the reconciliation between the operations strategy's perspectives of market requirements and operations resources (Slack & Lewis, 2017; Slack et al., 2010).

For market requirements, the performance objectives are dimensions used to define and prioritize an intended market position and potential competitors in that market; thus, determining the relative competitive priorities that the organization should compete within that position.

For operations resources, the performance objectives are used to define the implications of that market position, and to reveal other potential competitive factors(s) not yet 'asked' for on the market. Additionally, those implications could be used to indicate the level of complexity for a set of market requirements. Knowing the levels of operations capabilites and the market requirements, the distance between the two could indicate a level of complexity. For example, it would be a complex task for a taxi service to compete with a public transit market, where cost most liekly is the main competitive objective, as illustrated in Figure 4.4 below.

Slack & Lewis (2017) and Slack et al. (2010) shows that polar representation of performance objectives is an effective way of, through visualization, analyze and examine different competitive offerings as exemplified in Figure 4.4 below. The figure could also be useful in comparing expected versus actual performance of a product or project. As a final note, emphasis is placed on flexibilty and cost being opposed of one another meaning that high levels of one of them implies low levels of the other.

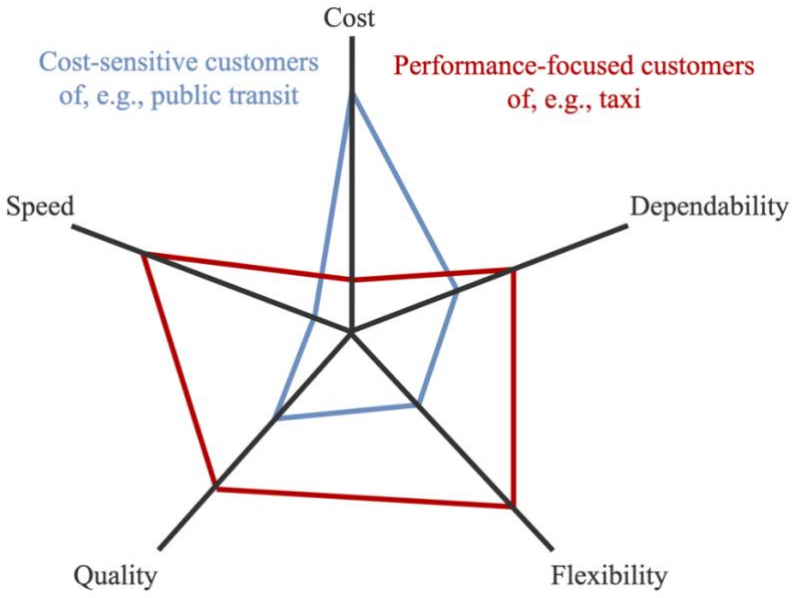

Figure 4.4 - Two examples of performance objectives polar representation

4.2.3 Strategic alignment

Strategic alignment is most often explained as the operations strategy's level of 'agreement' between the market position requirements and operations capabilities, as mentioned before could be evaluated by comparing the relative importance (competitive priority) of performance objectives between the two (Slack & Lewis, 2017). To better understand this concept, Slack & Lewis (2017) presents an illustration tool for strategic alignment called the 'line of fit,' shown

in Figure 4.5 below. It illustrates that for any market position, in order to supply that position, there are requirements to be fulfilled by the operations capabilities.

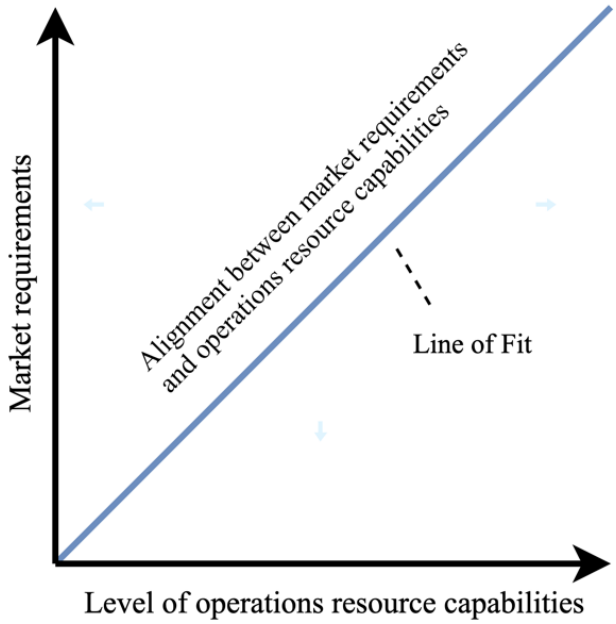

Figure 4.5 – Illustration of the Line of Fit

Hypothetically, if the capabilities are precisely aligned with the market position requirements, the operation's output accurately matches the customer's requirements and expectations (Slack & Lewis, 2017). However, that situation implies that the operations lack the capabilities to either, in terms of requirements, reveal and supply other unexploited or known market positions, i.e., perfect uncompromised alignment only supplies one position. Noteworthy, this hypothetical situation is only valid for a period in time, so Slack & Lewis (2017) emphasizes on that once an operations strategy is created, it should be updated/reformulated over time in order to maintain an 'acceptable' alignment between the market requirements and the capabilities; thus, remaining 'acceptably' competitive. 'Acceptably' competitive is an important consideration because maintaining an uncompromised alignment over time, with dynamic and ever-changing operations capabilities and market requirements, is a near-impossible (or at least very capital intensive) task for organizations, as they must then continually evaluate the market position requirements and adapt the operations capabilities (or the other way around) (Dess & Davis, 1984; Hamel, 2002; Miller & Friesen, 1983; Pine & Victor, 1993). To understand the necessary compromises of maintaining strategic alignment in operations strategy, Slack & Lewis (2017) complements the illustration tool 'line of fit' to include *tight* and *loose* fits, as illustrated in Figure 4.6 below.

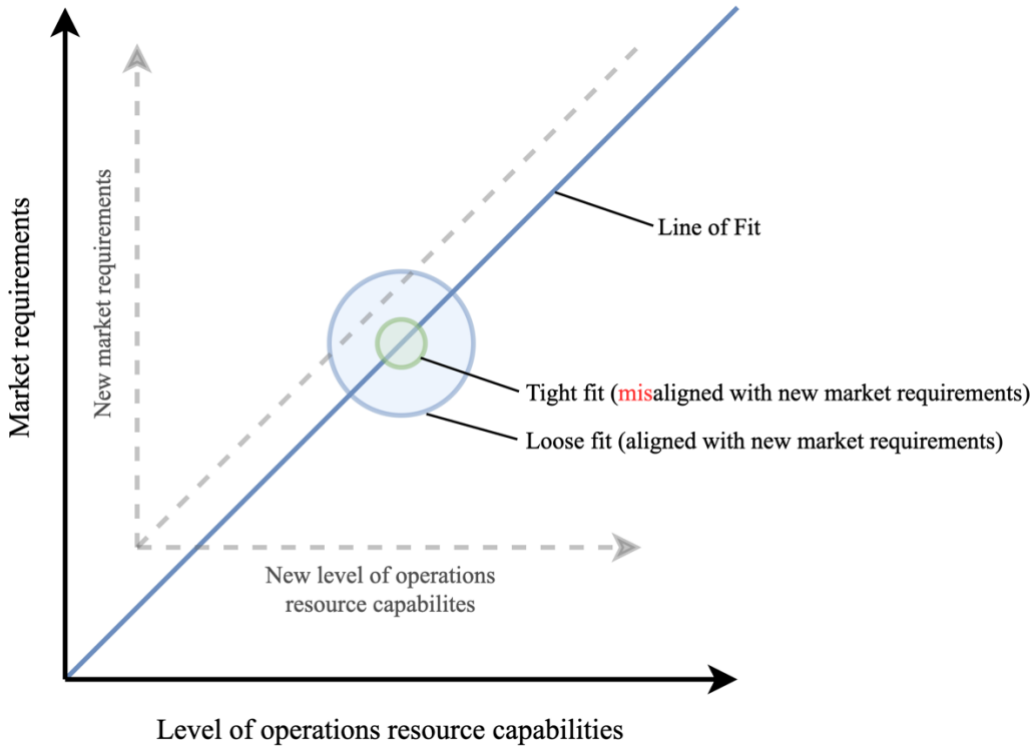

Figure 4.6 – Illustrations of the loose and tight Line of Fits

The tight fit represents an organization that has a close alignment between its operations capabilities and market requirements, meaning that the market is mostly expecting what the operations are supplying, and vice versa (Slack & Lewis, 2017). Having this type of alignment means that the operations resource capability utilization is efficiently optimized related to the current market position, therefore, less likely to be able to supply any other, or new, market positions in an efficient way without re-deploying the operations resources for new capabilities (Slack & Lewis, 2017). This kind of entrance on a new market would require knowledge about current capabilities and market requirements and could imply anything from a complete re-organization to 'simply' designing a new process. In other words, the operations strategy 'content' in a tight alignment dictates that the resource deployment is optimized to supply a specific market position.

The loose fit represents an organization that has a broader alignment between its operations capabilities and market requirements, meaning that more flexibility and insurance against unexpected shifts are hardwired into the operations strategy (Brown & Blackmon, 2005; Slack & Lewis, 2017). This alignment is not efficiently optimized for just one market position but instead for several possible positions by modifying the resource deployment to alter the capabilities, accordingly, enabling alignment. However, this increases both the significance and complexity for an organization in understanding the market requirements, its operations capabilities, and the interrelations between. The 'content' of a loosely aligned operations strategy dictates how the resource deployment should be carried out depending on the relative competitive priorities of the relative market positions.

4.2.4 Strategic consensus

The *strategic consensus* is described by Boyer & McDermott (1999) as an organization's level of consensus between its operational goals and the relative importance of performance objectives. This description is in the high-level context of an organization, and refers to how an entire organization has a level of shared understanding of its competitive priorities, i.e. what performance objectives are the organization competing on. Using descriptive statistics and surveying the organization could provide insight into how the organization is considering itself, called strategic consensus mapping (Ates, Tarakci, Porck, vaan Knippenberg, & Groenen, 2020). Having an organizational strategic consensus is regarded to be equally as crucial as the competitive-critical strategic alignment for operations strategy. This significance stems from consensus being a critical dimension of operations strategy (or any other strategy) to consider, as it provides insight into how the organization is adhering to a strategy and its direction. This is supported by Hayes & Wheelwright (1984), as a shared understanding of an operations strategy and its implications could result in employees pulling the organization in the same direction through e.g., effective and aligned decision-making.

There is another strategic consensus to consider, the lower-level consensus within smaller 'organizations' such as departments or teams. According to literature, a high team-level strategic consensus implies that the team members have a higher sense of purpose and commitment through their shared understanding of the agreed-upon team-goals and their protentional contribution to the competitive strategic priorities and/or operational goals (Ates et al., 2020; van Knippenberg, van Ginkel, & Homan, 2013).

4.3 Objectives of product development projects

Product development projects have four key objectives (Smith & Reinertsen, 1991), These are *development speed, product cost, product performance,* and *development program expense,* and are presented below in Figure 4.7.

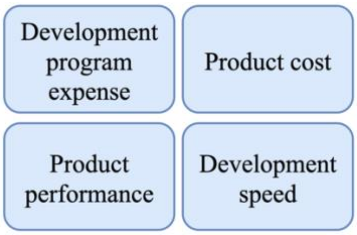

Figure 4.7 - Four key development objectives

The first objective listed by Smith & Reinertsen (1991) is the development speed of the project. The effort toward this objective determines how long it will take for the project's initialization until the product is available to the customer. According to Smith & Reinertsen (1991), this time is measured from the time someone could have started the development project. This is not intuitive for many managers, as most would start measuring the development speed from the official start of the project.

The second objective is the product cost. This is the cost that the customer will pay for the final product.

The third objective is the performance of the product. The performance of the product is determined by comparing the actual measured performance to a market-specified performance. The terms performance is interchangeable with quality if the quality is defined as conformance to customer requirements (Smith & Reinertsen, 1991).

The fourth and last objective is, according to Smith & Reinertsen (1991), the development program expense. They claim that this objective often receives undue attention from managers that are expected to decrease program expenses. This objective is often deemed to be of less significance than the others (Smith & Reinertsen, 1991).

Atkinson (1999) presents a slightly different framework, focusing on three goal areas for product development projects, namely, cost, quality, and time. Thus, this framework is similar to the one presented by Smith and Reinertsen (1991), but without the differentiation between development program costs and final product costs.

4.4 Organizing product development

Wheelwright & Clark (1992) states that the organization of projects is usually not an issue for companies in the start-up phase, as things are usually organized in an organic fashion around one project. However, when a company grows to have multiple concurrent product development projects, the organization of the projects becomes a critical factor for success. Organizations usually organize development teams in structures resembling one or more of the structures presented in Figure 4.8 below (Slack & Lewis, 2017; Wheelwright & Clark, 1992)

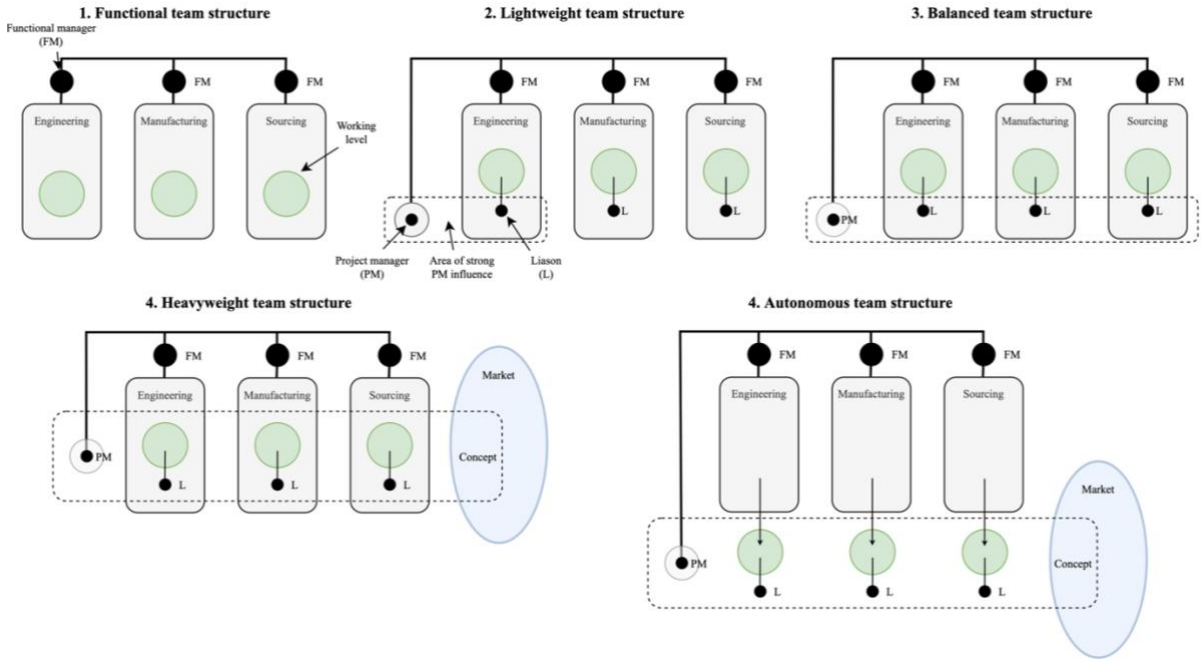

Figure 4.8 – Common organizational project team structures

4.4.1 Functional team structure

The functional team structure is usually found in older, more mature firms. The functional structure allows a company to organize itself around specialized subfunctions, such as engineering and manufacturing (Slack & Lewis, 2017). This organization also tends to have

some merit when the organizations work on one project at a time or when none of the projects are big enough to justify a team leader (Smith & Reinertsen, 1991).

All functions are involved in creating a detailed specification of each project, and the ownership of that project is then passed between functions as the project progresses. This approach often results in less than smooth transfers of projects between functions, due to the fact all projects are different, and all projects might not fit the division as easily (Wheelwright & Clark, 1992). In contrast to this, Wheelwright and Clark (1992) describe the functional approach as presenting some strengths for a company applying it in its development of products. As resources are managed by the same managers that are responsible for the success of the project, conflicts can be avoided.

Another strength is the clear career opportunities within the functional departments. Employees could be measured by the success of the projects while their managers are the ones in charge of promotions and organizational changes. This functional approach is also considered well-constructed for keeping specialized knowledge connected and in a clearly defined area of the organization, a strength that is also supported by other authors, such as Smith and Reinertsen (1991). This can give an organization better resource utilization for specialized staff, with the added risk of solutions becoming less innovative with the added isolation.

4.4.2 Lightweight team structure

The Lightweight team structure is usually a relatively minor modification to the functional team structure (Slack & Lewis, 2017). The lightweight team will consist of a liaison from each function and a project manager. A person is selected as a liaison to the lightweight team in addition to their regular functional role (Wheelwright & Clark, 1992).

The project manager is usually not a higher-level employee, which is one of the reasons it is called a “lightweight” approach. It is common that the person is skilled in project management and has low influence and status in the organization (Slack & Lewis, 2017). It is also common that the project manager has experience within one of the functions and that the project manager role is seen as an opportunity to move out of a function and into a new role (Wheelwright & Clark, 1992). The responsibilities of a project manager include informing and coordinating the activities in the different functions, functions in which resources remain in control of the functional managers. The project manager is, therefore, spending much time on administrative tasks. The project manager will commonly spend 25% or less of their time on each project (Wheelwright & Clark, 1992).

The strength of the lightweight approach is, in addition to the ones mentioned in the functional approach, the fact that the organization will have a manager that seeks to coordinate activities in a timely fashion (Smith & Reinertsen, 1991). Any cross-functional flows of information are also made more accessible (Smith & Reinertsen, 1991). Apart from these strengths, there are also some weaknesses of the lightweight team structure. The lightweight approach is sometimes expected to result in considerable improvements in areas such areas as quality and speed. These expectations are seldom met due to the fact that the project leader is limited in the ability to allocate resources and is, therefore, reliant on the functional managers. This often

results in a situation where the project manager is not feeling fulfilled in the new role (Wheelwright & Clark, 1992).

4.4.3 Balanced team structure

The balanced team structure makes an attempt to balance the power of functional managers with project leaders (Slack & Lewis, 2017). Smith and Reinertsen (1991) describe that one way this could be done is to give the project manager power over one individual's time while the functional manager is responsible for that individual's career and development within the company. This type of division of authority can be found in the heavyweight team structure, described below. Another way to divide power in a so-called matrix structure is to give the project managers control over project-related matters and the functional managers' power over developing general functional expertise. This type of uniformity within the organization can lead to positive effects in quality and serviceability, according to Smith and Reinertsen (1991). They also describe the downsides as the trade-offs that have to be done by both parties, such as the project managers being bound to functional or department strategies or that these strategies are being disturbed by the needs of specific projects. Discussing and evaluating the strategic alignment and consensus could be valuable to mitigate the negative trade-off's regarding the strategies (Boyer & McDermott, 1999; Hayes & Wheelwright, 1984).

4.4.4 Heavyweight team structure

The heavyweight teams offer better communication, a higher sense of ownership, and better cross-functional problem solving (Wheelwright & Clark, 1992). In the heavyweight project team, the project manager has direct access to and responsibility for those involved in the project (Slack & Lewis, 2017). Wheelwright and Clark (1992) describe that these project leaders are "heavyweight" and are senior managers. They often outrank or are at the same level as the functional managers. As a result, they are experienced and have significant authority in the company. The heavyweight leader is the primary influence over the people working on the project and supervise their work directly or through people in the functional areas. The core group of the heavyweight team is often co-located, and the rest of the team is usually not working on the project full time (Wheelwright & Clark, 1992). The part-time members are working in a more traditional functional environment and are still in the team. The functional manager is still in charge of career development for the team members since the project manager is only running a temporary project (Smith & Reinertsen, 1991; Wheelwright & Clark, 1992).

The role of the heavyweight leader differs between projects and organizations. There are a number of dimensions in which the profile of the manager will vary, such as direct contact with the customer and the duration of responsibilities (Wheelwright & Clark, 1992).

4.4.5 Autonomous team structure

The autonomous team often referred to as a "tiger team," is, to a high degree, separated from the functional organization. The team is co-located, and the project leader is given control over resources contributed by the functional managers. This leader is a heavyweight within the

organization and is the sole evaluator of project members; thus, having an impact on the career development of the team members.

The autonomous team will not have to follow regular practices within the organization and is instead expected to create its own set of procedures. This includes incentives and rewards, as well as responsibilities and expectations (Smith & Reinertsen, 1991). The focus of the autonomous team is its main strength. They can have a high degree of cross-functional collaboration, and all team members have the project as their sole focus. This generally leads to the rapid development of new products and high efficiency in the development (Wheelwright & Clark, 1992). Smith and Reinertsen describe disadvantages, such as including the risk of the project not having explicit bounds. The project will grow, and existing solutions might not be considered and instead developed in a new form. They also describe problems with the autonomous team creating custom solutions that are harder to integrate into the organization. The autonomy of these teams often makes senior managers reluctant to use them because of the risk that the teams will be less visible and have consequences for the rest of the organization (Wheelwright & Clark, 1992).

4.5 Stage-gate development process

The stage-gate development process is a systematic approach to new product development processes, most often recognized by organizations as a risk management model by allowing management more control and oversight of the ongoing development projects (Cooper, Edgett, & Kleinschmidt, 2002). Slack & Lewis (2017) denotes this systematic approach as a sequential arrangement of stages in the development project.

As illustrated in Figure 4.9 below, a stage-gate process will follow a development project throughout its lifetime, from ideas to finished product, most often consisting of an *idea* pre-stage, *five stage-gates*, and *post-launch evaluation* (Cooper et al., 2002). Each gate is followed by a stage. At each gate, managers and other project-responsible employees are making a 'Go/No go/Kill' decision depending on the information provided, fundamentally evaluating the levels of readiness, completion, and timing of the project to determine if it is allowed into the following stage. When a project is allowed to advance, additional resources are unlocked to complete the pre-defined tasks that are to be completed in the next stage prior to the next gate. It is essential that the requirements and tasks of each stage and gate are pre-defined. Developers are **only** allowed to work on the tasks of the current stage.

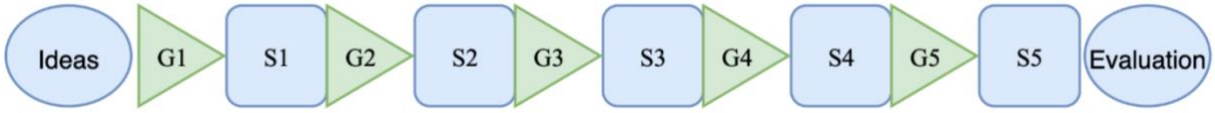

Figure 4.9 - Example of a typical stage-gate process design

Organizations designing the development processes according to a stage-gate approach at some point usually tends to realize that there are apparent trade-offs needed to consider, e.g., between risk mitigation and development speed. A trend amongst best-practice organizations is to improve and streamline their stage-gate processes by changing the number of stages and gates depending on a preset number of factors, such as size, complexity, or risk, of the projects (Cooper et al., 2002). For example, these organizations would not have an incremental product

improvement and a new platform development project go through the same number of stages and gates due to the comprehensiveness, as for most projects, the development time increases with the number of gates; however, the development risk of not fulfilling the business-case requirements are most often lowered. Cooper et al. (2002) emphasizes to never let projects, of any size, circumvent the stage-gate process as this would prevent any 'no' decisions, which in an extreme case, could lead to higher risks for the organiztion and resoucres spread out thin.

4.6 Communication in projects

The pattern of communication between the upstream and downstream groups is critical for the success of projects (Wheelwright & Clark, 1992). According to Wheelwright and Clark (1992), communications can be analyzed in four dimensions. The dimensions are listed below in Table 4.2, and some examples are presented in the range of the choice column.

Table 4.2 - The four dimensions of communication

Dimensions of communication	*Range of choice*
Richness of media	Sparse: Communication through documents on computer networks. Rich: Face to face communication or models.
Frequency	Low: One-shot communication or communication in batches. High: Piece by piece, inline, intensive communications.
Direction	One-way: Monologue. Two-way: Dialogue.
Timing	Late: Completed work, ends the process. Early: Preliminary, begins the process.

The first options in the range of choice represent communication where upstream engineers deliver documents in a finished form to downstream activities without much room for revisions or feedback (Wheelwright & Clark, 1992). Furthermore, the contrasting variant of communications would be richer, more frequent, two-way, and early. This would mean that information would be shared early in the projects and then continuously—the plan for how communications should be carried out (Hallin & Karrbom Gustavsson, 2012). Furthermore, the planning of communication should be decided with the whole project team.

Moving to the second type of communication will help the organization improve problem solving in projects and have more resource-efficient and development projects with higher speed (Wheelwright & Clark, 1992).

4.7 Project Management

Projects are likely to have a lower chance of success if pre-execution activities are handled poorly (Tonnqvist, 2009). This means that the organization must create plans for the project,

precise project specifications, and well-defined customer contracts as early in the project as possible (Hallin & Karrbom Gustavsson, 2012; Smith & Reinertsen, 1991).

Project lifecycles are often divided into multiple stages; however, depending on the author, the stages and process-layout are designed with minor differences. Based on Hallin & Karrbom Gustavsson (2012), Lock (2003), and Tonnqvist (2009), Figure 4.10 below illustrates a generalized project and its stages. The two first stages in project lifecycles, called *initiation*, and *planning and design,* will be described in more detail below.

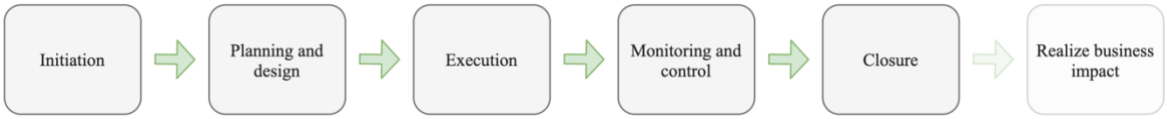

Figure 4.10 - General project lifecycle stages

4.7.1 Initiation

Hallin & Karrbom Gustavsson (2012) describe this stage as a project that is usually initiated by a problem or a need that can come from many different sources, e.g., outspoken customer need or an internal source. The need has to be formulated into some tangible specifications that can be used to convince people of the necessity of this project and to involve people in the project as early as possible (Hallin & Karrbom Gustavsson, 2012).

4.7.1.1 Project Specifications (Project Charter)

The project specifications should be written before the start if the pre-study. It is the foundation that is guiding the project throughout its existence. According to Smith and Reinertsen (1991), project specifications (sometimes called the project charter (Tonnqvist, 2009)) are often seen as just another piece of documentation that product developers compose before getting back to what is seen as their "real" tasks. They argue that the main concern for the developers might, in these cases, is that the project specifications are there to prove the developer's innocence in case of issues later on.

The project specification should function as more than that. All downstream activities are, in some sense, dependent on the specifications, e.g., the product complexity will significantly be influenced by the specifications (Tonnqvist, 2009). The influence on the complexity of the project specifications is often unknown. Complexity generally adds to the development time as well, which is another example of why specifications matter (Smith & Reinertsen, 1991). Precise specifications of the project can also be handy if the customer can sign off on these specifications (Lock, 2003).

The project schedule and the product design are constructed by translating the project specifications (or charter) into activities and products. If the specifications are not set by involving expertise and listening to different perspectives, the project schedule cannot be considered much more than fiction (Smith & Reinertsen, 1991). The project specification writing is also vital to give a sense of ownership of the projects to participants. Without this sense of ownership and a clear idea of what the goals are, employees are less likely to be satisfied, and it is a common reason for high employee turnover (Tonnqvist, 2009). If someone

has agreed on a project specification, it is also more apparent that this participant will put more effort into making it work if necessary. It is also clear who should be contacted about the specification. These are all reasons why the writing of specifications should be seen as more than 'just a step' that should be overcome as quickly as possible to avoid controversy (Smith & Reinertsen, 1991).

One of the hardest parts of writing project specification is the collection of input from multiple types of knowledge, such as manufacturing and engineering. Having one person collect information from all sources is not enough (Smith & Reinertsen, 1991). The parties must discuss with each other and come up with the specifications together. Additionally, some specifications are hard to quantify. This means that parties must be even more aligned. There is also an added complexity of specifications affecting each other. It is also common that the design process itself is needed to set some specifications. This means that project specifications will be clarified over time, but new project specifications should still be as concrete as possible (Smith & Reinertsen, 1991).

It is also common that some organizations use two different specifications for the same project – one for marketing specification and one for engineering. This can be problematic, firstly, because it does not force marketing and engineering to agree, and secondly, because specifications often change over time, the marketing one remains unchanged when the engineers change theirs (Smith & Reinertsen, 1991).

4.7.1.2 Writing specifications and understanding customers

Having an engineering (technical) specification is not the same as having a project specification. The specification should deal with what should be done, not how. It should have a focus on the customer's needs, their problem, and how the customer will judge the product, etc. (Tonnqvist, 2009). Everyone involved in the project must understand what the customer is expecting from the project and what needs must be satisfied. It is not enough that the sales department knows this since this knowledge will be distorted when it is translated (Smith & Reinertsen, 1991).

The specification will often be only a few sentences with a "reason of existence" for the product. This is not enough; the specification must come from a more detailed discussion with those who will make trade-off decisions later in the project. This will guide developers in decisions that are not explicitly covered by the specification (Tonnqvist, 2009). This process of understanding the customer will significantly benefit if the customer is taking part in writing the specification (Lock, 2003). The company could consider involving departments from the customer's organization, e.g., sourcing that knows what needs they are satisfying by placing an order, or testing and verification employees that understand the specifications (Tonnqvist, 2009). Additionally, consider writing the contact information of contacts on the specification to give an easy way to reality-check the project.

According to Smith and Reinertsen (1991), the most helpful customers in this stage are the ones that are lead-users, which means that they understand the requirements of new solutions and that they are aware of the shortcomings of current alternatives. Furthermore, the lead-user will also provide the company with an insight as to where market and technology trends are

moving. Lead-users are also more likely to pay a premium for the tailored solution. Lead-user projects must, however, be carefully evaluated against the strategy of the business (Smith & Reinertsen, 1991; Wheelwright & Clark, 1992). They note that if the project's connection to the strategy is not considered, lead-users can lead the company astray, and the capabilities needed for project success can be missing, as supported by Slack & Lewis (2017).

According to Smith and Reinertsen (1991), it is also valuable to consider and understand the end-users and their perspective of the customers, as this would simplify following what customers should receive the focus of the company. Furthermore, a lead-user might be technically advanced and in a market of the future, but there might be other trends, and the changes in markets are often not quick enough to warrant substantial changes in capabilities. They add that this is why strategy must be well defined to help with the specification and selection of projects. Perhaps more importantly, the understanding of the customers must be shared by everyone involved in the project.

4.7.1.3 Defining the product benefits

It is essential to understand what benefits the product will give the customer before specifying the features of the product. It is a common mistake to focus on features, such as hardware components, before defining the benefits (Tonnqvist, 2009). This mistake can lead to falling into two traps (Smith & Reinertsen, 1991). The first trap is unnecessarily restricting the design by adding features that are not clearly value-adding or benefiting the customer. The other risk is that some element that is necessary to fill some benefit is omitted because the interest was not clearly stated. Smith and Reinertsen (1991) state that by not considering and understanding the implications of these two traps, the product might end up with fatal flaws.

4.7.1.4 Not restricting design options

A specification (or project charter) should focus on what is needed of the project, not how to make it by stating design options (Tonnqvist, 2009). As there are often many options available during the design phase, it is suitable to avoid them being part of the specifications. This is true as, during the implementation, the designers will have more flexibility to use and switch components, as trade-offs between components might be realized over time. If design options are specified, against this recommendation, the design will be left to personal preference of a designer, which must have a high degree of knowledge about how components interact and their trade-offs before even moving beyond specifications. This is not a sustainable process (Smith & Reinertsen, 1991).

4.7.1.5 Involving all functions

The product specification or charter should, according to Smith and Reinertsen (1991), be written jointly by department representatives from, at a minimum, marketing or sales, engineering, and manufacturing. They describe the common practice of writing a specification and then passing it between functions to get the necessary approvals. This leaves the project at risk of unexpected problems since the approval is often done without proper understanding from the approvers (Tonnqvist, 2009). If the project is not seen as being jointly specified, it will also be harder to overcome the usual organizational inertia. Smith and Reinertsen (1991) and Tonnqvist (2009) both emphasize that the project specifications are simply too important

to be allowed to advance to a sequential process. The essence of a proper specification is a balance between trade-offs that have to be made between and within functions. The joint writing of the specifications is also functioning as a way to commit to the project, which is likely to get the project finished in a shorter time (Smith & Reinertsen, 1991).

4.7.1.6 Crucial factors for success

Specifications are often written with a focus on the things that people know. This is why specifications about new and unknown aspects are often left vague and brief. When this happens, the organization will have to deal with these problems later in the process, to a higher cost and resulting in a prolonged time to market. The specifications can be prevented from becoming trivial by not using a form, and this practice can also help people to avoid looking at the specifications as an internal contract that can be used to place blame on specific individuals or groups. Tonnqvist (2009) suggests that these problems can also be avoided by utilizing "user stories" as guidance throughout the project. The specifications could also be constructed with the help of checklist listing problems with previous project specifications (Smith & Reinertsen, 1991). The specifications should also not be too long – this will lead to fewer people actually reading the full specifications. There might be concerns that the specifications will change during the project and that they, therefore, should be less detailed. The specifications will still serve as an authoritative guide for the whole organization, which means that participants should do their best to specify unknown areas as clearly as possible. This also adds to the team spirit and commitment (Smith & Reinertsen, 1991).

4.7.2 Planning and Design

According to Hallin & Karrbom Gustavsson (2012), project planning is done once the project is deemed feasible, and the planning of the project can begin. This includes scheduling and allocating resources such as engineering time and resources for prototype testing. Furthermore, the planning phase also contains activities for more detailed estimations of the product cost, which is vital before a plan is executed.

4.7.2.1 Product cost calculation

Companies are often well aware of their demands on the quality and functionality of their products. When analyzing the successful launch of new products, the cost can be concluded to be just as crucial for success (Hallin & Karrbom Gustavsson, 2012). This cost of producing a product is often divided into direct and indirect costs (Lock, 2003). The direct cost can be attached to one single cost object (one product), such as the cost of the components. The indirect costs cannot be attributed to a single cost object and are often subsequently added to the product cost by spreading the cost (Layer, Brinke, Van Houten, Kals, & Haasis, 2002).

Layer et al. (2002) explains that product cost is generally divided into three distinct types of calculations: pre-calculation, intermediate calculation, and post calculation. The pre-calculation is where an estimate of costs is made before the product is being produced. Pre-calculations are therefore based on data from the previous project and the expertise of employees. Since the descriptions of the product are not likely to be very detailed, there is a great need for a sustainable process in this phase. The intermediate calculation is made during the development of the process to control the evolution of the cost. The post-calculation is

made after the product is in production, and internal systems and databases can be used to calculate something closer to an actual cost. Layer et al. (2002) finishes with underlining that the data from the post-calculation can be used in future projects to improve the accuracy of the pre-calculations.

According to Hallin & Karrbom Gustavsson (2012), key performance indicators and checklists can also be used to estimate the product cost. When using key performance indicators, it is important to be cautious, make sure that they correspond to costs, and consider any other implications that might arise by focusing on them.

Different versions of cost estimates for products will exist as the project progresses. The project is also likely to have many different concepts with their own cost estimates (Lock, 2003). All cost estimates must be clearly marked for each version to avoid mix-ups and other problems,

5 Empirical findings

This section first briefly explains the general design of the case company's stage-gate development process, followed by individually presenting the summarized empirical findings of the four investigated projects. The presentation of the summaries was proactively divided per country of origin into two main segments, Sweden and Germany, each consisting of two projects. Each of the project-specific summaries were divided into seven categories, accordingly: *introduction*, *problem description*, *project organization*, *project management*, *cost and cost calculations*, *project communication*, and finish with *operations strategy*. Each category will include limited findings, which means that each category will only be described within the scope of the interviews.

The findings presented here are founded on 16 one-hour interviews involving 15 professional engineers and one with both business and technical expertise relevant in the case company's context.

5.1 Stage-gate development process

The case company has designed and follows a traditional stage-gate process for customer-oriented projects with eight stages and seven gates, as illustrated in Figure 5.1 below. Across the eight stages, the role of the project manager is successively divided between individuals from three functions depending on how far the project has progressed.

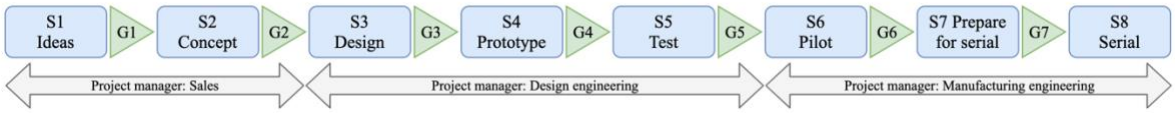

Figure 5.1 - Illustration of the stage-gate development process

In the first stage S1, the project has not yet been created and fully committed to as this stage aims to evaluate the project's feasibility and potential business outcomes it could yield. If the project is given a 'go' at G1, then the customer is to be presented with a concept. This implies that in S2, the development of a concept is conducted and, also, commercial and technical specifications come into existence; stated representatives from sales and design engineering. If the customer approves the concept, and if the project is given an internal 'go' at G2, resources are to be allocated individually by the functional resource managers, consequently creating a cross-functional project team. At this point, the role of the project manager shifts over to a representative from design engineering until approval at G5 is received. At that point, a representative from manufacturing engineering becomes the third and final project manager as the project is prepared to be industrialized.

Noteworthy, in cases of other than customer-oriented projects, the case company has enabled modifications to the development process to mitigate arising uncertainties due to, e.g., there not being any customer that can give feedback. The summarized findings below will indicate and specify if the project was developed according to the process with an actual customer or not. In instances of no customer, the modifications to the development process will be detailed to some extent in the project's findings.

5.2 Projects originated in Sweden

This segment will present the empirical findings from the two projects that originated in Sweden. Each of the project-specific summaries were determined based on the transcriptions from four project-specific interviews. The structure of the sub-headers represents the areas of focus in the interviews.

5.2.1 Project A description

The project was initiated by a salesperson that had been contacted by a current customer that was in the process of developing a new excavator. The case company was tasked with developing the HVAC system for the vehicle, and the customer and the salesperson estimated that the project as ordinary for the case company. The customer specified that the casing would need to be made from plastic, which made the development of the product more complicated than when using casings made of metal. Significant investments had been made to produce molds for the plastic casings, rendering both the case company and its suppliers invested in this project, and therefore, eager to see it through. The plastic casing competence was sourced internally from a non-European part of the organization.

A serious design flaw on the excavator, made by the customer, forced the case company's design engineers in Sweden to start over and completely redesign the HVAC system. This affected the cost of producing a new unit. The customer was not willing to accept a new higher price. The initial agreement with the customer had been made in good faith, but the customer decided not to renegotiate for the new, more complex product. A project was initiated to redesign to reduce the cost of the product, while the original project was still ongoing. This meant that there were two ongoing projects for the same customer project involving, for the most part, the same employees.

Time of project initiation: June, 2018

5.2.1.1 Problem description

The redesign of the product made the previous design obsolete. This meant that the organization had to allocate additional resources to a redesign. The new design was also more complex, and the cost of the new components surpassed the product cost-limits. The customer contract also fluctuated over time in terms of estimated orders, which made it even more complicated to negotiate with suppliers. Other problems also arose due to late scheduling/allocation of more resources to the project, and that the design development expenses were doubled. The European organization had, at the time, no competences in designing and working with plastic casings.

Some interviews indicated that it was hard for team members to distinguish between the original project and the "cost-cutting" project as the project(s) progressed.

5.2.1.2 Project organization

The project was organized according to the internal stage-gate process, meaning that the representative from Sales that was initiating the project is also the project manager in the first stages. At a late stage in the stage-gate process (during prototypes), the customer started to

make substantial changes in design-requirements due to them realizing a serious flaw in the design of the vehicle.

The leadership of the project changed in the creation of the redesign. The original project manager, for the engineering part of the stage-gate process, left the company for some time, and a new project manager was assigned from the same site. The project manager role was to be taken over by the manufacturing department once a design-freeze of the second design was made, and it was time for industrialization.

The sourcing department was involved in producing quotes for the product as the project progressed, in both the original project and later the "cost-cutting" project. As the projects progressed, the sourcing department representative described the organization of the project as working well as the people involved in the project started having periodical meetings to keep everyone updated. This meant that potential problems could be found early on and that everyone had the same idea of what was going on. The collaboration of the departments was, according to all interviewees working well throughout the project.

Some participants in this project had been working together before and stated that the previous experiences made it easier to collaborate. There was also an occasion were the representatives from all involved departments met in Poland. This was an appreciated opportunity to go beyond work-related discussions, especially for the recently hired employees.

5.2.1.3 Project management

The project specifications were written with the sales representative together with a design engineer. Most people that were interviewed did not know who had been involved in writing specifications for the project. The specifications of the project were, according to the interviewees, well specified for the original project, but the customer changes made the original technical specifications obsolete. The number of units that should be ordered was also not clearly specified, and how changes in customer needs should be handled was not specified enough either. As the fluctuating order volumes were re-iterated several times, it created uncertainties for the project team, e.g., as preparations for industrialization and quotes are affected by the order volumes.

One interviewee stated that more focus should have been put on the contractual terms of the project and less on the product design because the product design can be (and was) revised while the contract could not. There was a strong consensus among the interviewees that the contract should have been better specified. Several interviewees stated that the product specifications and design were not anything out of the ordinary, apart from the plastic casing.

One of the interviewee's seriously agreed that many problems could have been avoided if the customer and their readiness was better understood from the beginning.

5.2.1.4 Cost and cost calculations

The final cost of the product was described as a critical factor for the success of this project by all interviewees. The price of the project was also seen as critical for even getting the project, and since the product was seen as relatively straight forward, there was a consensus that the project goals could be reached.

No interviewee had a clear picture of how exactly the initial cost calculations had been done or what components were included. As costs were calculated over time, the salesperson was informed about the problems with the increased costs. The account manager was then unable to change the already agreed-upon price. One interview also suggested that there was no 'Go/No-Go' decision, where the cost was reviewed in the stage-gate process that the project followed.

No interviewee indicated any insights into the monitoring of the development program expense.

5.2.1.5 Project communication

The progress and activities of the project were initially documented in excel documents on a company server. The team members and their roles were also documented in this place. Some interviewees commented that it was hard to find the latest updates on documents and that some information was communicated orally while other details were documented in the folder documents. A project management software was introduced later in the project. This software received good reviews from everyone involved, and there were hopes that the software would reduce the number of internal emails in the future.

Communication of design changes could sometimes have been better communicated to the downstream departments, according to one interviewee. It was generally understood the structure and versioning in old system would not have been optimal for communication.

5.2.1.6 Operations strategy

None of the interviewees could recall any spoken business strategy at the time of this project. However, all agreed to some extent that the project was a good fit for the business strategy and goals due to its high-volume estimated orders, new customer in the European market, familiar product complexity, and substantial contribution to sales. The interviews highlighted that, for the European organization, available resources became the primary strain reducing the capabilities of achieving the project goals.

All interviewees felt that their departments all had the required capabilities to succeed with the original project goals, except lacking the formal capabilities in designing plastic casings. However, this changed due to the redesign of the project drastically affected the circumstances for some departments with a lack of time and resources and maintaining readiness in components and suppliers.

The interviewees all agreed that the product cost was a critical success factor. However, this appeared not to have been emphasized early on. None of the interviewees were aware of specific strategies for other departments. One interviewee highlighted that the case company's organization of the development processes (stage-gate and department-specific) was not supporting an efficient flow in the project after having to go back several gates because of the customer changes.

5.2.2 Project B description

The project was initiated by a customer that was unsatisfied with the performance of a competitor's HVAC system. The customer was in the process of iterating the design of a high-end forestry machine with a 360-degree rotating cabin, which increased the product complexity of designing the HVAC system. The project complexity was further increased by other customer requirements, mainly regarding software controls. Due to unforeseen events, the Swedish design engineer that was the project manager was for a limited time on leave from the case company, and the project manager role was shifted to a recently hired design engineer located in Poland. The supporting electrical engineer for the project left the company before the design was finished.

At the time of the study, the second version of the prototype was being tested.

Time of project initiation: April, 2018

5.2.2.1 Problem description

The product was controlled through software, a competence that the European organization did not have capabilities to develop, which meant they had to request support from an internal non-European software department. The software support was, by all indications, not prioritized by the software department, resulting in that deliveries and revisions had to be pushed by the project team. The project was delayed because of this, meaning that the customer had to wait for prototype software updates that were to be integrated within their own systems. This meant that the customer was aware of the relative simplicity of the required software updates and became aware of the case company's internal delays with software development. Changes in the software development approach for the European organization have since been made.

There was a consensus amongst the interviewees that the hardest to reach objective was the product performance, mostly in terms of the software development and the complexity related to the 360-degree rotating cabin. With that in mind, one of the interviewees highlighted a unique perspective that the development speed was the major problem, due to the delays from the software development. All interviews indicated that the project was inclined towards focusing on the performance of the product, and not the cost and that everyone understood this.

During the design phase, consultants had to be brought in when the lack of electrical engineering resources became apparent. The interviews indicated that the sense of ownership appears to not be as high from a consultant's perspective.

5.2.2.2 Project organization

The project followed the traditional stage-gate process, but the project manager role was, at one point, shifted from one design engineer to another, newly hired, design engineer. This was due to unforeseen events that caused the first design engineer to go on leave for a limited amount of time. When the first design engineer returned, he was again put in the project manager role of the project with an administrative focus, and his stand-in remained within the project team as a design engineer focused on operational tasks.

The collaboration between the departments was described as working well during this project. The collaboration between designers and the manufacturing engineers was also seen as

working exceptionally well when the design engineer (also acting as the project manager) was located in Poland. Having the design engineer and the manufacturing engineer in the same office allowed them to have a closer and more effective collaboration.

The interviews indicated that in some instances and projects, the project manager role is not something that is asked for or a suitable responsibility for all employees.

The project also showed some of the problems that can come when departments within the same company are not used to working together, such as seen when the software was developed in Canada. This, however, is outside the scope of this study.

5.2.2.3 Project management

The project specifications were, following the stage-gate process, written by representatives from the sales and design engineering departments. Some interviews indicated that the project scope and deliverables to the customer could have been better specified early on. This was because the product was more complex (more technically advanced) than what is usually developed. The salesperson that initiated the project left the case company in the early stages of the project.

The necessity of electrical engineering resources was identified and allocated early on, but these tasks were assigned to consultants as the electrical engineer left the case company.

All interviews agree that the customer (and their customers) was understood early on and that more details could not have helped to mitigate any of the problems that later occurred. They all agreed that the specifications and planning of the project worked fine.

When the first design engineer returned and became the project manager again, he started scheduling periodic weekly meetings with the project team, which the interviews emphasized had a significant improvement regarding the progress visibility and collaboration within the team.

5.2.2.4 Cost and cost calculations

An estimate of the product cost was made at the project initiation and was later updated and recalculated after every prototype-cycle. The interviews indicated that the customer was not that cost-sensitive. Therefore, not everyone was aware of any current cost estimations as they were more focused on the performance and readiness of the product.

The first cost estimations were based on the production and component costs of previous products, together with estimations from experienced designers. The cost of the product was not seen as too critical for the success of the project by any interviewee; in other words, the limits were not too low. The customer was more interested in the performance than having a low price.

No interviewee indicated any insights into the monitoring of the development program expense.

5.2.2.5 Project communication

The timetables for the project were changed several times, mainly due to internal factors but also from the customer. The project was documented in a shared folder, and the progress and

activities were listed in documents. The members of the team and their roles had also been documented in the folder. The members of the team changed several times during the project. Changes in the project and the product documents were often made locally, which made it hard to keep track of changes. Most communication was done by email.

A new project management software was introduced during the project that all interviewees thought of as a significant improvement. Communication could be stored in the public, forum-like, areas. Files could also be stored, and the activities could be visualized to create an overview of the project.

5.2.2.6 Operations strategy

All interviewees understood the project as fitting well with the strategy of the case company and the respective departments despite not being able to recall any specifics of a communicated strategy. The interviews indicated that the project's contribution to the case company business was crystal clear due to this being a returning customer and was a, for the case company, high-volume production product. All interviews agreed that the critical success factor of this project was the performance of the product and that this was widely understood as being a good fit for the case company.

The eventual lack of electrical engineering capabilities and the lack of software development capabilities were, however, problematic for the project. Despite this, most of the interviews indicated that the project members felt that their department had most, or all, of the required capabilities for project success. However, the interviewees differed in their view regarding if the European organization had the required capabilities, mostly due to the apparent lack of software and electrical capabilities. When discussing the lack of specific capabilities, one interview also highlighted that it is essential to remember that a project can be profitable and successful even if not all capabilities are there at the beginning of the project.

The interviews showed that most of the interviewees were not aware of any concrete strategies of other departments during this project. Some interviewees stated that they lacked insight into the goals of departments for the development process, subsequently making it hard to match department goals according to according to the interviews.

5.3 Projects originated in Germany

This segment will present the empirical findings from the two projects that originated in Germany. Each of the project-specific summaries were determined based on the transcriptions from four project-specific interviews. The structure of the sub-headers represents the areas of focus in the interviews.

5.3.1 Project C description

Project C derives from a platform project that essentially was three variants of a product that could be installed in buses for HVAC capabilities. A new customer requested a prototype to be built, while the development of the product platform was still ongoing, and Project C was therefore initiated separately. The customer requested more functions when they understood that the organization was developing a platform with more optional functions than the customer

initially requested. The German design department that was tasked with designing this new product had also recently been added to the organization. The roadmap of the platform product development was specified to three variants that were planned to be developed consequently. However, due to the new customer requesting the third and most complex variant, the roadmap was changed. This was done because there was the potential of acquiring a large customer operating in a new market segment, which was of strategic imperative.

Time of project initiation: October, 2019

5.3.1.1 Problem description

The product was designed as a modification to an already existing design. The existing design was produced outside of Europe and had to be redesigned while maintaining as much as possible of the original design and its components. The project team in charge of the redesign did not have experience with the non-European operations. Therefore, frustrating misunderstandings and problems in communication led to development delays.

The customer did not fully understand their own needs and made changes to the scope that increased project complexity slightly in the stages before prototyping. This forced the manufacturing, sourcing, and design departments to use ad hoc solutions to get the prototype done in time. The functionality of the prototype product was not confirmed until very late in the project. The European organization had not worked with this type of product before, which added complexity to the project.

Based on the interviews, there was no clear direction or common understanding of the goals in the project. The fact that Project C was for a customer but executed in parallel to the platform project affecting one of the three variants of the platform product added confusion. This project was not following the standardized state-gate process. This added to the delays and became a frustrating topic for some interviewees.

This was also one of the first definite projects that the German and the Polish organizations were collaborating in, consequently not shortening the development time.

All interviewees felt they were motivated in the project, of which, most felt that the time-pressure was the primary motivator to put in extra time and effort.

5.3.1.2 Project organization

This project was an extension of the platform project, and the same project team was allocated for this customer project as they were most acquainted with the variant. The interviews indicated that this project did not follow the stage-gate process for customer projects, and that taking another path that required the project team to increase their communication and improve their collaboration. The interviews strongly indicated that this was not achieved until some resources were assigned full-time to the project as the project closed in on the prototype deadline and thus, became increasingly urgent. This full-time allocation included one sourcing representative and the involved German design engineers to support, amongst others, the manufacturing department with the prototype. One interviewee described it as a tiger team-like approach. The interviews indicated that this approach had a significant positive effect on the project team's productivity and collaboration. However, the interviews indicated that some

team members had hoped this approach would not be necessary and that the problems to be solved proactively.

The project ownership was in the hands of the new design engineering department in Germany, while the other capabilities were located in Poland. Some interviewees described that the leadership of both the customer and platform projects was sometimes unclear, moreover, also the distinction between the two projects. The interviews indicated that additional complexity was added to the project since only one project team member could communicate in the language of the customer.

5.3.1.3 Project management

The platform project's specifications were co-written by the sales department and design engineers with experience of designing products for that market segment. Other departments were not involved. As the customer project was initiated, it used the platform specifications for the third variant in combination with customer specifications to define the project specification. All interviewees felt that there was a sense of consensus regarding the project specifications, but there were indications that the people that joined the project late, as support, might not have seen and reflected on the specifications. The customer that ordered the prototype of the variant was not described as having a clear understanding of their own needs. This resulted in the customer making changes over time that led to delays in development. The new customer segment was also seen as a segment with a higher tendency for changes in specifications over time than the more traditional customers that had been working with the Swedish design department.

The early-stage planning found some risks that were mitigation was prioritized. These included a lack of expertise in electrical components. Most interviewees felt that most risks were mitigated except for the lack of electrical competence resources. One interview recalled that concerns regarding components changes and availability were also raised early in the prototype development by the sourcing department. Furthermore, this led the sourcing department to take responsibility for solutions that were less than optimal due to the time-scarcity, even though concerns were raised.

5.3.1.4 Cost and cost calculations

The customer was seen as a cost-sensitive by most of the interviews. However, the interviews also indicated that the product cost as a critical factor was not emphasized for the prototype. Instead, it was emphasized that the project team was to focus on delivering the prototype according to the customer timetable. This later led to initiating efforts to lower the product cost was, once the platform project and its variants were further developed. The cost of the prototype was estimated by aggregated costs of components used, and the development program expenses were not being accounted for explicitly.

5.3.1.5 Project communication

The progress and activities of the project were listed in excel files on company servers within project-specific folders, and as an interview indicated, there was confusion between the

platform project and the customer project folders. Some interviews indicated that all project team members were not aware that this information existed or simply did not review it.

Changes were made within the organization during the project to implement and use a project management software. All interviewees reported this as a significant improvement for the communication and progress transparency of the project. The names and roles of the project team were clearer and easier to view with the change, according to the interviews. The project specifications were translated to the project management software and were with this visible for everyone. However, some interviews indicated that not everyone regarded that information as relevant due to historical lack of updates.

The interviews showed a consensus that changes in the project was stored in one place that was accessible to everyone.

5.3.1.6 Operations strategy

All interviews agreed that the critical success factors of this project were to achieve a low cost of the final product and that the project was a good fit for the goals and business strategy of the case company. However, the interviews also indicated that there were different perspectives or limited insights into what the strategy was. The answers implied more that the project and the customer was nothing out of the ordinary in terms of the organization. Some interviewees also described an understanding that some departments had specific goals or strategies themselves apart, and that there was a lack of a well-communicated strategy that enabled all departments to guide their goals and strategies.

Most of the interviewees were not aware of any specific strategies or goals of other departments apart from the strategy of the German design engineering site. This site had specifically been tasked to develop products for the new market segment that the case company wanted to enter.

The interviews also made it clear that the strategies of the German department were well aligned with the platform project. However, some interviews indicated that the execution of this customer-project focusing on the third variant of the platform could have been a rushed decision; as the initial roadmap and plan for the development was completely turned upside-down.

The interviewees all stated that the European organization was thought to have the capabilities to achieve success in the project in the beginning. According to some interviews, as the project progressed, it became abundantly clear that not all capabilities were fulfilled, mostly related to electrical components and how the project was prepared and executed, which then slowed the development speed. Furthermore, it was stated that this project helped some individuals within the team to realize the importance of being proactive instead of reactive in the activities as the capabilities and strategies of other departments became more visible.

Only one of the interviews indicated that the case company had made investments in the manufacturing plant to be able to accommodate this new line of products. The strategies of the manufacturing department were also changed as an effect of the project, according to one interviewee.

5.3.2 Project D description

The objective of this platform project was to redesign an original platform design for the European bus market. Significant changes were made to the platform design that was originally designed and manufactured for the North American market by the case company's offices in North America. The project specifications were based on the previous experiences and market knowledge of the sales and design engineers at the German office. The scope of this platform project was to develop two similar variants.

Manufacturers of buses were seen as different from the "off-road" customers that the case company in Europe had previously mostly worked with. The customers for this project would need flexible solutions that could be slightly altered to fit their product while at the same time not requesting a complete customized solution.

Time of project initiation: February, 2019

5.3.2.1 Problem description

All interviewees agreed that the development speed of this project was the objective that was hardest to achieve satisfactory levels of. Factors such as problems with finding suppliers that would fit the platform variant's needs was part of slowing the project down. The speed was also affected by another project becoming more urgent and allocating most of the available resources. The Polish operations were also lacking resources with electrical competence. In addition to these problems, the German design department also had to get to know the European organization in which it had just been integrated and was to operate within. Some interviews expressed that the Polish operations were mainly geared to satisfy the needs of customers that needed highly customized solutions, as was a critical part of the case company's history. The German design department required more collaboration and resources from the Polish operations to develop a manufacturable, well-designed, and source-able platform variant. The Polish operations indicated to have a different mindset and perspective on this. The German design department was still new in the organization, which occasionally added some friction to the communication. The project did, however, improve the understanding between the departments as the project progressed. Some interviewees also noted that ownership of some activities was unclear.

5.3.2.2 Project organization

The platform project was organized with a project manager from Germany. The project had assigned members from the relevant departments, and the members were assigned to the project by their department manager. The interviews indicated that this project manager role was above the case company's traditional stage-gate process, which meant that the project manager was taking responsibility and leadership for the full project. Further interviews indicated that the stage-gate process was not the process used in this project, and another path was taken instead. This approach required the project team to increase their communication, as there were indications of confusion from all interviewees.

The project team members from the downstream departments were not especially involved in the earlier stages of the platform project. There was some confusion regarding this involvement, as some of the interviewees felt that they were not aware of what level of

involvement was expected from them, and other interviewees expressed that they did not get the level of involvement they expected.

Allocated resources to the project team were temporarily lost as another project was prioritized.

5.3.2.3 Project management

The initial project definition was made by the German sales and design departments without any involvement from other departments. The project was based on a set of "artificial" customer needs that the experienced design engineers understood to represent the needs of customers in this market. The interviewees from downstream departments pointed out that it would have helped to know the reasoning behind some of the assumptions made in the project specifications since these departments are responsible for ensuring that all of the platform variants are producible at the end.

The project specifications were seen by most interviewees as a document that had to be filled in for formal reasons and not used as a tool for the effective development of the platform variants. Some risks that were identified in the early stages turned out to become problematic in the later stages. Several interviewees stated that the main risk that became a problem was the lack of resources with electrical competence at the Polish site. One interviewee also mentioned that it was hard to know which documents contained what information.

The project was one of the first ones to come out of the German design engineering department, an important fact that the project manager thought should have been more emphasized in hindsight.

5.3.2.4 Cost and cost calculations

The cost of components for this project was seen as relatively clear by the project manager. The designs were based on previous designs, which made the estimations easier to make. There were regular meetings between the sourcing department and the design department to get updated cost estimations. As components changed, the project manager would get support from the sourcing department with new pricing.

There was a shared sense from the interviewees that the project objective was to achieve readiness of design for the platform, and it would then provide the actual platform cost. Any customizations and cost reductions efforts were to be dealt with after the readiness of the designs was proven.

No interviewee indicated any insights into the monitoring of the development program expense.

5.3.2.5 Project communication

Documents such as the project specifications and documents containing upcoming and ongoing activities were stored in a project folder on a company server. Some interviewees described the files as being accessible to everyone but that the project specifications were not looked at by everyone.

A "list of open points" also kept track of the progress, activities, and changes in the project. One interviewee mentioned that there were weekly meetings to go through the status of any

open points; however, the project team's involvement varied throughout project execution. One interviewee described the visibility of what was going on in the design department as low prior to the project management software. This required the interviewee to contact designers to understand the status of the project. Some of the interviews also indicated that the communication did not detail how certain activities were to be carried out, which made it hard to understand exactly what needed to be done, and how. There were also limited channels to deliver the voice of downstream departments up the stream.

The new project management software with activity visualization and file share capabilities was rolled out during this project. The software had chats and a better overview of team members and historical communications. This software was described as an improvement by all interviewees.

5.3.2.6 Operations strategy

All interviewees agreed that this project was a fit for the case company. They were all aware that the effort to enter the new on-road market was part of the overall European business goal, but most were not aware of any other concrete strategies or goals of the European organization, or its departments.

All interviewees agreed to various degrees that the European organization was not thought to be capable of smoothly achieving the project goals, and all had arguments to support this claim. Most were aware of the lack of resources with electrical competence; some stated that there was a lack of resources in general; some agreed that the case company was not prepared to efficiently work with this type of a [platform] project without any spoken customer requirements, and that some of the processes did not allow for the kind of support and collaboration required. I.e., platform projects were not something that most of the European operations were used to working with. One interviewee stated that the platform projects require more flexibility and resources from the organization and the processes compared to the more customer-focused projects originated in Sweden.

All interviewees agreed that this project increased the capabilities for similar projects in all departments as some improvement-areas seemed to be realized. It was further indicated that the involved departments in Poland changed their strategies to grow capabilities for similar projects. The design department had the capabilities for this project according to interviewees, except for the electrical capabilities and that the department was new to the organization, thus, only on paper familiar with the processes.

The need for departments to understand each other's perspectives and to together work towards the same goal was echoed by all interviewees. None of the interviewees said they knew details of some other department's strategy, but all felt that the project had brought them closer together.

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6 Analysis and discussion of findings

This section was structured to create an overview of the analysis and discussion of project origination and literature. In order to enable an analysis and discussion of the four areas, as illustrated by Figure 6.1 below, the two project-focused areas must first be defined. This was done by reviewing and summarizing the *Empirical findings* presented in the previous section, in which, the five categories focused on during the interviews were analyzed and discussed. Furthermore, the brief introduction and the problem description of each project was infused into each of the five categories. The third (3) area in Figure 6.1 below was based on the first two (1, 2) areas, using the same set of five categories.

The fourth and final analysis and discussion of all projects in the literature context was based on an aggregation of the findings in the four projects. It was structured with the five categories in mind; however, this final area shifts the focus from a detailed categorized level to a more general and higher level highlighting the category's interrelations.

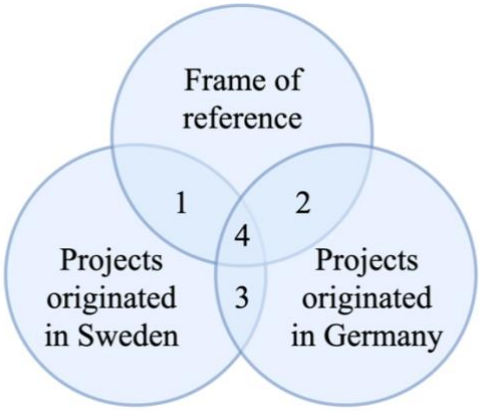

Figure 6.1 - The four overlapping areas indicate the four parts of the analysis

6.1 Analysis and discussion of projects originated in Sweden

This sub-section contains an individual analysis and discussion of the findings from the projects that originated in Sweden (5.2), followed by an analysis and discussion of the common elements of the two Swedish projects studied.

6.1.1 Project A analysis and discussion

For readability reasons, the analysis and discussion below are using the same categories as in the empirical findings (5.2.1). Some elements will be repeated for the same reason.

6.1.1.1 Project organization

The project was executed in a functional fashion, as is standard for the case company and its stage-gate process, with the project ownership moving between departments as the project progressed. This approach is suggested by Slack & Lewis (2017) to work best when the project/product is not very complex. This project was seen as being different because of the complexity of the plastic components. Beyond that, the project was similar to other projects,

and the project was also on schedule and working well until the customer changes were made. This supports the choice of development organization for this project.

The design engineer was also the project manager of this project. This meant that the design engineer had to work on the administration of the changes the customer required, while also assuming the task of creating the new design. In a lightweight team, the project manager is taking care of administrative tasks, but in functionally organized projects, this is not typically needed (Wheelwright & Clark, 1992). This project could have benefited from a division of tasks, but since changes were not expected, it suffered from some of the weaknesses of a traditional functional team.

The idea of the functional organization is that all functions should agree on project specifications of the project as the project starts to avoid mismatches between functions (Wheelwright & Clark, 1992). This will be discussed under "Project management".

6.1.1.2 Project management

The project specifications should function as a guiding light throughout the development of a product (Smith & Reinertsen, 1991). Furthermore, specifications should then be translated into activities and, if the specifications are done by all functions, the activities will better reflect the actual needs of the project. This project seemed to be progressing well until changes were made, which meant that the activities were likely to have been well planned.

The issue with the management of this project seems to be that the customer contract did not limit the customer in how they could make changes to the project. These issues can, according to Lock (2003), be prevented by avoiding trivial descriptions in any specifications. Furthermore, trivial descriptions can be avoided by not using a form to write the specifications, and instead of involving all functions in trying to formulate them as non-trivially as possible. This might be seen as unnecessary by some, but this allows possible problems to be solved early on and therefore reducing the development time as a whole (Lock, 2003). Furthermore, specifications should reflect the contracts that have been written. If this is not the case, the development actor will put itself in a risky position.

The project specifications that the sales department writes should not be different from what the engineering team specifies the project (Smith & Reinertsen, 1991). This is what happened in this project, and it led to the project going ahead with engineering specifications that later turned out to be wrong for the customer.

Tonnqvist (2009) suggests that needs can be better understood if there is an understanding of what the customer of the customer (end-user) wants and expects. In this case, it would have been tough to avoid the problem by understanding the customer or any other stakeholder. The customer did not have a clear enough understanding of what their customer wanted, and the problem that the customer had with their initial vehicle design would have been near impossible to identify for the case company. However, there were indications that the customer did not fully comprehend the significance of this vehicle design flaw and how it would render the case company's design completely obsolete.

6.1.1.3 Cost and cost calculations

Layer et al. (2002) suggests that the process for the pre-project cost calculations need to be based on a sustainable process. This will mitigate the risk of projects going over budget, or in this case that the product cost did not over-reach a predetermined limit. The process in this project seems to have been less than sustainable. It is important to note that the customer changes were very unexpected and that these kinds of significant changes are not something that occurs regularly and are therefore very hard to accommodate and include in the calculation process. Intermediate cost calculations are where the cost problems were beginning to surface. This illustrates the importance of keeping track of costs over time, and to emphasize having some type of a periodic cost reviewal as part of the process, especially for projects with cost as the critical success factor, enabling immediate and data-driven decisions, as emphasized by Layer et al. (2002) .

6.1.1.4 Project Communication

Despite all project files being stored in one location on a company server, there were still uncertainties regarding trusting the files, non-updated revisions, or if anyone was reviewing the documents. These uncertainties were mitigated by informal verbal and email communication, thus reducing the visibility and transparency of progress, changes, activities, and project team. This increases collaboration complexity. According to the interviewees, the project management software that was introduced later in the project significantly improved visibility and, therefore, the collaboration and transparency, making the project progress easier to overview. This also simplified storing all communication in one place, thus reducing the amount and uncertainties of informal communication. In terms of dimensions of upstream/downstream communication, it can be argued that all dimensions were improved, except perhaps the richness of media (Wheelwright & Clark, 1992). Furthermore, improvements are likely to have positive effects on cross-functional problem solving, which was also the case in this project, according to interviewees.

The functional organization of teams allows for specialization of the company capabilities, but also often with a decreased visibility into functions other than one's own (Wheelwright & Clark, 1992). This visibility issue can be mitigated by communicating the project in one place, clearly, so that other function's progress and activities are visible.

The communications in this project could have been started earlier, as described in the project management sub-section. By using project management software, members of the functions later in the process can get an overview and collaborate on the project before documents would typically be communicated. This could influence both the timing and the direction dimensions of communications in a positive way (Wheelwright & Clark, 1992).

6.1.1.5 Operations strategy

The interviews indicated a shared perspective regarding the project being in line with the idea of a market strategy and goals of the European organization despite none of the interviewees being able to recall any specific strategy or goals (in terms of business, market, technology, or operations). This indicates that despite not explicitly communicating any specific business strategy or its implications for other strategies, the organization still manages to organize

resources to enable the operational capabilities to achieve the project goal, with one exception – failing to fulfill the customer-critical importance of product cost. According to Slack & Lewis (2017), this could mean that the case company in this project did not have an 'acceptable' enough strategic alignment as the main competitive priority of cost was not dealt with until late in the process, upon which, much friction was created by the uncertainties about the project outcome as well as the initiation of a parallel cost reduction project.

This project highlights the case company's main strength and competitive advantage: possessing the operations capabilities of achieving high degrees of the performance objectives quality and flexibility by supporting and adhering to the customers and their changes, subsequently satisfying their requirements. This was especially highlighted in this project as the case company managed to re-allocated and re-iterate the project. However, by not realizing the underlying trade-offs of its main strength, other competing priorities such as cost seemed to be lost in translation.

There seemed to have been a strategic consensus within the project team as all interviews shared the same understanding about the competitive market reasons within this project, showing what performance objectives (flexibility and quality) were focused on, and that the cost objective would have to be an entirely separate project. The interviews also showed that most of the interviewees were aware of the existence of some strategies or goals for their respective departments; however, there was an apparent lack of insight into them. With that in mind and the fact that there was no explicit overall strategy communicated, it could be argued that there was not a strategic consensus within the organization. There are indications from the interviews suggesting that despite any overall strategy to relate to, the organization was able to roughly pull in the same direction. To mitigate the risk of pulling in separate directions, the case company should look into implementing an operations strategy (Hayes & Wheelwright, 1984; Slack & Lewis, 2017). The primary purpose of a formulated operations strategy is to provide a direction for everyone within the operations organization to pull towards. Hayes & Wheelwright (1984), Skinner, (1969), and Slack & Lewis (2017) all emphasize that this is a critical component to improve an organization's competitiveness.

For Project A, the interviews indicate that the operations did not have a loose enough fit to enable and align capabilities with project requirements, as not being fully aware of the actual prioritization of the cost objective resulted in a new project reactively being created. To clarify, Figure 6.2 below illustrates an estimation of the situation, and a complexity indication in terms of performance objectives.

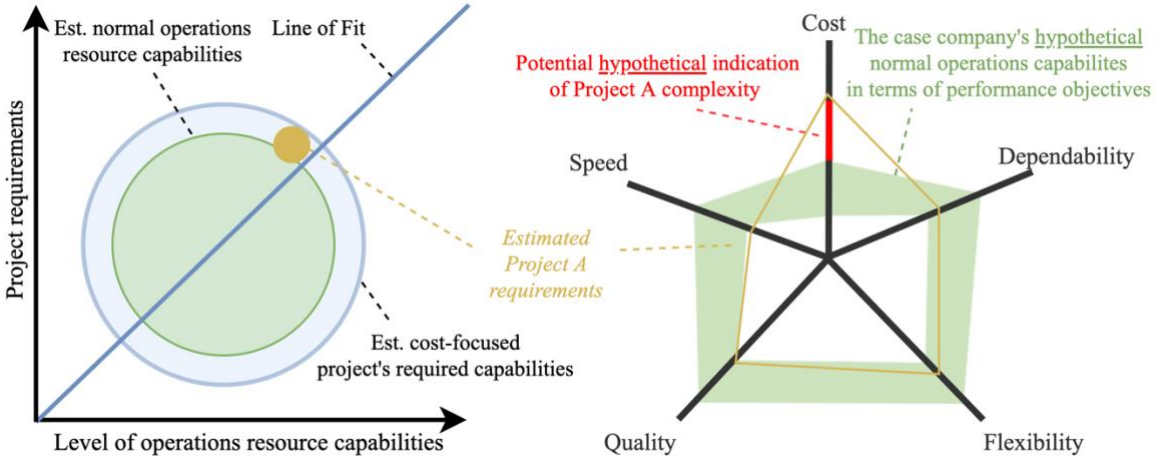

Figure 6.2 – Estimated illustration of Project A's line of fit and complexity indication

6.1.2 Project B analysis and discussion

For readability reasons, the analysis and discussion below are using the same categories as in the empirical findings (5.2.2). Some elements will be repeated for the same reason.

6.1.2.1 Project organization

The project was organized in what would best be described as a functional manner. The project followed the traditional stage-gate process, with a design engineer taking over the role of project manager from the salesperson. The interviews indicated that this project was considered relatively complex due to the lack of electrical engineering resources and the missing software development capabilities within the European organization. According to Wheelwright & Clark (1992), the functional project organization is best suited when the project/product is not very complicated, which does not speak in favor of a functional approach for this project.

The motivation of using a lightweight structure instead of a functional structure is often to make the planning of activities structured and proceeding in a timely fashion, consequently reducing the development time by coordinating activities across functional lines (Wheelwright & Clark, 1992). Furthermore, the lightweight structure is, however, sometimes weak as the project manager does not have authority over the allocated resources within the departments. That common weakness relates significantly to this project and the issues regarding the lack of electrical know-how and software development resources. However, with a lightweight structure, the workload of the project-responsible design engineer could have significantly been reduced as the administration of the consultants as electrical resources, and the lightweight project manager would have managed the communication with the software development department. This speaks in favor of the lightweight structure over the functional structure for this project.

The second (stand-in) design engineer was located at the same physical location as the majority of the project team, including the manufacturing department, which significantly improved the communication and mutual understanding of the project goals. This can be seen as an example of how close communication is vital to overcome the functional silos of departments, as described by Wheelwright & Clark (1992). Furthermore, the product development performance is not only affected by the design of the development process but also the

organization that is executing the process. Based on the interviews, the structure of this project seemed to move towards a lightweight structure as, once the first design engineer returned, he resumed the position of project manager focusing on administrative tasks and coordination activities. The stand-in design engineer from Poland continued as an operational design engineer resource within the project.

Utilizing a balanced team structure could also have been beneficial in this project. However, this would imply a European project manager to have responsibility for non-European resources, which is outside of the scope of this study.

Using a heavyweight team would not have been resource-efficient in this case. Heavyweight teams should be used when the project required much more allocated resources and a full-time team with members with experience from each function (Wheelwright & Clark, 1992). Furthermore, the development time for activities other than the delayed software development was not a critical factor in this project. Another trade-off described by Wheelwright & Clark (1992), that would not argue in favor of the heavyweight team, is that it often disrupts the activities of the normal operations, and the scope sometimes grows significantly.

6.1.2.2 Project management

The project was considered to have been managed well. The project definitions seemed to have been guiding the project well. Smith & Reinertsen (1991) suggests that all involved functions should co-write the specifications. They claim that this is important to solve potential problems as early as possible, but also to create a sense of ownership for all functions. Furthermore, if the sense of ownership is felt by people involved in the project, it can hurt the satisfaction of employees and negatively impact employee turnover. Since the company does not involve all functions in the project specifications, it could be an improvement to consider.

It should also be noted that some of the problems in this project were due to changes having to be made in the software. It might be the case that some of these issues could have been prevented if expertise in this area could take part in the writing of project specifications. “User Stories” is one suggestion from Tonnqvist (2009), that can be used to express customer needs. It is possible that this, or another approach, with the help of expertise, could be used to avoid problems from surfacing later in the project.

6.1.2.3 Cost and cost calculations

Cost-related problems did not occur at any time during this project. The product costs were re-calculated after every prototype cycle and were within the agreeable limits. All interviews indicated that the product cost was not the main competitive priority for this project, as the customer was focused on performance. The case company has historically had customers with more focus on performance than cost, and the approach to their iterations of cost calculations and experiences indicate that this is their usual way of working.

6.1.2.4 Project communication

When files are not available to everyone, as some were in this project, it reduces the visibility of the project. This makes it harder to collaborate, as it is harder to get an overview. The project had one representative from each function, and transparency is essential to reduce gaps between

departments (Wheelwright & Clark, 1992). The new project management software that was introduced helped mitigate some of the problems that usually appear in a functional organization. People could now easily see where the project progress was, even when other functions were taking ownership. This meant that the need for communication through email decreased, which limited the risks of misunderstandings and versioning problems of documents. The dimensions of communication between upstream and downstream groups could be affected positively in three areas by this change: timing, direction, and frequency (Wheelwright & Clark, 1992). According to Wheelwright & Clark (1992), the timing is improved when the downstream groups get earlier communications and the frequency, as communications in batches can be avoided. The direction is improved as downstream groups get access to more information and can communicate upstream earlier.

The shared location of the design engineer and the manufacturing/sourcing departments had a significant impact on the upstream/downstream communication. The weekly meetings with the lightweight manager also had a positive impact on communication. The communication was improved in all dimensions, according to the interviewees, improvements that had a positive effect on the performance of the project.

6.1.2.5 Operations strategy

The competitive market reason for this project was understood by everyone in the project team, apart from indications that the importance was not as realized by the non-European software development department. This was achieved despite no formal or explicit strategy of the business, market, technology, operations, or any departments were communicated, which to the researchers indicate that this project was well aligned with the case company's perspective of the reason for its existence. This indicates that there was a strategic consensus within the project team during this project, supported by all the interviews, stating that this project appeared to suit the organization and its processes well (Ates et al., 2020; van Knippenberg, van Ginkel, & Homan, 2013). However, strategic consensus might not have been for the organization as a whole as there was no explicit strategy or goals to represent the project (Boyer & McDermott, 1999). Furthermore, the missing capabilities in electrical and software development were known by the European organization, and this project supported future efforts to develop long-term capabilities.

All interviews indicated that during this project, the organization was, to some degree, strategically aligned as they were able to match the operations resource capabilities with the customer's competitive priorities. This further highlights the case company's main strength of flexibility as being able to realize what capabilities were missing, followed by a temporary short-term allocation of these to try and satisfy the customer requirements. Despite the short-term allocation of capabilities not being flawless, the customer requirements were eventually fulfilled, which also indicates strength in quality as a natural performance objective.

For this project, the interviews indicate that the operations had a loose enough fit that enabled aligning capabilities with project requirements. To clarify, Figure 6.3 below illustrates an estimation of the situation, and a complexity indication in terms of performance objectives.

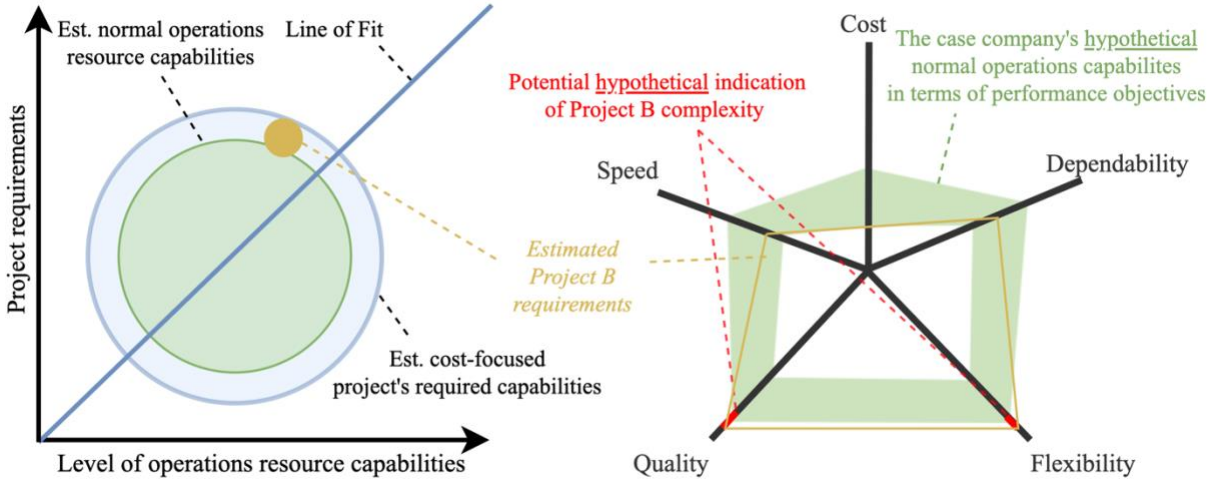

Figure 6.3 – Estimated illustration of Project B's line of fit and complexity indication

6.1.3 Summary of Swedish projects

Both projects were initiated by customers that wanted customized products for their commercial vehicles in development. Both were customers that had worked with the case company before. The both customers requested product elements that added to the complexity of the products. Both projects were initiated in 2018 and followed the stage-gate process that had been developed by the case company. For readability reasons, the summary of the analysis and discussion of these projects was divided into the same areas of analysis as the projects were in their individual analysis. Some elements will be repeated for the same reason.

6.1.3.1 Project organization

Both projects were organized functionally, with functions passing the leadership of the project downstream, as specified in the stage-gate process. The functional structure generally works best when there is a shared understanding of the project between functions, and the complexity does not warrant a project manager (Wheelwright & Clark, 1992). Both projects had specifications that added to the complexity, and both projects could have benefitted from a lightweight structure. This extra complexity required both projects, during the design process, to use resources from outside the European organization, which put extra administrative pressure on the design engineers acting as project managers. Moreover, the necessity for a lightweight structure was realized due to the heavy administrative workload put on the design engineers in both projects. Project B moved to a lightweight team structure, while the design process was ongoing. This had a positive effect on the project, potentially indicating that for similar other projects it could be beneficially argued to be allowed to modify the project organization differently than how the usual development process dictates.

6.1.3.2 Project management

The specifications for the projects were not co-written by all departments in any of the cases. This could be a reason to why the downstream departments were not fully aware of the goals of the projects, the reasoning behind the organization of the projects, or the reasoning behind some of the assumptions that were made in the project specifications. This could have been a reason for some of the issues that the projects later saw. It could also likely reduce employee

turnover and increase employee satisfaction, according to the literature (Smith & Reinertsen, 1991).

Both projects could also have benefited from more specified project specifications, which is important to the success of any project (Lock, 2003). For Project A, it was the product cost and contractual terms, and for Project B, it was details in the product specifications where expertise was not present to write more detailed specifications. Project A's contract could possibly also have been more precise if cross-functional expertise was involved in the co-writing.

6.1.3.3 Cost and cost calculations

The cost of the project and the product seemed to be under control in both cases, as experienced employees did the estimations. This only became a problem when the customer contracts forced the company to change the design in Project A. This is an indication that the process for pre-project calculations was not sustainable, and if they were done (most likely) in the same way for Project B, that project could also have been open for risk if there was an apparent need for changes to design, etc.

6.1.3.4 Project communication

Both projects had some problems with communication between the parties. This included versioning problems of product drawings and project specifications. Communications were also made in a way that risked lowering the visibility of the projects for all members. This was, in both cases, improved by a new project management software. This could, in both cases, have lowered the isolation between departments due to the increased project visibility. In terms of dimensions of communications, as described by Wheelwright & Clark (1992), this could be an improvement in timing, direction, and frequency. Furthermore, this means that the cross-functional problem solving could be improved by having earlier, more frequent dialogues between upstream and downstream actors. Project B also saw benefits from having the design engineer and the manufacturing engineer at the same location, and the better communications of a co-located team could have been an essential factor for these benefits.

6.1.3.5 Operations strategy

Both of the Swedish projects highlighted the main competitive strengths of the case company's European operations, namely focusing on flexibility and quality. The usual stage-gate process used in these projects is designed to optimize the two objectives. The analysis suggests that the case company does not seem to be aware of how to deploy resources and modify the processes (Slack & Lewis, 2017) to add some competitive importance to the cost objective during customer projects, as this in Project A was done by a separate cost-reduction project later. Alternatively, at least not how to include that objective without adding too much complexity to the project execution.

The analysis provided no evidence that the Swedish projects were strategically chosen due to any communicated guiding strategy (e.g., business, market, technology, or operations). Instead, the departments seem to be guided in their decisions by an uncommunicated market strategy that only focuses on the customers and their requirements.

The Swedish projects indicate that the operations' departments typically realize the lack of capabilities once the project specifications are determined, resulting in the allocation of short-term capabilities to strategically align the capabilities. This implies that an informal and non-explicit operations strategy is reactively shaped as the problems are revealed. Reactive strategic alignment still enables the operations' departments to align their capabilities with the customer's project requirements; however, in an uncontrolled manner as the operations strategy is not explicitly formulated.

For the Swedish projects, the analysis suggests that there was a loose line of fit utilizing the built-in flexibility to adhere operations resource capabilities to customer requirements, except for the cost objective in Project A, thus failing its alignment.

6.2 Analysis and discussion projects originated in Germany

This sub-section contains an individual analysis and discussion of the findings from the projects that originated in Germany (5.3), followed by an analysis and discussion of the common elements of the two German projects studied.

6.2.1 Project C analysis and discussion

For readability reasons, the analysis and discussion below are using the same categories as in the empirical findings (5.3.1). Some elements will be repeated for the same reason.

6.2.1.1 Project organization

The organization of this project was not formally structured as other customer-projects usually are, as this project became a branch-off of the original platform project. The interviews first suggested that the platform project was organized in a functional fashion like the stage-gate process, with two exceptions: the platform project did not have any customer input, and it appeared to have a more weighted and experienced project manager. This choice of organization is supported by Slack and Lewis (2007), as a new platform project with a range of variants that will require strong cross-functional collaboration should have a more weighted structure than the functional structure has.

Since the company usually used the stage-gate process, the downstream departments were expecting the platform variants to go through the gates according to the first roadmap, meaning in some type of a regular fashion. However, the interviews later supported that the platform project was not following the usual stage-gate process, but was in fact, adhering to another similar approach that was designed to develop and ensure manufacturing-readiness in platform projects; thus, requiring a lot more cross-functional collaboration. This had some effect on how Project C was organized, as all the interviews specified that there was no shared understanding regarding the development process. The project was communicated as a customer project, which would imply following the stage-gate process designed for these types of projects. This created lots of confusion as there were now two parallel projects, with roughly the same organization, rushing to work on the same product variant without one communicated process. Executing this in a functional structure would create much friction and would require high levels of cross-functional collaboration (Wheelwright & Clark, 1992).

As the project(s) progressed, the project team started to look more like a tiger team as it became clear that the organization and the processes lacked the capabilities to solve this. So, resources started being allocated full-time to finish the first prototype for customer delivery. Completion on time became a success story, and the learnings from this effort were useful for the collaboration between the German and Polish departments.

Developing the first platform products with the tiger team structure allowed both projects to gain valuable insights, especially from the manufacturing department that may have been very hard to get with a platform project without a customer in an organization that is built around a stage-gate process designed for other types of projects.

The uncertainties generated for the departments by not following the usual stage-gate process highlighted the limited range of non-allocated resources and lack of built-in flexibility in the department-specific processes. This was supported by most of the interviews, as most of the involved departments appeared not to have any processes other than the usual stage-gate process with its functional project organization.

6.2.1.2 Project management

As this project was an extension of the platform project, roughly the same project team was allocated for this customer project to simplify the knowledge transfer as most of the project team was familiar with the specifications of the project and the variant.

Some interviews suggested that there appeared to be a low sense of ownership by the departments that were not part of formulating the specifications, and this is something that literature strongly suggests is significant for the likelihood of having a sense of ownership (Tonnqvist, 2009). Furthermore, this can help reduce employee turnover and increase the satisfaction of employees in general.

The risk of not having enough electrical competence and resources was identified early in the project, but it still became a problem later. This is analyzed in the 'Operations strategy' below.

The customer requested the most technically advanced out of the three variants in the platform line, a platform line that was still in development. Based on the definitions of Smith & Reinertsen (1991), this customer could be categorized as a "lead customer" that is aware of the limits of current product-offerings and has customer-perspective insights into the market and the competition. According to this definition, the customer would, in this case, have valuable feedback and likely to be willing to pay a premium for the product once it was ready to be delivered. The case company would just have to avoid taking on projects from lead customers if the project is not in line with company strategies. This does, however, not seem to have happened in this case, since the product was already being developed before the customer got interested. The issue of the "lead customer" misjudging the market is also not likely due to the same reasons (Smith & Reinertsen, 1991).

Some of the interviews support that when the customer changes their specification because they were not completely aware of the actual needs, its usually something that could have been proactively solved, as the changes are usually not wholly unexpected. Therefore, the case company should do its best to assist the customer in understanding their own needs to mitigate risks of delays and late changes; thus, utilizing and capitalizing on the know-how and

experience of the case company's employees. This would also enable closer collaboration, and even a co-development, between the customer and the case company as value, is hereby added by both this service as well as the product.

6.2.1.3 Cost and cost calculations

The product cost factor was not prioritized for this prototype despite most interviewees agreeing that this was a cost-sensitive customer. However, this was not seen as a problem since the prototype was regarded as a proof-of-capability in which the delivery time was prioritized, and that a cost-reducing effort would be deployed once the project and the platform project were further developed.

The costs of the customer project and the platform project were both not accounted for or summarized; instead, the product cost was always the main cost-focus. This would indicate that there could be valuable insights for the case company to consider further investigating and understanding their development cost-structure. This could support data-driven decisions in development projects when additional capabilities, reports, tools, or similar are requested.

6.2.1.4 Project communication

At the initiation of this project, all files and documents were located on a company server project folder, accessible for the team. As the team was roughly the same as for the platform project, this created some confusion as some information was stored in another folder for that project. The communications were most often done via email or orally, and a list of open points was updated to keep track of changes and progress. This setup was not optimal for either of the projects, as the more complex the project, the higher the need is for cross-functional problem-solving. Cross-functional problem solving is directly dependent on the nature of communications, as described by Wheelwright & Clark (1992). Furthermore, the level and quality of communication are greatly affected by the project organization and by the physical location.

The implementation of the project management software increased the visibility between departments, which helped decrease the barriers for cross-functional communications and collaboration. This was also seen as a helpful software when the tiger team structure was implemented, which indicates that it was useful even when the teams were working in a non-functional structure. This improved cross-functional problem solving according to interviews, possibly because the communications were improved in all dimensions except the richness of media, as supported by Wheelwright & Clark (1992).

As the tiger team was working at the same physical location, all four dimensions of the upstream/downstream communications were significantly improved. The fact that the project progressed faster with the way the tiger-team communicated in this case conforms with literature.

6.2.1.5 Operations strategy

All interviewees agreed about the competitive market reason for this project and that it was a good fit for the goals and strategies of the European organization; however, not all shared the same perspectives as to why it was a good fit. The fact that all interviewees agreed speaks in

favor of strategic consensus in the project team (Ates et al., 2020; van Knippenberg, van Ginkel, & Homan, 2013). However, the strategic consensus of the organization was a bit unclear as the different perspectives of why this project was a good fit for the organization could support the notion that there are several revisions of a strategy, or several strategies, being vaguely stated and communicated; essentially derailing the organization (Boyer & McDermott, 1999; Hayes & Wheelwright, 1984; Skinner, 1969). This was supported by several interviews indicating that it felt like the strategy was not guiding the project(s), or that it was not listened to.

As supported by the interviews, there could be an apparent lack of internal communication regarding any clear business strategies that would indicate the direction of the case company. This is also true for the strategies and goals of departments, as all interviewees were aware of the German department's reason for existence but failed to specify any goals or strategies for other departments than their own. This is supported by Slack & Lewis (2017), and Hayes & Wheelwright (1984) as a possible root-cause for employees of an organization not pulling in the same direction, or not pulling at all. All reviewed literature emphasizes that there should always be a clear and concrete operations strategy to act as a compass for all departments, necessitating its translatable for all departments, ensuring that the operations are aligned with the overall business strategy (Hayes & Wheelwright, 1984; Skinner, 1969; Slack & Lewis, 2017).

All interviews suggested the same perspective of the project that the organization was lacking resources with electrical competences and that the resource deployment resulted in misaligned capabilities versus the project requirements. Therefore, there appeared to have been a strategic misalignment for this project (prior to tiger team deployment). This is supported by despite being early-on aware of the apparent lack of electrical competence, and the organization appeared not to be flexible enough to allocate short-term electrical capabilities enabling a smoother project execution that could have supported in reducing the complexity and the development speed. Furthermore, the researchers argue that the chosen resource deployment of the project was not suitable for a project of this complexity, especially under a time-constraint (Wheelwright & Clark, 1992). Moreover, not only was the product variant complex, but it was part of a complex platform project still in development, which typically is very resource-demanding projects due to their demand for cross-functional problem-solving. As the results of the interviews showed, once the resource deployment was changed to a tiger team structure, the most weighted of them all, the project performance drastically increased, and strategic alignment to some degree was achieved as the capabilities were aligned with the project requirements.

Most of the interviewees indicated that the European organization at first was thought to have the capabilities to execute this project, but that this realization changed during the project. The researchers would, in this case, emphasize understanding what factors will have what implication regarding complexity, either in project execution or in product development. The earlier these risks are realized, the less comprehensive and extreme the resource deployment (or re-deployment) must be.

For this project, the interviews indicate that the operations had too tight of a fit to enable and align capabilities with project requirements, until the tiger team approach was deployed loosening the fit, at which, strategic alignment was achieved. To clarify, Figure 6.4 below illustrates an estimation of the situation, and a complexity indication in terms of performance objectives .

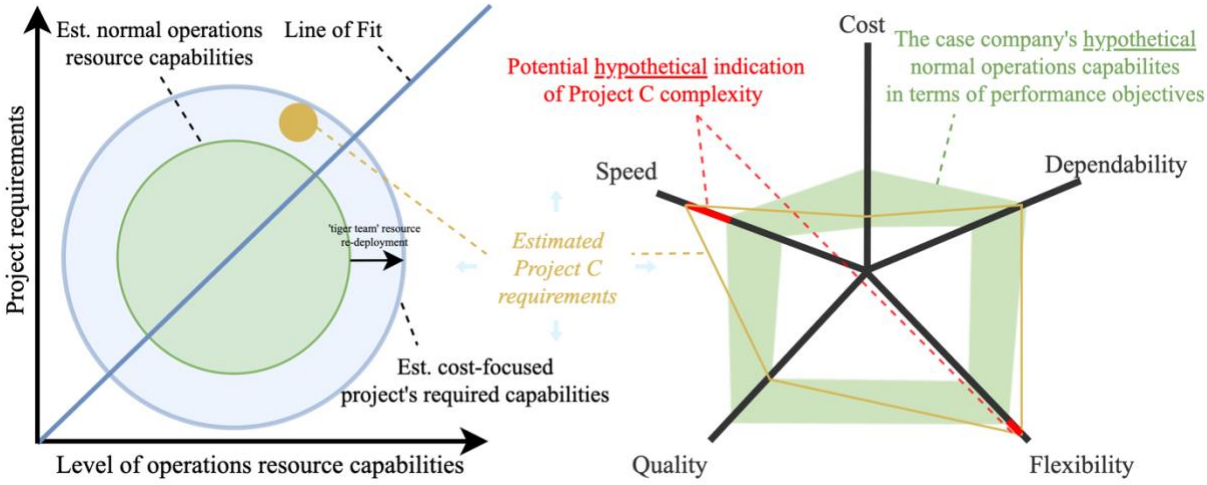

Figure 6.4 - Estimated illustration of Project C's line of fit and complexity indication

6.2.2 Project D analysis and discussion

For readability reasons, the analysis and discussion below are using the same categories as in the empirical findings (5.3.2). Some elements will be repeated for the same reason.

6.2.2.1 Project organization

This platform project was organized with a cross-functional team similar to usual the stage-gate process, but with one key distinction, there was a weighted project manager allocated with the project ownership, something that was a source of confusion. The interviews indicated this was a lightweight project structure, since the project team members were still working from their respective departments not being allocated full-time, and the project manager did not have any authority over resource allocation from the departments. However, the project manager was the resource manager of the design department, indicating a heavier-than-lightweight approach within that department.

The project was distinctive from the typical projects the organization works within its processes in that this project was without any customer and spoken requirements. The interviews indicated that there was a necessity for better and more communication and collaboration within the project team, as there were uncertainties about what actions and activities were needed and when for this type of project. Certain downstream departments were aware that things were done differently but were not aware of how to adequately prepare, adapt, allocate resources, and collaborate with this new approach. In these types of scenarios, the reviewed literature, including Wheelwright & Clark (1992), indicates that, with the more uncertainties and collaboration required, the heavier the project structure should be to mitigate these uncertainties and to simplify improving the collaboration. All interviews describe what appears to be in line with what Wheelwright and Clark (1992) together with Slack & Lewis (2017)

describe as problems and uncertainties that could be expected when having a non- or low-weighted cross-functional team structure.

The interviews indicate that the project structure was, on paper, mostly lightweight, but not all perspectives were completely aware of this, the reason, or its implications. This will be further analyzed in "project communication" and "project management" below.

A balanced team borrowing more elements from the heavyweight structure might have brought benefits to the projects as all resources could have been directly authorized and controlled by the project manager. These types of team structures specifically give a higher degree of collaboration and better cross-functional problem solving, things that the interviewees saw as problems during this project (Wheelwright & Clark, 1992).

6.2.2.2 Project management

The project definition was not co-written with all departments, a practice that the literature emphasizes to be very important to keep functions from having different understandings of the project according to Smith & Reinertsen (1991). Furhermore, co-writing is also an essential factor for the creation of a sense of ownership, something that can increase work satisfaction and decrease employee turnover. If all functions are involved in these early activities, it is less likely that team members will understand the details of the project and why it is organized as it is (Smith & Reinertsen, 1991).

Since the project was for a platform project, the volumes that could be sold were only estimations. This information is crucial for most of the downstream departments involved in ensuring that the variants are producible, regarding everything from supplier negotiations to manufacturing processes. Therefore, having all departments take part in the co-writing of the project specifications could possibly have mitigated some of the assumptions without necessarily having any limiting effects of the platform concept and design.

Lock (2003) also supports that the more knowledge, insights, and shared understandings a project team has regarding the project specifications, the more effective the development efforts will be. However, most of the interviews described these types of documents as more of a formal requirement for the organization than an effective tool.

Early in the project, it was identified that the lack of resources with electrical competence could become a problem, which most of the interviews also supported became a problem that had a negative effect on the development speed. This will be further analyzed in "operations strategy" below.

6.2.2.3 Cost and cost calculations

Some of the interviews stated that the costs of this platform were initially made with pre-calculations based on previous similar variants being produced by one of the case company's non-European organizations, therefore, also providing estimations about production costs, which could reduce risks related to costs. Achieving readiness of designs was a shared understanding by the interviewees, and that indicated that since the project already had a good overview of the costs, it was no cost-limit communicated as a critical success factor, thus not hindering the development speed by not allowing the project to advance.

The interviews indicated a good collaboration between the project manager, design engineering department, and sourcing department regarding the costs of the platform's two variants and how they were updated as the designs changed, mostly due to changes in components. This were similar to the approaches suggested by Lock (2003) for versioning and could be one of the reasons that no interviewee described the cost calculations as being problematic.

6.2.2.4 Project Communication

Files were initially stored in a shared document folder accessible to all team members. It is vital that team members have a shared understanding of the project, and keeping documents in one place can help simplify this. The new project management software that was introduced later in the project was seen as an improvement to current practices. The new software helped with visualizing activities, keeping communications in one open forum, having a visual representation of the project progress, and more. These are all crucial factors for keeping the visibility of the project high, and the visibility of the project is especially important to avoid misunderstandings in a functional organization that already could struggle with this according to literature (Wheelwright & Clark, 1992). In Wheelwright & Clark's (1992) terms of the dimensions of communications described in the frame of reference, the timing, frequency, and direction were all improved to improve the required cross-functional problem-solving.

The interviews especially emphasized that the communication needs to improve in projects such as this one, as they become a bit more complex requiring cross-functional problem solving and that the uncertainties increase more without any customer to involve for feedback. Not sharing an understanding of the "artificially" generated project specifications, its implications, and the level of required involvement seemed to be a worrying consensus of most of the interviewees. It is also essential that the reasoning behind the organization of the project is communicated, and this is something that can be better understood by all team members if all functions can take part in the co-writing of project specifications.

6.2.2.5 Operations strategy

All interviews agreed about the competitive market reasons for this project, sharing the perspective that was a good fit for the European business strategy of entering the new market. As the interviews all shared both of these perspectives, it indicates that there was a strategic consensus within the project team and also within the organization as the interviewees could, in most cases, specifically refer to an overall strategy of wanting to enter a new market (Ates et al., 2020; Boyer & McDermott, 1999; van Knippenberg, van Ginkel, & Homan, 2013). This would mean that the project team knew both about the competitive reasons for the project itself and that it was represented by the business strategy and its goals. This is referred to in the literature as to when the overall strategy is acting as a guiding compass, indicating what direction the company wants to move in (Hayes & Wheelwright, 1984; Skinner, 1969; Slack & Lewis, 2017).

Regarding the strategies and goals of departments, there was a consensus amongst the interviewees about not being aware of any specific strategies or goals of other departments than their own, apart from the goals of the German design engineering department, which all, to some extent, were aware of. Based on the literature, this analysis has already indicated that

there was a strategic consensus for both the project and the direction of the case company, one can assume that the departments should have individual strategies reflecting the overall strategy, and thus the direction(Ates et al., 2020; van Knippenberg, van Ginkel, & Homan, 2013).. However, in the absence of an operations strategy, the overall strategy could be vague enough to enable departments to translate it differently and thus trying to pull the company in different directions. Literature states that to ensure that an organization and its departments are pulling in the same direction, there needs to be an operations strategy that is representing the business strategy, is more detailed and concrete, and should be easy to translate, thus mitigating the risks of translating a vague strategy (Brown & Blackmon, 2005; Slack & Lewis, 2017).

An analysis of the interviews from this project indicates that the case company failed to organize and deploy their operations resources in such a manner enabling the necessary capabilities to satisfy the project requirements and goals efficiently. This strongly indicates that there was a strategic misalignment for this project (Slack & Lewis, 2017). This is supported by the operations not being flexible enough to allocate short-term capabilities mitigating the early identified lack of electrical competence. Moreover, despite it being a consensus about the product complexity, the complexity of executing this platform project was underestimated. Platform projects, in general, are very resource-demanding and require cross-functional problem-solving to be effective in their development, thus reducing the development time (Wheelwright & Clark, 1992). This platform project should not be considered to be anything else, and therefore, the resource deployment should represent this. The resource deployment was done mostly in a lightweight structure, which could seem fitting for this platform project; however, the interviews indicate that there was no common understanding about this being done, and there seemed to be no processes designed for other functions than the design engineering department to be able to work in this manner outside of the normal stage-gate process. The literature suggests a heavier resource deployment to increase the flexibility of the operations, thus simplifying the strategic alignment between operations resources and project requirements (Slack & Lewis, 2017; Wheelwright & Clark, 1992).

For this project, the interviews indicate that the operations had too tight of a fit to enable and align capabilities with project requirements. To clarify, Figure 6.5 below illustrates an estimation of the situation, and a complexity indication in terms of performance objectives.

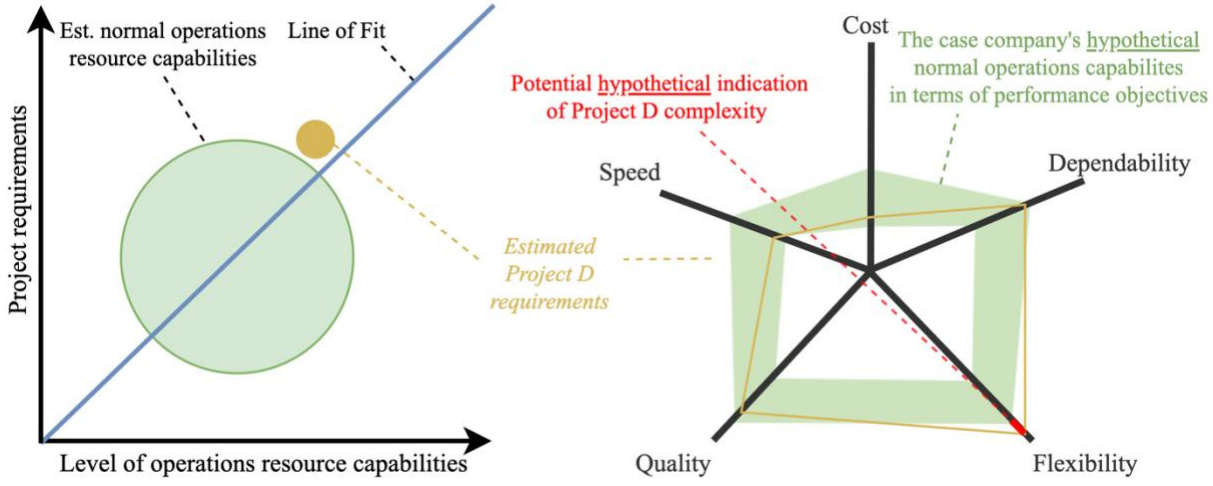

Figure 6.5 - Estimated illustration of Project D's line of fit and complexity indication

6.2.3 Summary of German projects

Both German projects were rather complex projects that required support and collaboration from the Polish departments, with Project D being a platform project and Project C being a branched-off customer project from an in-development platform project. Both projects did not follow the usual stage-gate process that the case company usually uses for customer projects. For readability reasons, the summary of the analysis and discussion of these projects will be divided into the same areas of analysis as the projects were in their individual analysis. Some elements will be repeated for the same reason.

6.2.3.1 Project organization

Both projects had a lightweight project manager, something that stood out of the usual stage-gate process that the case company was used to. This structure was necessary since the complexity of both projects warranted a project manager. Both projects had problems with downstream departments not fully understanding the organization of the project, and what the motivations and implications were for choosing the team structures that were used. The lightweight team structure also has the intrinsic weakness of the project manager not having mandates over resources in other departments (Wheelwright & Clark, 1992), which was true for all departments, except for the German design engineering department were the project manager also was the resource/functional manager. This meant that resources for the projects could be allocated directly by the project leader within the department.

These factors created problems in both projects, and in Project C the less-than-smooth collaboration later forced the organization to apply a tiger-team-like organization. This effort allowed the company to deliver the prototype on time, which suggests that the cross-functional collaboration was essential for Project C.

6.2.3.2 Project management

None of the projects had a co-writing of the project specifications. This could be important to increase the sense of ownership in the projects (Smith & Reinertsen, 1991). According to Smith & Reinertsen (1991) could also increase work satisfaction and decrease employee turnover, while also increasing the collaboration and performance of projects as, for example, trade-offs can be discussed more thoroughly. The trade-offs and assumptions made in the project specifications were not clear for the downstream departments, which meant that the execution of both projects suffered because of uncertainty. This could mean that some problems could have been avoided if there the co-writing involved more departments.

The process and organization of the projects were also unclear for some downstream departments, something that led to misunderstandings and delays. This could probably have been avoided if the project specifications were better understood by downstream departments. One way to do this could have been to include them in the writing of the project specifications.

In Project C, the choice of taking on a customer project from a “lead customer” required the allocation of more resources. It would, therefore, have been necessary for the company not to take lightly the decision to invest in the market of this lead customer at the possible cost of other projects losing resources, according to Smith and Reinertsen (1991).

6.2.3.3 Cost and cost calculations

Both products were based on previous platform designs, and the involved engineers were experienced with similar designs, which meant that they could be more precise in their pre-project calculations, as supported by Layer et al. (2002). In addition to this, the costs were not seen as problematic for any of these projects. The costs were updated regularly, and the relationship with sourcing was seen as important in both projects to keep product costs up to date.

6.2.3.4 Project Communication

Both projects got benefits from changing to a new project management software. It was, in both cases, clear that the communication between departments suffered from having a late timing, which had a negative effect on the performance of the projects. This was, together with frequency and direction, improved with the new software. The tiger team that was later introduced in Project C increased cross-functional problem-solving and improved the upstream/downstream communications in all dimensions, as described by Wheelwright & Clark (1992).

The communication in both projects suffered from the new design department not being used to working in the European organization. This was improved over time in both projects, and the assumptions that were made in the project specifications then became better understood by downstream departments.

6.2.3.5 Operations strategy

The German projects represent a different competitive focus for the European operations compared to what competitive focus the organization, its processes, and projects usually has, therefore, adding complexity to the operations' execution. The analysis provided strong evidence that both German projects were strategically important based on a clearly outspoken market strategy to enter a new market segment. The competitive objectives of the new market strategy were increasing the focus on cost, thus lowering the demand for flexibility, which qualifies platforms to be used more efficiently.

Despite the outspoken market strategy for the German projects, it was clear that most of the operations' departments instead seemed to be reactively guided by an informal and non-explicit operations strategy based on the usual processes and projects. It supports the notion that the non-explicit operations strategy was not formulated to include the new market strategy (Brown & Blackmon, 2005; Hayes & Wheelright, 1984; Skinner, 1969).

The German projects ran into problems based on the capabilities of the operations resources not aligning with either of the project's requirements; however, Project C's requirements were solved by a tiger team resource re-deployment. The re-deployment aligned the capabilities and Project C's requirements by utilizing the reactive and flexible non-explicit operations strategy that the Polish downstream departments were used to be guided by in customer-requirement projects. This revealed that there seems to be a lack of understanding of how the operations' current capabilities are affected by the choice of resource deployment; therefore, effectively hindering a project's strategic alignment (Slack & Lewis, 2017).

For the German projects, the analysis suggests that the collective operations had too tight of a fit to support and strategically align the capabilities and requirements. This seems to be accurate as unsuccessfully understanding what effects the operations resources deployment has on the capabilities would lead to a misalignment with the project requirements. Tiger team deployment increased the operations resource capabilities to enable alignment for Project C.

6.3 Analysis and discussion based on country of origin

Based on the performed analyses and discussions of the projects originated in Sweden (6.1) and in Germany (6.2), this sub-section analyzes and discusses the similarities and differences based on the country of origin. For readability reasons, it was divided into the same five categories previously used. Some elements will be repeated for the same reason.

6.3.1 Project organization

All Swedish projects in this study were organized in a functional structure. According to Wheelwright & Clark (1991), this works best with projects where it is not justifiable to have a project leader. One of the projects later moved to a lightweight structure, which was positive for Project B.

The German projects needed more cross-functional collaboration and saw some issues in the collaboration. They were both organized as lightweight teams and had a different process. Project C later re-deployed to a "tiger-team" structure, which helped the project get completed on time, as previously studied by Wheelwright & Clark (1991) and Slack and Lewis (2017). Having the project team structure changed is something that projects B and C, from both countries, benefited from.

This could indicate that projects should be organized differently from the beginning based on the type of project, a change that would also require the stage-gate process to be changed for projects such as platform projects.

6.3.2 Project management

Smith & Reinertsen (1991) claim that project definitions should be co-written by all functions that are going to be involved in the projects. This could be used as an improvement in projects originating both in Sweden and in Germany. Projects from both countries encountered problems that could probably have been prevented if there was a more thorough co-writing of specifications. The co-writing should, apart from involving all functions, involve people with expertise in the areas that the project will need (Smith & Reinertsen, 1991). All four studied projects had a lack of electrical resources and competence. This could have meant that some specifications were left vague in that area, which generally means that problems will just resurface later in the projects. Both countries might also see positive effects on employee turnover and satisfaction by improving the writing of specifications.

Downstream departments were also unsure of the motivations behind some of the choices of project organization. This could probably have been avoided if the downstream departments could understand the choices in the project specifications better, possibly by co-writing.

6.3.3 Cost and cost calculations

Cost calculations were done periodically in all four studied projects. For the German projects, Project D was a platform project without a final customer; however, Project C was branched off from an in-development platform project for a customer. The customer was not seen as being sensitive to the costs of the prototype platform variant. The Swedish projects both had to be quoted before designs were frozen or components determined. This means that the risk of miscalculations in the Swedish projects and Project C would have been seen more directly than in Project D. A sustainable process for pre-project calculations was, therefore, more important in the customer projects A, B, and C than in Project D.

The German departments had more data from very similar platform designs, which will help make the estimations more accurate according to Layer et al. (2002), and could have assisted in mitigating the uncertainties in the pre-project calculations.

6.3.4 Project Communication

All four analyzed projects benefitted from the new project management software implementation. Communication, files, and project updates could be visible for everyone involved in the projects. There were some issues with file versioning in all projects, and even though this might be clearer with the new software, the case company might benefit from investigating this further in all European projects. There could be issues with cost calculations when versioning of documents is not adequately controlled (Lock, 2003).

The German projects were generally more complex, which meant that they needed enhanced cross-functional problem-solving. The German Project C achieved this when upstream and downstream departments were working together in a tiger-team structure. This enhanced communication was also experienced in the Swedish Project B, with the co-location of a design engineer and a manufacturing engineer.

In general, the need for cross-functional problem solving increased during the time of all projects, and almost all dimensions of upstream/downstream communication, as described by Wheelwright & Clark (1992), were improved as the projects progressed. The literature suggests that if the communications in these projects were started earlier, it could influence the speed of the development projects from both offices. The co-writing of specifications could be part of this early communication.

6.3.5 Operations strategy

The analyses strongly suggest that a clear distinction between two different market strategies and how the case company's operations adhere to their contexts and competitive objectives. One is an uncommunicated and non-explicit market strategy that seems to be based on an operations-wide strategic consensus about the case company's competitiveness in the market, focusing on customers and their requirements competing with high levels of quality and flexibility. Both of the Swedish projects (A, B) seemed to be in line with this uncommunicated and non-explicit market strategy. The other is a well-communicated market strategy emphasizing to enter a new market with platform products that has a different set of competitive

objectives being more focused on cost and less on flexibility. Both of the German projects (C, B) strongly supports the well-communicated market strategy.

There are strong indications to support the notion that there exists an uncontrolled non-explicit operations strategy that is shaped by the non-explicit market strategy. As the market strategies are not including one another, the operations strategy will also not include the new market strategy; thus, supporting the alignment-problems between the German department and the Polish departments, and supporting the strategic alignment seen between Swedish and Polish departments.

The non-explicit operations strategy seems to approach strategic alignment by realizing the lack of capabilities once the project requirements are determined and then attempting to allocate capabilities for alignment reactively. Since the operations strategy is not formulated, this reactive alignment becomes complex and problematic for projects (A, D) focusing on other objectives than the non-explicit market strategy, such as cost-focused (A), or platform (D), projects. Additionally, the analyses strongly indicate that there is a lack of understanding of how the operations' current capabilities are affected by choice of operations resource deployment, therefore, effectively delaying or preventing strategic alignment with project requirements (Slack & Lewis, 2017).

In general, two customer projects (Project B, Sweden and Project C, Germany) were to the most part able to strategically align with a loose line of fit at some point, but Project A (cost-focused) and Project D (platform) did not strategically align with the operations capabilities.

6.4 Analysis and discussion of all projects

The previous three parts (6.1, 6.2, 6.3) of the analysis and discussion of findings is the base of this sub-section.

Figure 6.6 below acts as a vital part of this final sub-section, demonstrating the importance of resource deployment for an effective project execution. *Project X* and *Project Y* are both fictional projects shaped to easier communicate the concluding analysis and discussion.

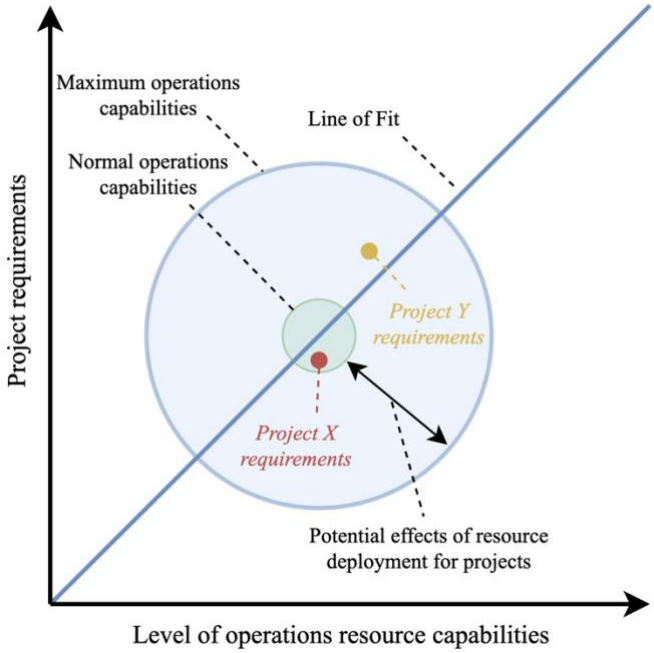

Figure 6.6 - Illustration of resource deployment for specific projects

The line of fit, with its tight (small green circle) and loose (larger blue circle) fit, illustrates how the strategic fit can be tighter or looser depending on how resources are deployed for a project, similar to what is presented by Slack & Lewis (2017). The type of structure that is used to organize a development project is part of the resource deployment as a project is taken on (Slack & Lewis, Operations Strategy, 2017). For example, the case company will have the capabilities to effectively execute Project X following the usual stage-gate process with a functional team. However, the case company will not have the capabilities to effectively execute a Project Y following the usual stage-gate process with a functional team, but the capabilities may be increased if resources are deployed differently, and the team is weighed further, as described by Wheelwright & Clark (1991). Furthermore, a weighted team will give the organization better communication, a higher sense of ownership, and better cross-functional problem-solving. These are all factors that would allow the case company to take on more complex projects, such as Project Y, in an effective way. Other things that are part of the resource deployment are the management of the project, and of course, what process is used to guide the project. This capability of creating weighted teams is one of many ways to loosen the fit from the normal operations capabilities.

The previous analyses of the projects show that the resources that were deployed to a project often had to be changed during the project execution. This indicates that the fit of the company got looser as projects progressed to eventually get loose enough to get the necessary capabilities. The case company also understood how its operations resources should be deployed as the problems and complexities of the projects became clear. The early-stage planning of development projects could help the case company realize potential problems in a project and deploy resources accordingly, instead of doing so reactively (Lock, 2003). Furthermore, becoming a bit more proactive in deploying the suitable resources, which also enables strategic alignment, could have a positive impact on project performance, as previous analyses imply. Early stage involvement and co-writing of project specification can also have

positive effects on sense of ownership, employee satisfaction, and reduced employee turnover (Tonnqvist, 2009).

The fit is loosened by what operations resources the case company has and how they are deployed, thus enabling different capabilities (Slack & Lewis, Operations Strategy, 2017). Furthermore, the operations strategy of a company can guide the organization to change these capabilities. The operations strategy of the case company was not explicitly communicated during the studied projects, according to the interviews, which meant that the capabilities that were needed for the projects could only be understood during the execution of the projects, and thus not proactively. In the case of Project A, this eventually necessitated the initiation of a second project to reactively bridge the unresolved gaps in capability and requirement left from Project A. The non-explicit operations strategy was then changed as the need for new capabilities were realized during the execution of the projects, something that could possibly be done earlier by improving the early project planning. One capability that was noted as in need of improvement was the need for close communication between the German design department and the Polish departments in the complex projects C and D.

The nature of communications in projects is essential for a loose fit since it gives the organization more capabilities (Wheelwright & Clark, 1992). The communications of all projects were improved by the implementation of a new project management system. This change improved communications in, with dimensions as described by Wheelwright and Clark (1992), the dimensions of timing, direction, and frequency.

7 Further discussion and recommendations

This section provides two final subjects for discussion followed by a recommendation for the case company. The discussion was divided between this and the previous section, as to distinct between 'discussion of findings' and this supplementary discussion. The case company's recommendation attempts to synthesize and summarize the entire previous *Analysis and discussion of findings* section into their context.

7.1 Discussion of design and data quality

This case study was based on four projects, two originating in Sweden (A, B) and two in Germany (C, D). It is therefore important to note that these projects are not representative of the operations of the European organization in general. In addition to this, the studied projects were selected because they were deemed problematic, so the study cannot be representative for unproblematic projects. It is, therefore, important for the case company to consider these project findings in the context of their collective European operations.

The methodology of this project included a compilation of answers in interviews to a description of projects. There were cases were answers contradicted each other, which was an important finding, but that at the same time made the analysis more complicated. This could be an interesting indication of how it can be to work in projects were decisions must be made on conflicting information.

7.2 The case company's perspective of a problematic project

Determining what is a problematic project is not always simple. The categorization used in this study regarded four areas that make projects problematic: *development speed, product cost, product performance,* and *program development expense.* None of the projects studied were described as having problems with the program development expense. The study suggests that a reason for this could be that the organization did not seem to account for all costs related to the development projects. Noteworthy, this practice has since changed but it highlights the problem of issues not always being visible, which means that some projects might have had problems that were never noticed during project execution.

Apart from the categorization and identification of issues it should be noted that people and organizations will have different views on what constitutes a problematic project. It is not uncommon that projects that were problematic still become commercial successes. This can of course lead to problems not being ignored, which could lead to long-term competitive issues, and to short-term reductions in margins. Even if the studied projects became commercial successes, some problems were still identified, and not ignoring them is imperative for the success of any company. The fact that this study was requested shows that commercial success is not seen as the solitary measurement for project success at the case company.

7.3 Recommendations for the case company

The operations strategy is the translation of market needs to capabilities in the company. Some capabilities that are needed are currently brought to the attention of the case company by

executing projects and then understanding what capabilities are needed. To avoid having to do this during the execution of a project, the operations strategy can be changed proactively to create capabilities before the execution of projects. This will make it easier to satisfy market requirements but necessitates knowledge about the capabilities and the interrelations between operations resources and market requirements. An operations strategy matrix analysis could provide that knowledge, see Appendix B. The operations strategy is easier to change if it is somehow formulated. The operations strategy is also easier to communicate if it is formulated, and the departmental collaboration is likely to improve if the common need for capabilities is understood. The first recommendation is therefore to **formulate and communicate the operations strategy**.

Part of creating a formalized operations strategy is to understand what capabilities the case company has, and what capabilities the case company requires. If the case company is aware of what capabilities are present and which capabilities are not present, resources can be more accurately deployed as projects are executed. The capabilities that a project will require can be more clearly understood if there is a co-writing of the project's specifications, where expertise in different areas can create a more shared understanding of the requirements and risks of the project. The second recommendation is, therefore, to **include all upstream and downstream departments in the co-writing of project specifications.** The problematic projects in this study often had the team structure of the projects (B, C) changed. This is one of the things that could be avoided if the needs of the project and the capabilities of the organization is better understood at project initiation.

Project A suffered from not being able to renegotiate the product price, which indicates that the process for quoting and estimating costs was not sustainable. The literature suggests that there should not be different specifications for sales and engineering, which means that specifications and changes that are made by customer requests should be reflected in one set of specifications. The third recommendation is therefore to **avoid having separate specifications of the project between sales and engineering**.

Since the resource deployment in projects are sometimes going to be similar, the approach of resource deployments can, to a certain extent, be standardized to avoid having to plan each project from scratch. One way to standardize the deployment in a project is through a stage-gate process. The organization has a stage-gate process and based on the problematic projects that were studied this is a good starting point for the projects (A, B) originating in Sweden. The process of more complex projects, such as the projects (C, D) from Germany were not as formulated and communicated, especially lacking understanding for how the downstream departments were to support the project. To make resource deployment in similar projects easier, the fourth recommendation is to **create and communicate a more standardized process for more complex projects**. The early-stage activities, such as the writing of the project specifications is where the decision of which process to use should be taken, which means that to succeed with standardized processes, the pre-project activities must be able to reliably evaluate the requirements and complexity of the project and, thereby, emphasizing on the critical second recommendation.

All studied projects benefitted from the new project management software. The software improved the communication in all projects, and this kind of improvements will increase the performance of all projects, regardless, for example, the choice of development process. Similar improvements are good ways to increase the capabilities of the case company, which leads to the fifth recommendation: **use continuous improvements to increase performance across all projects**.

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8 Conclusions

The three research questions, presented in the introduction under problem statement, will be answered below. The questions are answered in a summarized form, and more details can be found in the section *Analysis and discussion of findings*.

RQ1. Why were there problems in the studied projects?

The research provided both general and project-specific causes as to why the projects were problematic. These are grouped together per project and presented below in Table 8.1.

Table 8.1 - Reasons for problematic projects

Project	*Identified reasons for the problems*
Project A	Misaligned capabilities for cost-sensitive projects that could be seen in, for example, the unsustainable process for cost calculations and pre-project planning. As problems due to this surfaced later in the project, the added complexity was still managed in a functional team structure. By using this team structure, the resource deployment failed to meet the requirements of the project.
Project B	Missing capabilities in the form of technical expertise in key areas where not present within the organization. This made the initial project specifications vague and problems surfaced later in the project. A functional team structure was deployed, and as technical problems arose during late design and prototype phases the project was delayed. The design engineer was then put under the pressure of extra administrative tasks needed to work with the external capabilities.
Project C	A new market strategy had not been translated into new capabilities for the organization. Since this was not done before the project, the misalignment of capabilities was discovered during the project. The resource deployment of the project was, therefore, changed during the project to enable the required capabilities, such as much closer cross-departmental problem-solving and communications. These capabilities were from the start weaker as the sites seemed to not have a shared understanding of what development process was used. The lightweight team structure that the project used in the beginning was not capable of handling the complexity of this project.
Project D	The new market strategy of the company had not yet been translated into capabilities of the organization. A lightweight team structure was used, and the development process was not understood by downstream departments. This deployment of resources did not allow for a smooth development process.

RQ2. How were the causes of the problems in the projects similar/different depending on the project's origin?

Problems arising from failing to realize a suitable rescore deployment were identified in projects from both sites. The analysis indicated that not all departments involved in co-writing the project specifications could be a root-cause.

Problems arising from a non-formulated operations strategy were identified in projects from both sites. The analysis indicated that this prevented understanding which capabilities were available, and which were missing, eventually leading to an attempt of reactive allocation of capabilities.

Problems arising from uncertainties in the development processes were different depending on which site they originated in. The complexity of the Swedish projects was approached with a more shared understanding of the process and what needs to be done by all involved operations. For the German projects, the complexity of the projects had no shared understanding within the operations of how to approach and solve the issues. Resources were deployed differently in an attempt to solve the complexity issues.

It was also made clear that the cost calculations and quotation in the pre-project activities was a cause for issues within the Swedish projects, but not represented in the German projects.

RQ3. How can these problems be avoided in the future?

The recommendations for how the case company can attempt to solve, to mitigate the impact, or to avoid problems were compiled into a list of five points:

- Formulate and communicate the operations strategy.
- Include all upstream and downstream departments in the co-writing of project specifications.
- Avoid having separate specifications of the project between sales and engineering.
- Create and communicate a more standardized process for more complex projects.
- Use continuous improvements to increase performance across all projects.

These points are further explained in detail in sub-section 7.3.

8.1 Suggestions for further research

This research focused on the high-level of the organization, its process, and methods and tools of the case company, and the effects that these structural and concrete factors had on the execution of problematic projects. The researchers would suggest that further research could focus on the effects of change management, organization culture, and national cultures within the international organizations, and how they influence and affect the project and business performance in the long-term.

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Appendix

A. Consent form template

2020-03-11

Project information and Consent form

This document contains general information about the research project. This document also aims to give participants a choice to participate in the project by signing the Consent form.

Project Description

The purpose of the upcoming master's thesis is to provide insights into known and unknown weaknesses of European product development, studying both Engineering and Manufacturing at *the case company*, and the projects that they collaborate on. The goal is that these insights will enable more fact-based decisions in strategic improvements within the company while providing relevant academic research on the subject.

On a project-level within the mentioned processes, there have, for example, been occasions of missing gate-dates without any clear understanding of the root-causes. The research aims to provide new information about the current state of the affected processes by better understanding what the root-causes could be, and why they might be occurring. Potential improvements will be suggested.

The research will be based on a failure analysis of historical projects. Information about the projects will be gathered through historical documentation, and interviews with relevant personnel from the Engineering (product development), and Manufacturing functions. The interviews will be conducted at each office, located in *Germany, Sweden, and Poland.*

Consent

By signing this document, I, the undersigned, confirm that:

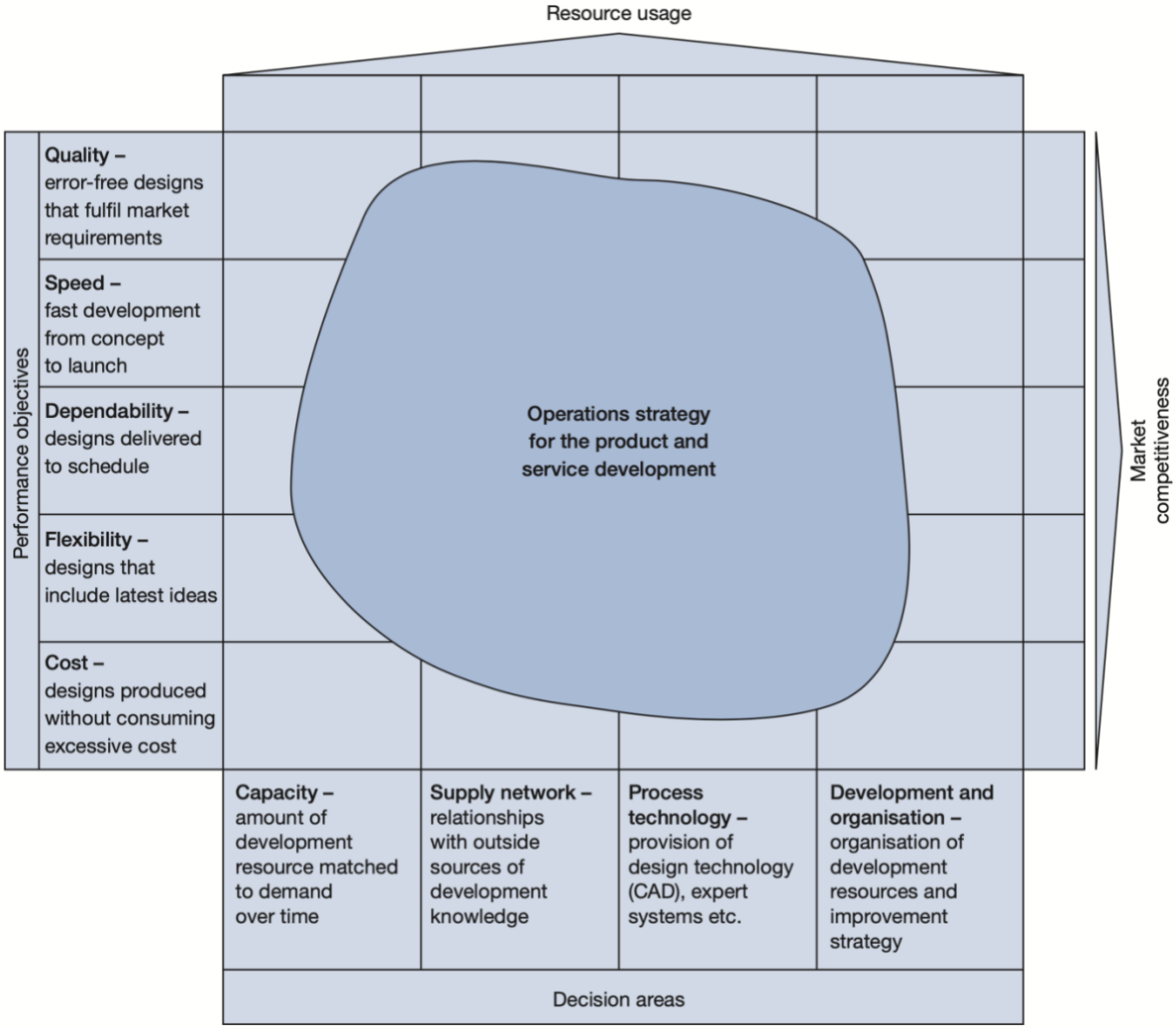
- I have read and understood the Study Information Sheet provided.
- I have been given the opportunity to ask questions about the Study.
- I understand that taking part in the Study will include being interviewed and audio recorded.
- I have been given adequate time to consider my decision and I agree to take part in the Study.
- I understand that my personal details such as name and employer address will not be revealed to people outside the project.
- I understand that my words may be quoted in publications, reports, web pages and other research outputs but my name will not be used.
- I understand that I can withdraw from the Study at any time and I will not be asked any questions about why I no longer want to take part.

Name of Participant: _____

Signature of Participant: _____ Date:_____

Name of Researcher: _____

B. Operations strategy matrix analysis



Appendix B - Operations strategy matrix analysis (Slack & Lewis, 2017)

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