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Designing a fixed cost model for Aftermarket at a surveillance company

Master's thesis in Quality and Operations Management

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Abstract

Introduction - For companies in general, Aftermarket is an important business area for achieving longtime success. The Case Company, where the thesis was conducted at, desired to improve their operations within their Aftermarket division. The Repair Process at The Case Company is time-consuming and complex with their current way of operating. The lead times are affected due to the following four aspects; products, customers, sub-contractors, and in-house operations.

Aim - The aim of the thesis consisted of fulfilling three parts; (1) an analysis of all costs related to establishing quotation, (2) defining a fixed cost model for Aftermarket, and (3) suggesting an implementation of such a fixed cost model.

Methods - To obtain the best result, a mixed-method approach, combining qualitative and quantitative methods, was used during the thesis. Several interviews were conducted to receive information regarding how quotations are established. Regarding the fixed cost model, interviews, focus groups, observations and a Beta Distribution Estimation was used to develop the model. As a complement to the various methods a literature review was conducted, and for the implementation of the model it can be regarded as the primary source for the evolution of the process. Further, ethical considerations were an important aspect of the thesis since The Case Company operates within the military field.

Results - Found was that a quotation, with the current process, consists of four parts; Fault Verification Process & Shipment, Reparation In-House, Fault verification Process for Sub-Contractors, and Reparation Sub-Contractor. The fixed cost model was developed with the help of a Process Information Database. The implementation process that was established for the fixed cost model is based on an eighth step approach.

Conclusion - Overall, the empirical results demonstrate that The Case Company will improve their efficiency in their after-sales service due to a more automatized quotation process. The authors have encountered challenges that have slowed down the process of constructing the fixed cost model. Despite that, the authors believe that the fixed cost model, in a future state, will contribute to The Case Company's longtime success.

Keywords: Fixed cost model, Quotation, Aftermarket, Beta Distribution Estimation, Repair Process, Reduced lead time, Process Information Database (PID).

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The outcome of this master thesis would never have been possible without all the help we have received during the last five months, once again, thank you!

Lovisa Almér & Hugo Göthberg, Gothenburg, May 2020

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List of Glossaries

COC An abbreviation of Certificate of Conformance. A document used as a quality control.

COVID-19 A coronavirus pandemic that started spreading in 2019 and affected Sweden immensely during 2020.

ERP-system An abbreviation of Enterprise Resource Planning system. A software which handles internal business processes.

Fixed cost model A model which distributes a fixed cost for a specific product based on historical data points.

Quotation A statement which specifies the price and terms for producing a good or service to a customer.

Repair Process A process of handling products in need of repair, modification or an update. See Appendix A for further description of this process.

Spare Part Process A process of producing or sending spare parts to a customer or a customer owned inventory.

TCC An abbreviation of The Case Company. The company where the thesis is carried out at.

1 Introduction

This chapter starts with a context regarding the topic of this report and then follows a description regarding the background of the thesis. Further, the aim of the thesis is explained and research questions are presented. The chapter ends with presenting the delimitations of the thesis.

1.1 Context

For companies in general, the Aftermarket is an important business area for companies longtime success, mainly due to revenues ranging between 30 to 50 percent by servicing products (Cohen et al., 2006). Increasing one's services and combining them with products, in short servitization, is starting to become an increasingly popular concept to embrace (Baines et al., 2007). The success that is possible to gain with servitization is only possible if the company in question can manage the Aftermarket's processes efficiently. Further, Cohen et al. (2006) explains that a company who focuses on after-sales services benefit since the company will generate a steady revenue stream, with low risk, over a long period of time. In addition, companies also get a deep understanding of customer needs by providing these services, which contributes to a competitive advantage by understanding their needs. Even though customers do not expect products to function perfectly within their whole lifespan, they do expect that potential after-sales service is handled quickly, and is amended within the given time frame (Cohen et al., 2006). With a shorter lead time, it is possible to improve the efficiency and increase production and its quality (Suri, 2010). Furthermore, one can reduce the total cost of a product, and especially the overhead costs connected to the specific product (Suri, 2010).

1.2 Background

The Case Company, from here on named TCC, is a company that manufactures and operates within defense and security, and who wish to be anonymous. One of their business areas is called Surveillance, and this area provides solutions which can help detect, locate and protect against threats both within the civilian and military field. Sourcing and Production is a division within Surveillance which is the division of interest for the thesis. TCC is located in Gothenburg and its production unit is the main facility for the production of Radar systems and Laser products. The Aftermarket department, see Appendix B for an organizational chart and department description, within Sourcing and Production

also helps with modifications and repairs of these systems and products. In their operations, within Aftermarket, there are two main production flows which are of importance for the thesis: the Spare Part Process and the Repair Process.

Within these two flows, and especially within Repair Process, there are problems regarding the estimation of costs for repairs or modifications as well as long lead times. Regarding the estimation of costs, TCC is facing problems mainly due to producing quotations that are time-consuming and complex. This is since establishing a complete quotation there is a need to understand all different costs associated with the specific repair or modification that needs to be taken into account. Long lead times are a result of four different aspects; products, customers, sub-contractors, and in-house operations.

In regards to products, long lead times are a fact since products who are handled within the two production flows have both a wide range of variations as well as long product life span. This leads to product information, such as drawings, can be hard to locate, or product expertise may be limited to only one or a few people possessing it.

Lead times are also affected by customers who are sending products and systems to TCC with a wide range, from none at all to detailed, of information regarding both whom it is sent from and what error has occurred. Another aspect of why customers affect lead times are since TCC needs to await a reply regarding their sent quotation. TCC will not begin the modification or repair before the reply has been received.

TCC has sub-contractors to help them support their production. Due to this, some components bought via a sub-contractor can become end-purchased. End-purchased means that the sub-contractor has stopped manufactured the specific component. In addition, sub-contractors may have gone out of business. There are also circumstances of sub-contractors not prioritizing TCC's orders or requests due to TCC not being one of their major customers. These elements all contribute to longer lead time.

Related to in-house operations there are multiple factors that can contribute to longer lead times. The incoming products are handle in regular production, which has a set time plan for the next-coming three weeks. Aftermarket reserves production hours, but due to fluctuation of incoming products it is hard to estimate the right amount of hours. In addition, it can be problematic to understand which tests to run in order to find the error, and this is also a matter of having the right resources and expertise available for specific tests. Due to those reasons, the reserved hours do not always match having available resources and expertise, which contribute to longer lead times. Further, TCC has established a variety of contracts to its customers. There can be differences in having a set time frame or price, or nothing stated at all. There are also some customers who have service contracts where they can send in a broken product and get it replaced by TCC more or less immediately due to them having a spare part pool. Furthermore, the Marketing, Sales & Service department, see Appendix B for an organizational chart and department description, have individual contracts to different customers, meaning that contracts can differ in both terms and need of transparency when sending a quotation. These different procedures all add time to the lead time itself.

1.3 Aim

The aim of the thesis consists of fulfilling three parts; (1) an analysis of all costs related to establishing a quotation, (2) defining a fixed cost model for Aftermarket, and (3) suggesting an implementation of such a fixed cost model.

1.3.1 Research Questions

Based on the aim of the thesis the research will seek to understand and answer the following research questions:

RQ1: What costs are included in establishing quotations within Aftermarket at TCC?

RQ2: How could a fixed cost model be designed for Aftermarket at TCC?

RQ3: How could a fixed cost model be implemented within Aftermarket at TCC?

1.4 Delimitations

A delimitation for the thesis is to focus the research on the available information located at the site in Gothenburg and within the Surveillance department. In addition, the thesis is limited to only examine costs directly connected to a product that is in need of repair, e.g. the Repair Process. Further, the authors do not examine other Aftermarket processes, e.g. the Spare Parts Process.

2 | Methodology

This chapter explains the approach of how the quantitative and qualitative methods were used during the thesis to gather data. In addition to those two methods, a literature review was conducted and the approach of the review is explained as well. Lastly, ethical considerations are stated and reflected upon at the end of the chapter.

2.1 Data collection

The methodology is based upon a mixed-methods approach, which means using both quantitative and qualitative methods within one project (Easterby-Smith et al., 2015; Bryman, 2012). In addition to mixed methods, the data were collected through primary and secondary data sources. Primary data, which is collected through mixed methods, is used to collect new information by the authors by (Easterby-Smith et al., 2015). The authors used interviews, focus groups, and observations as primary qualitative data sources. Further, a quantitative approach is used to analyze historical data Easterby-Smith et al. (2015). Secondary data is the use of already established publications (Easterby-Smith et al., 2015) and the secondary data is obtained by a literature review made by the authors. The choice of using mixed methods was due to wanting to increase the validity and generalizability of the results, as well as increasing the credibility (Easterby-Smith et al., 2015; Bryman, 2012). Besides, using mixed methods enhances the completeness of a research (Bryman, 2012) since multiple methods to answer a research question is used. The validity and generalizability are increased since a mixed-methods approach will provide insights that are deeper (Easterby-Smith et al., 2015).

In addition to the mixed methods, the thesis uses the concept of case study as an overarching methodology. Meaning, according to (Easterby-Smith et al., 2015), that the research is designed in a manner that the thesis focuses in-depth on one organization. Further, the concept of a case study is not limited to only conducting either qualitative or quantitative methodologies (Bryman, 2012), and therefore, it could be seen as an overarching methodology in regards to this thesis.

2.1.1 Qualitative methods

The qualitative methods used as a data collection source for the thesis was interviews, focus group and observation. The variance of methods was used to gather data with a different depth (Waller et al., 2016). For example, observation was a good method to

get knowledge regarding the width of production, while the interviews and focus groups helped with understanding more specific problem statements (Easterby-Smith et al., 2015; Bryman, 2012). This section of the report hence describes how the methods was used throughout the thesis.

2.1.1.1 Interviews

As an initial step to understanding how quotations are established at Aftermarket one unstructured interview was conducted early on during the project with a participant from the Aftermarket division. The participant chosen for this interview was a senior coordinator who has worked in the business area for a long time period. A coordinator coordinates the repair cases within the Repair Process. The interviewee was chosen due to her great knowledge and understanding of their processes around quotations. Further, an unstructured interview was chosen since it is a well-known approach which is good for inspiring to a conversation instead of guiding the questions to a certain answer (Easterby-Smith et al., 2015; Burgess, 1984). The conversation led to a good understanding regarding the process since the interviewee could provide the authors with the necessary information regarding the process flow without structuring questions beforehand. In addition, a physical matrix located in a shared folder which states the cost categories, included in a quotation, was also mentioned in the conversation. Further, during the conversation, the authors got an understanding regarding what was included, in terms of costs, labour, activities, and material, in the various cost categories.

At another early stage during the project, an initial semi-structured interview was organized with an employee within the Marketing, Sales & Service division. The main purpose of this interview was to understand the whole process of quotations. The interviewee was chosen based upon asking Aftermarket employees who had the sharpest knowledge within Marketing, Sales & Service. In addition, the interviewee had worked at TCC for over twenty years and had great expertise within this area. A semi-structured interview was selected as a preferred approach since it is an appropriate way to guide the interview to answer a selection of subjects (Easterby-Smith et al., 2015). The subjects of interest for the interview was general information regarding TCC's agreements with its customer as well as how Marketing, Sales & Service's quotation process looks like. The interview lead to good knowledge regarding the process and what parts of a quotation that was important for Marketing, Sales & Service in order for them to do their job. Further, regarding the agreements, that is information that the authors will not be able to access due to strict confidentiality reasons. In order for the confidentiality reasons not to hinder the authors the research questions are established in such a way, especially the second research question, that the thesis will only cover the cost associated with the Repair Process. Since cost are established in-house and does not relate to the customer agreements the risks seem low. Despite that, there is a risk with censored information when later accessing the data in the ERP-system. There is thereby a risk with censored information affecting the amount of historical data points that could be used in the upcoming analysis regarding how to build the fixed cost model.

In addition, during the initial brainstorming of how to answer the second research question, regarding how to build a fixed cost model, an unstructured interview was held with

two senior employees within the Finance business unit, see Appendix B *Organizational Chart* for an organizational chart and department description. The unstructured approach was chosen since the authors wanted to spark a conversation (Easterby-Smith et al., 2015; Burgess, 1984) regarding if the researchers could use a specific financial computer program when building the model. The financial computer program in question is used within TCC to handle and track all costs and profits and is therefore relevant to gain more experience around. Moreover, the employees invited to the interview had been selected since both of them had great knowledge of the financial program in question and had a good understanding of TCC's operations.

To grasp how the managers within Production, see Appendix B *Organizational Chart* for an organizational chart and department description, consider a possible fixed cost model, future risks, and possibilities with such a model an interview, held in a semi-structured approach, was conducted as well. Initially, a line manager and one of his managers were invited to the interview. The line manager suggested upon the invite that another of his managers should take part in the interview, therefore, a total of three employees was interviewed in tandem. These employees were chosen to participate since they had great knowledge of production as well as had an understanding of the co-operation between Aftermarket and Production. The decision of conducting a semi-structured interview was based upon wanting to get a dialogue started in three specific areas. Therefore, a semi-structured approach is preferred when not wanting to control the conversation (Easterby-Smith et al., 2015; Waller et al., 2016). The three areas of interest were how the line manager and the managers regard a possible fixed cost model, the risk with such a model, as well as eventual possibilities. Throughout the interview, due to having three interviewees simultaneously, one of the authors was responsible for asking questions and getting the conversation flowing. The other author was instead responsible for writing down what was said, and if needed, fill in with follow-up questions.

To get an understanding regarding attitudes and conceptions to the fixed cost model within the division of Marketing, Sales & Service an interview was held with one of the managers. The interviewee was manager of the employee who was interviewed for the first research question. This specific manager was chosen as a subject due to, the authors believing, that the manager would have an understanding of how employees within the division would grasp the fixed cost model. In addition, the manager also had a great understanding of how processes within the company operate. Further, the interview was held in a semi-structured approach due to the authors wanting to get answers to some specific topics, but still keeping the interview rather gentle and easygoing (Waller et al., 2016; Bryman, 2012). The topics the authors wanted to gain understanding about were what the manager's conception of the fixed cost model are, potential risks the manager sees with an implementation, and how pricing works for repairs. The authors, due to having a semi-structured approach, had prior to the interview written down questions within these different areas (Easterby-Smith et al., 2015). As the interview went along the manager came with additional insights and more specific questions could be asked due to the authors gaining more understanding of the topics in question.

2.1.1.2 Focus Group

To get a better understanding of the most recurring products that Aftermarket receives for repair, the authors invited several employees from the Aftermarket division for a focus group meeting. These people were selected because of the knowledge they had and the experience they have achieved during the past years working at TCC. According to Easterby-Smith et al. (2015), interviews does not have to take place in a one-to-one form to receive information. Moreover, Easterby-Smith et al. states that focus groups is a good method to obtain information from several participants at the same time. In this scenario a "moderator" was used to structure the focus group, this moderator role were taken by the authors of this project. A moderator are used in focus groups to control, stimulate and encouraging the discussion (Waller et al., 2016).

Before the focus group, the moderators prepared a document of the 20 most recurring products, the data shown on the document were extracted from TCC's internal Enterprise Resource Planning system, ERP-system. After some discussion with the employees, the authors came to the decision that only seven of the twenty most recurring products were inside the project's scope. This decision was based on information from the employees that some products needed to be excluded due to specialized cases and confidentiality reasons. In addition, some of the products were discluded due to a very small amount of historical data. With a large database, the effect of outliers will be significantly lower and impact the final result less than compared to a small database (Kwak and Kim, 2017). The seven most recurring products can be found in Section 4.2.1 *Qualitative Data*, and the products are coded with fictitious Part IDs due to confidentiality reasons. The authors have made a template to keep track of which fictitious Part ID that is related to the real product, this template can not be included in the report due to confidentiality.

2.1.1.3 Observation

To increase the understanding of the products as well as the production itself a tour with a knowledgeable employee, with knowledge from both Aftermarket and Production, was performed. The tour could be explained as a complete observation, meaning that the authors kept a distance when observing and avoided all interaction with employees within production (Easterby-Smith et al., 2015; Waller et al., 2016). Even though observation is an important research technique according to Waller et al. (2016), Easterby-Smith et al. (2015) states that the depth of the data gathered from observation is rather limited. Despite that, a complete observation was valuable for the authors in terms of a greater understanding of the products which are analyzed in the thesis. The method gave enough insights based on the desire that existed before the conducted observation. Therefore, there was not an issue with limited data acquisition.

2.1.2 Quantitative methods

For the second research question, the development of a fixed cost model, multiple parts needed to be examined and used as a basis for quantitative analysis. How the parts were chosen is stated in Section 2.1.1.2 *Focus Group*, and the Part IDs are stated in Section 4.2.1 *Qualitative Data*. Information, such as in-house costs, quotations, product ID, dates

connected with the repair process, etc., was extracted through TCC's ERP-ssytem. All the data withdrawn from TCC's database has been modified with a secret factor due to confidentiality. The information was downloaded to a spreadsheet program were five steps followed.

The first three steps are a summary based upon multiple conditions, set by the authors, that the PID-question needed to follow, see Appendix C *Conditions for the PID-question* for a detailed description of the conditions. These three steps lay the foundation for a mock-up that the authors constructed. The mock-up was made by trail and error, meaning that the authors tried and learned what was candid and in the final stage of the development of the mock-up the conditions found in Appendix C *Conditions for the PID-question* had been developed and verified. The mock-up was made in spreadsheets because both authors had limited knowledge within the internal programs, therefore spreadsheets was the best platform to use for this issue.

The first step in creating the mock-up was to examine that all Order IDs only had one Part ID connected to the Order ID. Otherwise, if an Order ID was connected to multiple Part IDs, the Order ID should not be included in the forthcoming analysis of analyzing the historical data. An Order ID has an accrued cost connected to it, and if multiple Part IDs are connected to one Order ID it is hard to separate the cost and connect it to a specific Part ID.

The second step was to exclude those Order IDs which was used as a collection for PL-services to a specific customer, for the same reasons as stated for the Order IDs. After the completion of these two steps, the information that remained was considered analysis-friendly and less sensitive. Less sensitive, since some of the obvious small and large errors would not affect the data to the same extent due to less fluctuation (Easterby-Smith et al., 2015).

The third step was to conduct a Beta Distribution, a deeper description is found in Section 3.2.5 *Three-Point Estimating*. The Beta Distribution was conducted with help from a spreadsheet program and the theory behind the distribution. The Beta Distribution was chosen prior to Triangular Distribution, Parametric Estimation and Bottom-Up Estimation due to being more accurate (Project Management Institute, 2013; Mulligan, 2016). Beta distribution is more accurate due to being calculated with help from historical data (Gido et al., 2014). The Beta Distribution uses three different inputs: an Optimistic, a Most likely, and a Pessimistic (Gido et al., 2014). For the thesis, the inputs are costs that is associated with the Order IDs for a certain part. Therefore, in order to calculate the Beta Distribution, multiple data points were downloaded from the ERP-system to a spreadsheet. The most important information was the total cost for a completed repair and the Order IDs, for a full list see Appendix D *Cost Data*. For each specific product the three inputs was calculated and found. The most Optimistic cost was the lowest cost, the Most likely cost was developed through a average, and the Pessimistic cost was the highest cost for a specific product.

The fourth step was developing data visualizations that easily would describe the historical data and the results of the analysis made. These data visualizations were developed

from the data shown in Appendix E *Cost Charts*, with the function "Average" in the spreadsheet program, and with the use of the Beta Estimation theory.

The fifth step in the process was to create an autonomous process that could be used by the employees to efficiently come forward with a draft of a quotation by just entering the Part ID. Found was that such a process could be used by accessing a Process Information Database, PID for short. By using the concept of a PID-question, which will work as a basis for the fixed cost model, the process would become autonomous.

To be able to create a PID-question, the authors contacted a specialist at TCC that worked with PID-questions internally. A PID-question is a form of programming code that takes data from the different internal databases at TCC and codes them to do specific tasks. Moreover, a PID-question can be associated with Pivot tables in spreadsheets where data can be extracted from several documents and then summarized in a more extensive table (Fylstra et al., 1998). The author's purpose for this PID-question was to follow the conditions set in Appendix C *Conditions for the PID-question*.

The reasons behind why the authors choose an internal specialist to perform this programming task was due to the high level of confidentiality at TCC and the lack of knowledge acquired by the authors about this type of programming. Moreover, the authors agreed that using internal resources would also be more cost-efficient and effective due to the knowledge already obtained by the specialist (Klychova et al., 2014). The specialist had been working at TCC for a long time and was both helpful and excited to help the authors with the PID-question.

The first interview that was conducted with the specialist was in a semi-structured format, this was since a semi-structured interview is better when the interviewers want to control the interview to some extent (Easterby-Smith et al., 2015). The authors brought the specified document of conditions of the PID-question, as seen in Appendix C *Conditions for the PID-question*, to the interview with the specialist.

The specialist later returned with a draft, via email, of the PID-question that unfortunately did not solve any of the criteria and requests that the authors had asked for. The reason for this was due to the fact that the communication between the two parts was not that clear as the authors thought, it could also be that the issue was not that easy to solve as the specialist first thought. Therefore, a new meeting was scheduled to explain better and more detailed what the authors wanted the PID-question to do.

During the second meeting, it was decided that the team needed to recruit a new member to help the specialist with the issue. The new member had expertise within the area of extracting data from the financial databases within TCC.

The third meeting was held with both of the two specialist and the authors. During this meeting three goals was established. The first goal was to extract the relevant information through the right database. The second goal would then, later into the thesis, be to add the equations so that the estimation could be calculated. The third and last goal would be to create a graphical model which could be used in the daily work at the Aftermarket

division.

Unfortunately, due to COVID-19, one of the specialists had to rest at home due to illness for several weeks and that led to a big delay in developing the fixed cost model. Since the authors and the remaining specialist could not continue developing the model themselves during this time period the development came to a standstill. Instead, during this time period, the authors analyzed what potential advantages, risks, and cost savings the fixed cost model would lead to, see Section 5.2 *Research Question 2*. When the specialist had recovered the time for the thesis had run out and therefore the development of the model could not continue.

2.1.3 Literature Review

A literature review was conducted to gather secondary data. Especially important was the literature review for the third research question. This due to understanding the concepts of Change Management. Further, as Easterby-Smith et al. (2015) states, a literature review helps the authors to provide a guide for empirical research and helps the authors understand what is already know in the field. For the thesis, a narrative and traditional review were chosen. A narrative review is an approach that helps to gain a first impression of relevant topics that authors want to explore with their own research (Bryman, 2012). Further, a traditional review will summarize literature that is deemed most relevant for the thesis's aim (Easterby-Smith et al., 2015). It could be regarded as a more flexible way of reviewing literature (Bryman, 2012), compared with a systematic review, but that is also why the traditional approach was chosen, due to being more flexible. Further, a traditional approach was chosen since it will help the authors to stay open-minded about the findings, and the understanding of key concepts and theories, will continue throughout the thesis (Easterby-Smith et al., 2015; Bryman, 2012). Still, it is a structured approach were authors will retain a wide range of valuable knowledge (Bryman, 2012). Moreover, a narrative approach is deemed to be more appropriate when conducting a qualitative research design according to Bryman.

In terms of gathering literature for the review, two types of sources were used, electronic databases and libraries. An electronic database is an important tool for finding literature that considers being both important and relevant. Easterby-Smith et al. (2015) states that one should include sources of both types. Further, Easterby-Smith et al. explains that journals and books which could be considered important more generally have many citations, which is easily visible through an electronic database, and are older. Moreover, relevant literature is usually newer literature which could be recognized as follow-up work based on the older and more important literature (Easterby-Smith et al., 2015). The electronic databases which were used in the thesis were Google Scholar as well as Chalmers' electronic library. In addition to the electronic databases, psychical libraries such as Gothenburg's City Library and Chalmers Library was used as data sources. The authors have during their review included literature that can be considered both important and relevant based on the description above. This was accomplished since the authors wanted to produce a review that would cover a wide range of literature.

2.2 Ethical considerations

In terms of respect, which extends to both the actual conduction of the thesis as well as the stakeholders involved, it is important to consider how the data collection can be performed in a suitable way (Hoskinson and Kuratko, 2015). An important aspect to consider in terms of respect and involvement of stakeholders is to inform each stakeholder of how their participation will affect the outcome of the project and how the information gained from the stakeholder will be used by the authors. In addition, it is also important to respect all participant's decisions regarding involvement, and being mindful of differences in values, as well as honoring privacy, rights and the diversity of those who participate in the thesis (Research for Development & Impact Network, 2020). To achieve this aspect of respect the authors must stay mindful of participants throughout the research and respect any decisions that stakeholders might make.

Research merit is explained by Research for Development & Impact Network (2020) as having sufficient experience and competence to conduct a project with a suitable quality. The authors have an academic background with strong credentials and the experience of conducting a project prior to the thesis. The benefit of having multiple supervisors at both Chalmers and TCC is that the supervisors can assist the authors with thoughtful input were the author's own experience might be lacking.

Justice, and the question regarding if the research is fair (Hoskinson and Kuratko, 2015), is an aspect that the authors can consider throughout the project in terms of portraying the empirical data in a fair and just way. In order to meet that standard and avoid ethical dilemmas with justice, the authors need to not try to angle the data or influence stakeholders in any way. By conducting the thesis with an open-hearted mind and without gaining anything, example in terms of money, by achieving a certain result the authors believe with these aspects in mind a just way is attained. In addition, it is important when conducting interviews and such to show dignity to all participants regardless of any social categorization (Research for Development & Impact Network, 2020). To achieve showing dignity, the authors will try to their best ability to not come to hasty conclusions prior to the conduction of any qualitative method.

The last value, beneficence, which means to consider the risk of the research doing harm (US Department of Health & Human Services et al., 2013), is an important aspect for many reasons. Hoskinson and Kuratko (2015) further explains that beneficence is about both considering the participants and the social implications for the community that the research might have. In terms of this research, the community includes the country of Sweden as well as the local community, the municipality and TCC. To conduct the research in an ethical way it is, again, important to inform the participants about the potential outcome that the research might have (Research for Development & Impact Network, 2020). Since the participants, who all work at TCC, have made an active choice of being accepting of working at a company that produces, among other things, military products, it can be seen as an advantage when the authors inform the participants prior to the interview or similar. This is due to the employees already understand what social consequences their work might have. The conduction of the thesis itself will not affect the community since the data will be collected within TCC and with the help of their employees. In addition

to not causing harm to participants, it is important to handle data in a correct and secure way. TCC is a highly secure company with strict security routines and it is important that the authors keep all secure and classified documents on TCC's platforms during the whole thesis period. That will avoid any information being mishandled. In addition, while writing the thesis it is important to only add unclassified or classified information which has been altered to the report. Moreover, all information which is added to the thesis must be approved by the manager at the Aftermarket business area within TCC. This is an important factor since the thesis will be published and all information added will be accessible to the public.

When it comes to creating value with the outcome of the thesis or ethical dilemmas the potential outcome might have there are other dimensions to take into considerations. The authors must, in terms of the outcome of this research, consider how beneficence might cause risks. As Research for Development & Impact Network (2020) states it is not only creating physical, psychological, or emotional harm that is a risk but also consider the risks of creating harm to the welfare and security of individuals or a social group. In addition, by anticipating to do no harm and planning for it, one could avoid to do no harm with the intended research. Therefore, the authors need to consider how the outcome can affect society. Due to TCC producing both weapons and surveillance systems, which are used globally, there is a risk of beneficence. However, it is important to take into consideration that these products are also used for the protection of social groups. A dilemma the authors have is that the outcome might lead to shorter lead times when producing or distributing TCC's products. However, as stated prior, the product's main use is to keep societies safe and the products themselves are not military, but instead sometimes used for military purposes. It is also important to take into consideration that TCC itself does not operate and decide who to sell their products to, it is a collaboration with the state of Sweden. Therefore, one could say that the outcome with the thesis, will create value to TCC, to Sweden as an exporting country, and to the countries or organizations buying the products produces at TCC's site. One also does good to keep in mind, that technology helps military operations to be conducted in more novel ways (Mitcham and Siekevitz, 1989). For example, since military forces that uses surveillance system to track the surrounding environments will gain extra seconds during a potential attack to run away from the e.g. missile target in their camp or such.

Another important aspect to consider in terms of ethics is the sustainability aspect. Sustainability have many different definitions, but common ground is that it could be viewed from the perspective of Tripple Bottom Line, TBL (Arowoshegbe and Emmanuel, 2016). TBL includes people, planet and profit, see Figure 2.1 for visualization.

People refers to conducting operations within a business in a fair way and causing no harm to stakeholders, both within the organization or to the community (Elkington, 1997). Further, planet involves to be considerate of the environmental resources so that future generations can live on planet Earth. In addition, Elkington explains profit as the impact that the organization's operations have on the economic system.

In terms of people the possible outcome of the thesis, beside from already stated risks and benefits, can help reduce the workload for employees at TCC, due to focusing their efforts

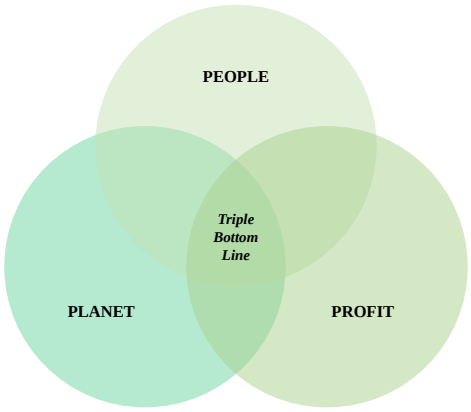

Figure 2.1: Triple Bottom Line.

on more critical tasks. In addition, the outcome can help reduce employees stress levels and help with easing the planning within the production facility. The planet can also benefit from the possible outcome of the thesis due to not using unnecessary resources since one focuses the time and effort on products that have been accepted by the customer to be repaired. That will result in less products spending time in the Reference System verifying errors, meaning less energy spent, and less materials used due to less components being replaced. In addition, oil changes, which is a critical and complex procedures, will only be conducted on repairs that TCC will get payed for. In general, streamline a company's repair process is beneficial for the environment since it is positive to help other organizations with reuse of products. Lastly, in terms of profit, the possible outcome can help TCC use their resources in a more effective way since the company's funds will be used on products that later will generate profit. This is since the outcome of the project has as aftermath that TCC will only have products in their production system that either are newly produced or a repair order with an accepted quotation from a customer.

3 | Literature Review

This chapter includes a literature review of various theoretical areas that are considered relevant for the thesis. The literature review aims to gain an understanding of the thesis's subjects in general, state and find suitable methodological approaches in regards to these subjects, as well as help building a foundation for the analysis and conclusion at the end of the thesis.

3.1 Elements of cost

This section, Elements of cost, is valuable for the thesis since it helps to understand the structure of how, within the field of Business Economics, one interpret the concept of costs. Understanding how costs are viewed is helpful for answering Research Question 1.

A product's cost is constructed based on three elements, these elements are (1) Materials, (2) Labor, and (3) Overhead (Horngren et al., 2002; Berggård, 2018; Skärvad and Olsson, 2017).

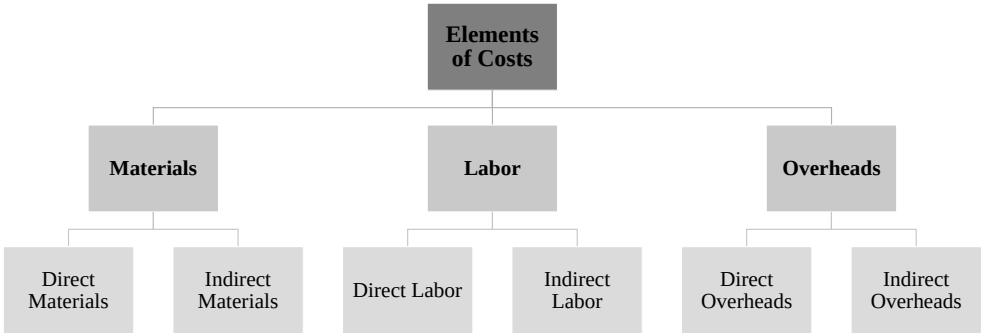

Figure 3.1: A model that shows the structure of Elements of Costs

The first element, Materials, can be divided into Direct Materials and Indirect Materials. Direct Materials include all raw materials or parts that are connected to producing or repairing a specific product (Horngren et al., 2002; Berggård, 2018; Skärvad and Olsson, 2017). Some costs which are possible to connect to a specific product, such as nails and screws, but could be seen as an insignificant cost, Horngren et al. (2002) claims would benefit to be seen as Indirect Materials. Horngren et al. states it would be beneficial to see it as Indirect Materials since it is not possible to justify such tracking of materials or parts. Indirect materials are costs that are related to the material but not material itself. For example, in a production line, it is the lubrication used in the production to produce a specific product. It can also be the cost of having the material on storage (Mishan, 2015).

The second element, Labor, can be divided into Direct Labor and Indirect Labor. Direct Labor includes all labor costs which are connected to a specific product that is being produced or repaired (Horngren et al., 2002; Berggård, 2018; Skärvad and Olsson, 2017). The cost of labor is composed based upon the hourly wage a certain task cost and the hours spent working with that task (Horngren et al., 2002). Indirect Labor can be described as the wages to those who are supervising the production and manufacturing activities but also maintenance within the company (Mishan, 2015).

The third and last element, Overheads, is divided into Direct Overheads and Indirect Overheads. Direct Overheads are costs that are related to a specific product, for example, rent of machinery or equipment needed for the production (Mishan, 2015). Indirect Overheads are costs that can not be directly traceable to the specific product but still connects to the operation (Horngren et al., 2002; Berggård, 2018; Skärvad and Olsson, 2017). Further, Indirect Overheads are described by Berggård (2018); Skärvad and Olsson (2017) as remaining costs that can not be traced to a specific product. The indirect expenses are costs that aim to cover the expenses of various other business areas within the company, for instance, sales, admin, electricity, advertisement, and the management salaries (Berggård, 2018; Skärvad and Olsson, 2017).

3.2 Estimation of cost

This section, Estimation of cost, is valuable for the thesis since it helps to understand the theories behind estimation methods and how the different methods can proceed. Understanding estimations is valuable for answering Research Question 2.

To decide an unknown variable, number or parameter, some kind of estimation has to be done. The most basic method for estimations is Wildy Aimes Guess, also known as WAG (Gido et al., 2014). This kind of estimation is simple but sometimes it is the best estimation that can be achieved. However, several estimating techniques are more accurate than a simple WAG (Tracy and Tracy, 2011). A normal estimation can be defined as a prediction that is based on the information known at the given point in time (Rose, 2013). These estimates, different from guesses, usually have some historical data connected to the estimation. Even though these estimations are more accurate they could still be far away from the actual result (Mislick and Nussbaum, 2015). If an estimation turns out to be incorrect from the actual result, the estimation could either been overestimated, which

means that the estimation has exceeded the actual result, or been underestimated, which happens if the estimation were lower than the actual result. According to Gido et al. (2014), cost estimations can be divided into five different tools/techniques that are most appropriate to use when estimating a cost. These tools/techniques will be explained in the following sections. Westermark (2000).

3.2.1 Expert Judgement

Expert Judgement is a cost estimation method that is commonly used in projects when the involved do not have the expertise needed to perform the estimation (Gido et al., 2014). When this occurs, the Project Leaders need to hire an external consultant or team that has the expertise needed to perform the estimation. These people have the skill, knowledge, and experience needed to execute the task. In addition, experts have learned the required skills from similar cases/projects done in the past. A study by Gido et al. (2014) stated that Expert Judgment, together with historical information, can provide valuable information and insights which will improve the estimation to a more accurate result.

3.2.2 Analogous Estimating

Analogous Estimating is a technique used to estimate costs from historical data and previous projects within the same field (Mislick and Nussbaum, 2015). In other words, this technique is a collection of data collected in the past to analyze and compare it to the current project. Studies have shown that the more data available the more accurate the estimation will be (Gido et al., 2014). Therefore, the larger the database collected is, the better the predictions and estimations in the future will be. Prior research from Gido et al. (2014) suggests that Analogous Cost Estimating is a good technique to apply to achieve low costs and it is generally less time consuming than other techniques, e.g. Three-Point Estimation or Bottom-Up Estimation. But, a closer look at the literature shows that it is less accurate and predictable than other techniques (Gido et al., 2014). However, the method has the advantage that if previous projects are similar to the current one, it has shown that it is quite effective, especially in the early phases of a project when there are a finite amount of information available (Mislick and Nussbaum, 2015).

3.2.3 Parametric Estimating

Parametric Estimating is a technique that uses historical data together with variables related to the specific project as a parameter (Gido et al., 2014). This technique can be used both to estimate the total cost of the project, as well as a segment of the project. Due to its underlying data, this technique provides a higher level of accuracy and is more reliable than other techniques (Mislick and Nussbaum, 2015).

3.2.4 Bottom-Up Estimating

Bottom-Up Estimating is a technique that starts to estimate the costs at the lowest available level of detail. The other levels of costs are later aggregated to a summary total in order to estimate the final cost. Several studies have shown that this technique is the most accurate approach to estimate costs (Gido et al., 2014). However, it has also been shown

that this technique is time-consuming and requires a lot of resources to perform (Mislick and Nussbaum, 2015).

3.2.5 Three-Point Estimating

Three-Point Estimating is a technique that utilizes an optimistic, realistic, and pessimistic scenario to estimate the ideal result for the total cost of the project (Gido et al., 2014). The technique is used to come forward to a closer estimate using one of the two equations stated below. The first equation, see Equation 3.1, is a simple average of the three estimates based on different scenarios. This equation is also known as Triangular Distribution (Project Management Institute, 2013). The second equation, see Equation 3.2, which also go under the name Beta Distribution or PERT, is a weighted average equation (Project Management Institute, 2013). This means that the most likely scenario weights heavier to the final result than the extreme scenarios. Several studies made by Project Management Institute (2013), has shown that Beta Distribution has majority of the time turned out to be more accurate than Triangular Distribution. Even though the studies were taken place in different countries, different industries as well as different time periods.

Estimation (E) Triangular Distribution, final result of the estimation.

Estimation (βE) Beta Distribution (PERT), final result of the estimation.

Optimistic (O) The predicted cost, based on a analysis of the best-case scenario.

Most likely (M) The predicted cost, based on a analysis of the most realistic scenario.

Pessimistic (P) The predicted cost, based on a analysis of the worst-case scenario.

$$E = \frac{O + M + P}{3} \tag{3.1}$$

$$\beta E = \frac{O + 4M + P}{6} \tag{3.2}$$

In the paper made by Mulligan (2016), it is mentioned that Beta Distribution is four times less sensitive to outliers and extreme values compared to a normal estimation equation, see Equation 3.1. Due to this, Beta Distribution is a more reliable and predictable Equation. Furthermore, it has shown that basing decision making with three-point estimates equations, especially Beta Distribution, has been highly successful both in cost and time efficiency aspects (Gransberg et al., 2016). Studies have shown that several companies have used this decision-making method for cost estimation in the early phases of projects to quickly be able to come forward with a result (Mulligan, 2016). Especially in complex engineering development and highly technical projects (Mulligan, 2016).

3.3 Statistics

This section, Statistics, is useful for the thesis since it helps to understand the basics of statistics. Statistics is an important field for analysing and developing a fixed cost model. Therefore, understanding statistics is valuable for answering Research Question 2.

Statistics summarizes data and transforms it to a compact numerical form. Further, the summarized data enables different analysis to be drawn (Lantz, 2020). Statistical analysis involves collecting data from a large population and then summarizing it to a smaller database, which is called a sample (Lantz, 2020). The statistical analysis can be conducted on this smaller database, sample, and still be relevant for the whole population. However, it is crucial to have the right sample size in order to find a statistically significant result (McClave and Sincich, 2016). The larger the sample size is, the better and more accurate the result will be. However, a larger sample size also means that it will cost both more time and money (McClave and Sincich, 2016).

Statistically significant is a term that is made to determine that the test or analysis is accurate and did not happen by chance (McClave and Sincich, 2016). The level of significance is determined by the p-value and when the p-value is lower than 5 % the test is considered statistically significant (Lantz, 2020). The p-value is calculated by analyzing the probability of the given study to reject the null hypothesis, assuming the null hypothesis were true. Moreover, as mentioned above, the test is only assumed to be statistically significant if the p-value is lower than 5 %, according to Lantz (2020).

In statistics, a confidence interval explains the likelihood that a sample factor will fall between two set values a certain proportion of times (Lantz, 2020). The confidence interval measures the level of certainty for the sampling technique. The confidence level can be set to any probability but is usually set to 95 % or 99 %. Furthermore, if the confidence level is set to 95 %, the probability that the true underlying parameter is within the confidence interval is equal to 95 % (Lantz, 2020).

Time series is a tool that is commonly used in statistical analysis to visually explain to the reader how numerical data points are changing over time (Granger and Newbold, 2014). The data in the time series chart is shown in a graph, usually, in a scatter plot or line graph. Time series tracks the movement of some factor over a specified period of time. However, there is no minimum or maximum amount of time that must be included (Granger and Newbold, 2014).

When performing a statistical analysis it is important to analyze the data itself. The distribution of the data can occur in different shapes, the most common definition is symmetric or asymmetric (Easterby-Smith et al., 2015). With symmetric data, it means that the values of the variables occur at regular frequencies and that the median and mean occur at the same point (Easterby-Smith et al., 2015). This can be visually explained with a bar chart and the median and mean should be drawn in the middle (Lantz, 2020). An asymmetric data would imply that the data is skewed either to the right, to the left or to the middle. This indicates that the mean is either smaller or larger than the median (Delucchi and Bostrom, 2004).

3.4 Change Management

This section, Change Management, is relevant for the thesis since it helps to understand how one could implement a change within an organization. Understanding and having knowledge about Change Management is considered helpful for answering Research Question 3.

Change Management can be explained as a controlled process that is conducted in order to achieve a smooth implementation with enduring benefits (Grimolizzi-Jensen, 2018; Hayes, 2018). The process usually moves from a current state to a future state where leadership is of great importance to become successful in the change initiative (Tang, 2019).

3.4.1 Emotions, culture and motivators connected with change

During a change initiative, leaders have the possibility to help their subordinates with coping with the change in order to change successfully. Ross (1969) created a model, the Kübler-Ross Change Curve, which describes the stages individuals go through in their response to grief. A modified model, with origin from the Kübler-Ross Change Curve, is presented in Figure 3.2 below and shows individuals response to organizational change. People are reluctant to change their habits (Garvin and Roberto, 2005), and emotions are triggered due to the fear of having to learn a new skill, getting involved in a new team or a power shift (Kegan and Lahey, 2001).

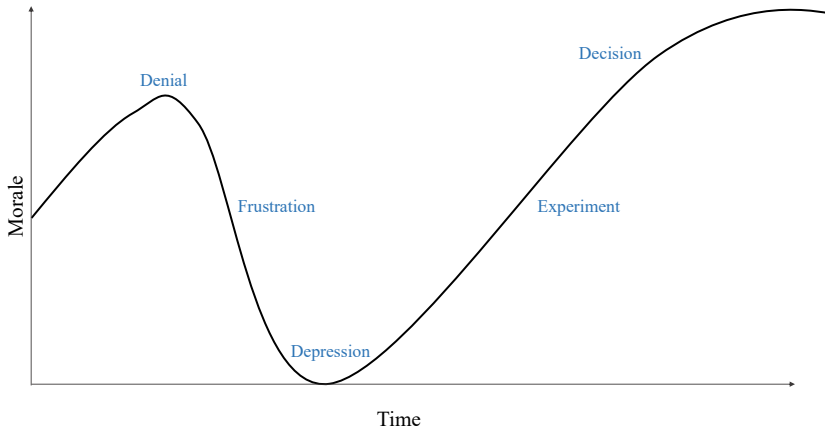

Figure 3.2: The Change Curve.

The Change Curve is a model with five stages and has its origin from the description of grief. Ross describes the five stages as follow. In the first stage, the employees might feel denial. Employees search for evidence that the change initiative might not take place and these employees need the time to cope with the fact that the change is happening. Important during this stage Ross states is the information should be available but not presented all at once due to employees easily could be overwhelmed. In the second stage of frustration, employees can understand why change is necessary but could still become

annoyed since their routines might change. Leaders must during this phase continue to have an open dialogue with their subordinates. During the third step, employees have accepted that they need to adapt their routines, but they will start trying to negotiate their terms in order to be the least affected by the change. During this stage, employees could be less productive, and management should ensure training to all employees according to Ross (1969). When employees continue to evolve their knowledge their morale and productivity might continue to be low when coming to terms with accepting that change is in fact happening. Important to continue to engage employees in the change during this phase. In the last stage, of the decision, the employees are accepting of the change initiative and start to see it in a more positive light and decide upon new goals that they want to reach.

Ford and Ford (2010) agrees with Ross (1969) that organizations face challenges with resistance to change when wanting to implement a change initiative. In addition to employees having difficulties accepting change, there are also other challenges organizations face during a change initiative. Ford and Ford explains further that there are challenges with insufficient communication and Greenhalgh and Papoutsi (2019) continues on the same track and explains the difficulties with spreading the change within the organization. Providing employees with sufficient communication is hard (Duck, 1993) due to change affects people differently. A change initiative will trigger individual responses (Smollan and Sayers, 2009) since it will lead to a different type of changes, such as technical or social (Lawrence, 1969). The change could be technical if the initiative results in a new physical way of working, e.g. change of routine, and social if the change affects the human relationships within the company (Lawrence, 1969). Often, according to Lawrence (1969), social change is due to a technical change. Handling a change initiative in a good manner, acknowledging feelings of employees, and treating them with respect, as well as providing them with sufficient communication will help employees engaging in the imitative (Smollan and Sayers, 2009), and that is why understanding emotions of employees and their motivators are important.

In addition to the emotions of stakeholders affected by the change, it is important to understand the cultural aspect and how that will influence a change initiative. It is long-standing that companies affect employees the most by values, e.g. beliefs and feelings (Duck, 1993). Further, culture can be viewed as a set of values, beliefs, structures, norms, etc., (Schein, 1990), and that is why it is important to understand the cultural aspect and how it influences. In addition to culture, sub-cultures can exist at companies (Smollan and Sayers, 2009), and could be identified at hierarchy levels, departments, for specific genders, and such. Smollan and Sayers (2009) describes that a stakeholder can become influenced by both the company culture as well as a sub-culture within the company. In addition, Smollan and Sayers describes that depending on a stakeholder's cultural influences the attitude, both positive and negative aspects, to a change initiative will vary. Since culture is, among other things, how a group of stakeholders learns hove to solve its problems and day-to-day tasks (Schein, 1990), it is important to understand that all changes will lead to an emotional and behavioral process (Smollan and Sayers, 2009) as explained above. The process will not only affect individuals but also the culture as a whole, and it is important to remember that those emotions could be hard to manage. Moreover, the emotions that the stakeholders experience during a change are shaped by the social relationships inside

the organizations (Bryant and Cox, 2006), and that is why the cultural aspects need to be taken into considerations when initiating a change and communicating the strategy.

Lastly, another aspect of the employees' emotions and how they might handle change depends on how they become motivated. It is an important aspect to consider since stakeholders choose how much effort they want to give to the organization they work for (Carucci, 2019). In addition, Carucci beliefs that it is the leaders who shape the conditions for which employees become motivated or not, and therefore it is important to understand the factors which motivate so that a leader can construct a good environment prior to the change.

One aspect of motivation is the concepts of extrinsic and intrinsic rewards. Extrinsic rewards are using means such as salary increase, bonuses, promotions, and such (Sansone and Harackiewicz, 2000). These types of rewards are easy to enforce, but usually, the positive effect is brief. In addition, extrinsic rewards can lead to employees developing wrong behaviors, not altering an attitude, or reduce their commitment to the (Sansone and Harackiewicz, 2000). Intrinsic rewards, on the other hand, could change an employee's behavior and attitude since people who are intrinsically motivated instead do things because they inherently desire to (Sansone and Harackiewicz, 2000). Intrinsic rewards are more abstract than extrinsic rewards, but intrinsic rewards develop individual satisfaction due to self-accomplishment, autonomy and a personal feeling of one's effort are appreciated by the company, a manager or another employee (Sansone and Harackiewicz, 2000).

3.4.2 Models for managing change

In addition to understanding stakeholders and what influences them, there are various models that can help with successfully managing change. Two models, ADKAR and Kotter's 8-step change model, are explained in depth in the forthcoming section.

The first model, called the ADKAR model, is based upon the idea that facilitating change means that one needs to understand the individual level and how it is affected during a change initiative (Hiatt, 2006). Further, Hiatt, who is the creator of the ADKAR model, explains that the model is based upon five elements that all need to be met in order for the change to be successful. The five elements of the ADKAR model is shown in Figure 3.3, the model has been modified by the authors but originates from Hiatt (2006). The elements are presented in such a way that one factor needs to be met before trying to reach the next one. The first element that needs to be met is awareness and the last one is reinforcement.

Awareness is created when a person understands why the change is important, both in terms of internal and external purposes for the organization, as well as for the benefits the individual will receive due to the change initiative (Hiatt, 2006). In addition, awareness is also about being aware of what will happen if the change is not implemented. Tang (2019) describes that awareness is built with targeted communication, with leaders spreading the vision and the reasons behind the change, and that employees have access to information regarding the initiative. Further, desire is explained by Hiatt (2006) as the willingness to take part in the change and to be supportive of it. Desire is created by leaders demonstrat-

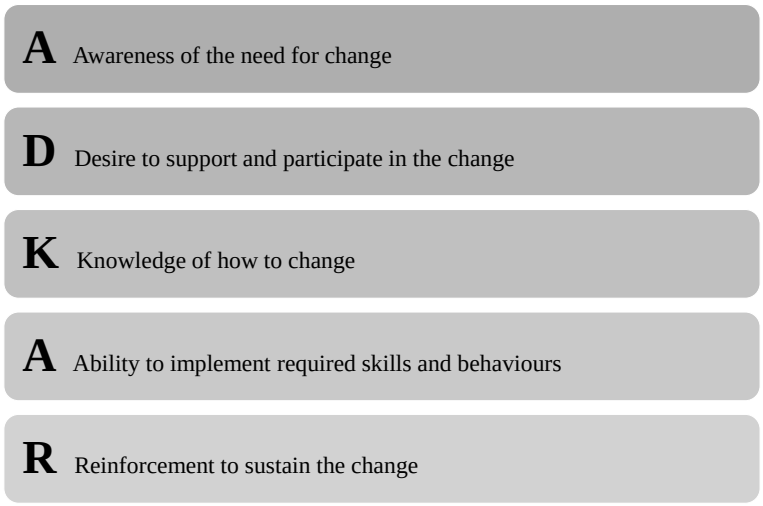

Figure 3.3: The ADKAR model.

ing their own commitment to their employees and subordinates than following that path and participating (Tang, 2019). Moreover, knowledge involves information and education that is necessary for implementing the change. Thereby, one needs to have knowledge regarding behaviors, tools, processes, and such, which are necessary for the change initiative (Hiatt, 2006). Therefore, the knowledge needed is developed with the training of change and with education during all elements of the change initiative (Tang, 2019). Hiatt (2006) explains ability as the execution of the change and turning the knowledge and information into actions. Tang (2019) therefore presents that ability is fostered by managers coaching their subordinates, and that subordinates get to take part in hands-on practices, while managers simultaneously try to eliminate potential barriers that might occur before, during, and after the change initiative. Lastly, reinforcement represents the factors, which might be both internal and/or external, that helps with sustaining the implemented change (Hiatt, 2006). The external factors, which could be examples of rewards and recognition, could, therefore, be reinforced by celebrating successful accomplishments within the organization (Tang, 2019). Important to remember that accomplishments could be achieved in both an individual and a team setting. In addition, internal factors, such as an individual's internal satisfaction, could be reinforced by feedback by managers on one's performance (Tang, 2019).

The second model is called Kotter's 8-step change model and is based upon the beliefs of Kotter (1995) and that leaders who can successfully transform organizations do eight things right and in the right order. The eight steps are presented in the list below.

1. Establishing a Sense of Urgency

2. Forming a Powerful Guiding Coalition

3. Creating a Vision
4. Communicating the Vision
5. Empowering Others to Act on the Vision
6. Planning for and Creating Short-Term Wins
7. Consolidating Improvements and Producing Still More Change
8. Institutionalizing New Approaches

The first step includes examine markets and competitors and identifying possible risks or opportunities (Kotter, 1995). Tang (2019) explains that urgency helps with increasing motivation among employees regarding the change. The second step Kotter (1995) states include constructing a group with the power to lead the change initiative. Tang (2019) believes that establishing a group of key influences and senior management who encourages unity as well as teamwork during the initiative will help with the change. The third step of creating a vision is a step of importance since it helps direct the change effort as well as developing necessary strategies for achieving the vision (Kotter, 1995). The fourth step includes not only communicating the vision to the whole organization with every means necessary but also teaching new behaviors that are necessary for the change, by example with help from the guiding coalition (Kotter, 1995). During this step, Tang (2019) states that using multiple key influencers will help to communicate the vision throughout the organization. The fifth step is about eliminating barriers and by that changing processes or systems that undermine the vision (Kotter, 1995). Kotter also includes, in the fifth step, the encouragement of risk-taking to spark nontraditional ideas or actions. The six-step include planning for how to visualize performance improvements and recognize and award employees that took part in creating those improvements (Kotter, 1995). Tang (2019) states that this is an important step for dividing the change into manageable pieces. In addition, Tang highlights the importance that one cannot forget about also recognize the leaders who are actively taking part in creating the change. The seventh step is about using the credibility developed by the prior improvements to reach broader within the organization and changing even more systems and processes which do not fit the vision (Kotter, 1995). In addition, one should hire and promote employees who can continue to implement the vision (Tang, 2019). The eight and last step is about connecting the change, and the new behaviors, with organizational success, as well as continuing developing leaders (Kotter, 1995).

The general ideas behind these two models seem to be related. First, it is important to developing a vision and incorporating an understanding of why the change is of importance. By doing so, it can become easier for the employees to accept the change (Garvin and Roberto, 2005) due to them knowing the reasons behind the change. But in order for the employees to understand the change, it is of great importance to secondly communicate it well and describe a plan for the employees. An important aspect to take into consideration during the preparations of the plan is to reflect upon which stakeholders that will be affected by the change and what possible conflict might arise by initiating it (McKinley

and Zielinski, 2009). In addition, a thirds step is to understanding employee's feelings. Thereafter, managing the moods of the affected stakeholders is of importance to become successful (Garvin and Roberto, 2005). Employees need to feel acknowledged while having them staying on board the plan according to Garvin and Roberto. In addition, McKinley and Zielinski (2009) states that it is important to understand that employees might feel that the change is happening to them and not actually for them. A leader needs to have the Change Curve by Ross (1969) in mind at this stage. Further, while managing the moods of other people one must remember to keep one's own emotions in check and not taking the stakeholder's attitudes towards the change personally (McKinley and Zielinski, 2009). During this stage, it is also important to involve what possible positive aspects one could draw from sub-cultures or cultures within the company (Katzenbach et al., 2012). During the process of managing moods, as well as developing an execution plan, some amount of participation could be valid since it is a concept of dealing with resistance toward change (Lawrence, 1969). Important to remember is though, as Lawrence states, that participation could also lead to more trouble since the dialogue might not come to an end. As the initiative unfolds, the last step one must-see is that employees are getting the required knowledge that they need to handle the change as well as seeing to the initiative being reinforced. This could, among other things, be fulfilled by providing employees with the possibility to practice on the new technology change (Garvin and Roberto, 2005).

3.5 Operations Management

This section, Operations Management, is useful for the thesis since it creates an understanding of why the thesis is an important topic for organizations, more specifically, why it is important to focus on value creation and waste minimization. Understanding Operations Management is viewed valuable to build a good analysis.

Operations Management is explained by Kumar and Suresh (2009) as managerial activities within service and production management with the aim to transform inputs to outputs at a certain quality level. Furthermore, to understand the importance of Operations Management, the production system is explained by Kumar and Suresh as a set of inputs going through a transformation process, which leads to an output. Within the environment, there is a control system that sends continuous feedback about the transformation. A schematic overlook over the production system can be found in Figure 3.4.

Within the field of Production Management, there is a need for the processes of planning, organizing, directing, and controlling activities within production. Kumar and Suresh (2009) explains that it is the resources used within the product that helps the organization with adding value to the product. In a job-shop production line, which is characterized by producing one or a few pieces of products which are specified by a customer (Yuan and Graves, 2016), it is even more important with planning and order prioritization (Kumar and Suresh, 2009). Further, Kumar and Suresh states that production planning within such production is complicated and should try to be limited.

Other important aspects to the work of Operations Management is the process of producing products with the right quality, in the right quantity, within a given time, and to an

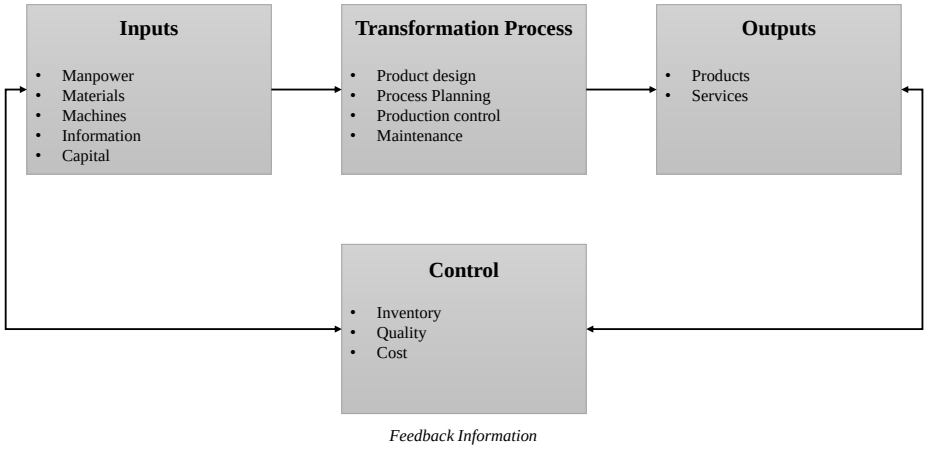

Figure 3.4: A simplification of a production system (Kumar and Suresh, 2009).

established manufacturing cost (Kumar and Suresh, 2009). The quality should meet the customer needs and the right quantity means neither block capital nor leads to shortages. In addition, timeliness means utilizing resources to achieve the production's objective and manufacturing costs include reducing variation between actual and pre-established cost.

Previous research shows that the common ground when wanting to optimize production is resource utilization. The research by Kumar and Suresh (2009) states that utilizing resources means achieving the maximal effect of the resources or minimizing the resources' loss, e.g. waste. Moreover, Just-In-Time (JIT) is an approach that seeks continuous improvement by eliminating wastes and therefore establishing a production system that responds to the customer needs while improving quality (Kumar and Suresh, 2009; Monden, 2011). Moreover, Monden (2011) employs that JIT helps with achieving the goal of cost reduction and improvement of productivity due to the elimination of waste. Meaning, that a company should not spend time on products that will not result in a profit for the company according to Monden. Foster and Horngren (1987) further express that there are four main aspects which lay the foundation for JIT, these are (1) elimination of all non-value-adding activities for a product or service, (2) accomplishing a high level of quality, (3) committing to continuous improvement, and (4) attention toward simplification and visibility to reduce the non-value-adding activities.

Several pieces of research break down the wastes within production and Cheng and Podolsky (1996) divides the wastes into seven categories. These categories are as follows:

Waste from over-production are wastes associated with producing more than demand, involves e.g. labor, materials, machine time.

The waste of motion are wastes associated with the motion and involvement

of employees within production.

Transportation wastes are wastes associated with transportation of goods and materials between inventory and production.

Processing wastes are wastes associated with the processing of parts that may affect the final products.

The waste of waiting or queuing time are wastes associated with the transit of idle inventory.

Product defects are wastes associated with the inspection of a finalized product since such an inspection might not allow to find the root cause of a defect.
Inventory costs are wastes associated with inventory, such as holding materials and parts.

Foster and Horngren (1987) further describes that by eliminating non-value adding activities will help with reducing the production lead time. Which will contribute to the company's responsive skills will be improved. In addition, Kumar and Suresh (2009) agrees with Foster and Horngren that the greatest benefit with a JIT approach, and limiting wastes, are the advantages of being responsive to the market place, e.g. customers.

Challenges within Operations Management is the fluctuation of demand and the forecast of demand. The fluctuation is troublesome due to it creating problems regarding the allocation of resources and planning production (Kumar and Suresh, 2009). Furthermore, Kumar and Suresh explains the importance of forecasting demand, and how it can help with planning future activities as well as being more responsive to customers. Monden (2011) expresses how the reduction of waste can help with forecast and fluctuation of demand. In summary, Kumar and Suresh (2009) communicates the importance of controlling inputs and simplifying transformation processes to yield greater output. Monden (2011) conform and believe that focusing resources will help with lead time reduction due to decrease of waiting time.

4 | Empirical Findings

This chapter presents the empirical findings associated with each of the three research questions. Each section begins with restating the research questions and then follows information regarding the findings for that specific research question.

4.1 RQ1

This section of the thesis presents the empirical findings associated with the first research question, which is defined as follows.

> *RQ1: What costs are included in establishing quotations within Aftermarket at TCC?*

A quotation that is sent to the Marketing, Sales & Service department consists of four crucial parts, these are (1) Fault Verification Process & Shipment, (2) Reparation In-House, (3) Fault Verification Process for Sub-Contractor, and (4) Reparation Sub-Contractor. These parts need to be separated as four since Marketing, Sales & Service needed that partition in their current way of working. Marketing, Sales & Service helps with establishing the quotation that is sent to the customer, see Appendix A *The Repair Process* for a description of the process. Below follows a description of the various operations that lie within each part of the established quotation.

Fault Verification Process & Shipment

This part consists of costs that are linked to the initiation of a product in need of repair and finalization of a repaired product, which occurs in-house at TCC.

> **Fault Verification Process Actual** includes all accrued costs, including man-hours, before the aftermarket receives the order on their table. These costs are generated from sanitation, receiving & unpacking, planning, in house logistics and other handling costs.
>
> **Purchasing** includes the labor costs from the employees who purchase material for the in-house Repair Process, this category does not include the actual material costs.
>
> **COC, Packing, Shipment** includes all costs related to the packaging, quality

assurance, and shipment process. These costs are generated from the material used for packaging as well as labor, the labor need for quality assurance, and the fees and other costs related to the shipment, such as shipping documents and customs.

Admin includes all labor costs from the employees who are involved in planning the order, e.g. Coordinators.

PL Services includes the costs, during the fault verification process period, for the Project Leader's labor, e.g. planning and control over the project.

Reparation In-House

If the Repair Process needs to be conducted internally within TCC the following operations can be executed depending on the type of problem the product seems to have.

Unit test includes costs that are generated by performing a test on a solitary unit to gain an understanding of the product's problem, unlike *Testing time machine shop*, where the test is performed in a complete reference system.

Repair time includes labor-related costs from the repair process in the production center.

Inspection time includes the labor costs of the inspection time needed to ensure the product has been correctly repaired, occurs while the product is still in production.

Total direct material cost includes the cost of all material that has been purchased in order to be able to repair the product.

Testing time reference system includes costs that are generated by performing a test on a solitary unit in a complete reference system, unlike *Unit test*, where the test is only performed on the unit itself.

Testing time machine shop includes the labor costs of the employees who control and analyze the results from the tests in the reference system.

Final inspection includes the labor costs of the inspection time needed to ensure the product has been correctly repaired, occurs after the product has been tested and approved in the reference system.

PL Services includes the costs, during the reparation process, for the Project Leader's labor, e.g. planning and control over the project.

Fault Verification Process for Sub-Contractors

If the product needs to be sent to a sub-contractor for fault verification process, the cost of conducting the fault verification process at the sub-contractors is specified in this part of the internal quotation.

Reparation Sub-Contractor

If the sub-contractor's quotation is accepted by TCC and the product is repaired at the sub-contractor the cost of the repair is specified in this part of the internal quotation.

4.2 RQ2

This section of the thesis presents the empirical findings associated with the second research question, which is defined as follows.

> *RQ2: How could a fixed cost model be designed for Aftermarket at TCC?*

4.2.1 Qualitative Data

From the Focus Group session with Aftermarket, the seven most recurring products that have been repaired between the years 2015-2019 were settled. The parts are shown in Figure 4.1. Due to the complicated situation that TCC is a highly secure company, the authors have not been allowed to expose the real Part ID or explain the parts in detail. Therefore, the real Part IDs have been replaced with a fictitious Part ID.

Part ID	Recurrence
A	57
B	38
C	22
D	21
E	11
F	10
G	3

Figure 4.1: The seven most recurring repairs at Aftermarket within our scope.

The interview with two managers and one line manager from Production gave multiple insights and the following general comments were pointed out, as well as possible risks and eventual possibilities with a fixed cost model.

In terms of general comments, the interviewees all agreed that there is much that could be gained with a fixed cost model. For example, in many cases, the managers only rewrite the fault descriptions to fit the quotation documents. In addition, when TCC conducts the fault verification process in many cases the product is repaired simultaneously. They also agreed that it is not many other industries where it is acceptable to send a product need of repair to a company without the name of the sender or a fault description. In addition, when the managers thought of themselves as customers with a broken product, they could not see the need of knowing the error before accepting a quotation. This due to that not being an issue when the manger, for example, needs a product repaired in other industries, e.g. a cellphone. The manager is only interesting in knowing the cost of the

repair, the time needed to get the product repaired, and what has been replaced, if even that. Therefore, all managers seemed to have a positive attitude toward a fixed cost model.

Regarding possible risks, there was consensus regarding that after completion of a repair some repairs will be more expensive than what had been assumed prior to the start. In some cases, the margin will become lower, but the possibility of a higher margin in some cases also exists. However, unity existed among the managers regarding that possibilities outweighed the risks with a fixed cost model.

In regards of possibilities, there was consent among interviewees that the main possibilities with a future fixed cost model are fewer interruptions within production and shorter lead times.

The managers explained that the repairs are non-planned activities, in today's process, which can appear very sudden. Meaning that the production is disrupted very often and it makes it difficult for the managers to plan time for repairs. When planning for repairs the managers estimate time for the repairs, but it is difficult since they appear very sudden. Consent among the interviewees that a fixed cost model, or the fact that one could send a quotation prior to the repair, would ease that disruption and make production more smooth.

The reduction of the length of the lead times is a possibility by the possible non-disruptive stated above as well as not having to wait for the customer to accept a quotation. The general consensus was that a fixed cost model would give the customer a chance to accept a quotation before even sending the product to TCC. With the current process, the longest wait for a product that needs repair is in between the fault verification process and the acceptance by the customer of a quotation. Even though a fixed cost model might not be applicable to all customers the large mass of customers will be affected by such a model and therefore, the managers believed, that the lead times could be reduced considerably.

The line manager also reckon, with the assent of the other managers, that customers would see a fixed cost model as a win-win situation due to the lead time reduction and the possibility of the customers knowing if it will be a good choice to repair, buy a new product, or dispose the product before handling it and sending it to TCC's site. The process as a whole, for both customers and TCC, would with a high probability become more efficient. In addition, some customer has an agreement were TCC needs to provide a quotation within a very short amount of time, a matter of weeks, and if not provided TCC are faced with a fine. Therefore, the general consensus among the managers was that a model would help TCC with not facing fines since a quotation would be able to be provided directly when a customer reports the need for a repair.

The interview held with the manager from Marketing, Sales, & Services led to useful information in the intended topics of the division's conception of the fixed cost model, potential risk with an implementation, and how pricing works for repairs. The general conception of the fixed cost model was positive, but the manager expressed a desire to separate the quotation with two elements; the fault verification process cost and the cost of reparation. Further, the manager highlighted, as the authors anticipated also, that re-

pairs sometimes will cost more and sometimes less than the fixed cost model anticipated. The manager believed that in the long term perspective will not be an issue if a product is being repaired quite often. In a situation where a product is not repaired as often, it might be an issue, but in those cases, the manager believed that TCC could fend the risk. The manager when observing the graphs seen in Appendix E *Cost Charts*, the positivity increases even further since some of the graphs do not fluctuate much. An input the manager gives the authors was to incorporate the graphs in the model, meaning the Coordinators would be able to see the graph alongside with the estimated cost. The idea behind that idea is that the coordinators thereby would have easier to understand if it is a reasonable estimation. But in general, the manager was very positive to the model since it automates the process of quotations and saves time in the customer relationship. Faster response with a customer will increase the cash flow and that is beneficial for TCC the manager states. In regards of the potential risk of implementation, the manager states that in today's work environment it would not be possible to change who makes the attestation, e.g. the definite quotation, since it needs to go through the division of Marketing, Sales, & Services due to permissions granted from the CEO. In the future, however, changing who makes the quotation and sends it to the customer might be possible. In addition, the manager believes that it is important to inform the project office about the model and how it could affect the internal accounting. Inform is important since some project will end with a positive result and some projects will lead to a negative result. The project office, as they should, focus often of the negative affairs, and therefore it is important that they are on track and understand that fluctuation might occur, but will be positive in the long run the manager claims. In terms of how pricing for repair works, the manager explained that different customer has different customer agreements between them and TCC. Some customer demanded different levels of transparency of a quotation, e.g. the number of hours spent on different work task, the hourly wages for those work tasks, or the margin in percentage. In addition, some customers analyze all the costs sent to them and they want to ensure that TCC follows laws or that TCC has sent a quotation that is fair and reasonable. Being fair and reasonable the manager explains could be to be able to show the customer multiple other customers having paid the same price or having the exact specification of the hours as explained above. Due to how the quotations are being built the manager expressed that implementing the fixed cost model might be easier and preferable for a customer who can not demand a high amount of transparency. Due to confidentiality reasons, the authors can not give examples of such countries. Further, the manager also beliefs that by choosing that type of customer, TCC would be able to learn how to implement the model further by time.

4.2.2 Quantitative Data

The usage of Beta Distribution gave results in terms of an estimated cost for future repair, Beta Estimation, as well as graphical representations. The graphical representation can be found in Appendix E *Cost Charts*. In Figure 4.2 below, the average cost of a repair, as well as the Beta Estimation, is stated for each of the Part Numbers.

Part ID	Average	Beta estimation
A	86 710 kr	97 419 kr
B	98 495 kr	115 837 kr
C	77 121 kr	91 587 kr
D	220 222 kr	279 618 kr
E	136 409 kr	156 702 kr
F	68 388 kr	74 140 kr
G	140 090 kr	141 723 kr

Figure 4.2: For each Part Number between A to G the average cost as well as Beta Estimation is stated.

4.2.2.1 PID-Question

The findings for the second research question, in regards of the PID-question, were limited due to COVID-19. A further explanation of how COVID-19 affected the thesis can be read in Section 2.1.2 *Quantitative methods*.

The authors was able to, within the area of a PID-question, complete several smaller steps in the reach of a final and working PID-question. The first part the authors completed was the mock-up question, see Appendix 2.1.2 *Quantitative methods* for details, and the second part the authors completed was the development of the demands and conditions for the PID-question, see Appendix C for details. Further, the authors developed a goal-setting plan to simplify the development process for the specialists and their work on the PID-question, see Section 2.1.2 *Quantitative methods* for details.

The PID-question will not be completed within the period of this thesis, but the steps mentioned above that has been completed are important for a future continued development of the PID-question. The final goal with the PID-question would include a visualization tool, in forms of graphs, that would simplify and increase awareness of how the historical cost has resembled in the past. The graphs would look similar to the ones presented in Appendix E *Cost Charts*. The PID-question would also separate the two costs, the fault verification process cost and the cost of the whole repair. This is further mentioned in 5.1 *Research Question 1*.

4.3 RQ3

This section of the thesis presents the empirical findings associated with the third and last research question, which is defined as follows.

> *RQ3: How could a fixed cost model be implemented within Aftermarket at TCC?*

The empirical findings of this research question is solely based upon the literature review found in Section 3.4 *Change Management*, and on the beliefs of the authors. The authors have established their beliefs from the data collected during the thesis and from their own understanding of how TCC operates by working at TCC's site during the time period of

the thesis.

The implementation process that the authors propose for realizing the fixed cost model into the daily operations is explained in the process below.

1. Build a case and prepare how the fixed cost model can benefit TCC's operations. Calculate potential cost savings and be aware of risks. Be aware of how culture and subcultures can affect the implementation. Present the case for relevant management.

2. Anticipate the emotions and conflicts of stakeholders affected by the change together with the management team. A stakeholder can become affected in terms of social and technical change, their emotions and attitudes can vary as by the Change Curve, be aware and anticipate. In terms of conflict, anticipate possible conflicts that might arise and prepare how to manage own emotions due to those conflicts.

3. Create a guiding group with participants from different divisions who will lead the change. Chose participant based on their interest in the change, knowledge of subcultures, and of their professional competence.

4. Create a vision with help from the guiding group. The vision needs to include why the change is important and what type of results the change can lead to for the divisions affected by the change.

5. Communicate the vision and spread it within TCC. Keep the Change Curve and subcultures in mind, as well as have an understanding of breaking a habit creates emotions. Spreading the vision should be done through multiple mediums, e.g.meeting, graphical shows on hallway TVs, emails, and such.

6. Empowering stakeholders to join the vision and participate in the change. With the help from the guiding group develop a plan of how to get stakeholders to follow and which stakeholders that are of important to get on board.

7. Plan the implementation and set short term goals with the help from the guiding group. Decide which customers that can not demand a high level of transparency is good to begin with and for which Part IDs. The authors will give a recommendation which due to confidentiality reasons could not be written in the thesis. Set short term goals which will give affected stakeholders interest in the change, such as lead time reduction tracking or first twenty repair orders with the new model.

8. Consolidate improvements with the guiding group as a lead. Produce more change by establishing frequent reoccurring meetings with the group to plan for continued implementation, such as additional customers or Part IDs that will work with the model.

5 | Analysis

This chapter includes a summary of the major findings found in regards to the three research questions. An analysis is made for each research question, but the focus lies at the fixed cost model, i.e. the second research question. Considered in that analysis are the potential benefits and risks with the model as well as probable cost savings. In addition, future topics for research and a discussion of methodology are stated at the end of the chapter.

5.1 Research Question 1

The findings of the first research question, regarding what costs that are included when quotations are established, showed that there are four categories of cost included in a quotation. These are (1) Fault Verification Process & Shipment, (2) Reparation In-House, (3) Fault Verification Process for Sub-Contractors, and (4) Reparation Sub-Contractor.

The authors, wanting to challenge the current processes at TCC, decided to develop a fixed cost model where these four cost categories are absent. At first, when authors developed the mock-up PID-question, the four cost categories were not kept in mind to be included. After the mock-up had been completed, and the interview had been held with a manager at Marketing, Sales, & Services, the authors received approval that the four cost categories are not necessary for developing a quotation. Therefore, the development of the PID-question continued to not include these categories. With that said, the empirical results found for the first research question was important in terms of understanding the current process within TCC. Moreover, the manager gave insights regarding separating the quotation into two costs; the fault verification process cost and the cost of the whole repair. The cost of the whole repair would then include the fault verification process cost. These insights have the authors hold on to and is further presented in Section 4.2.2.1 *PID-Question* where the PID-question is presented.

5.2 Research Question 2

The findings of the second research question, regarding how a fixed cost model can be designed, have resulted in that the authors have, with help from specialists from TCC, developed a model with the help of the concept of PID-questions. Possible benefits found with the fixed cost model that the authors have developed, with help from specialists, are

as follow (1) a simpler and faster quotation process , (2) a continuous process with shorter breaks, (3) heavily reduced amount of follow-up questions connected with a quotation, (4) shorter set-up time, (5) a smoother and less disrupted production flow, (6) only orders that has been confirmed will be processed, (7) fewer products will require the fault verification process, (8) repairs will not occupy physical space pending an accepted quotation, (9) material and products will have less chance to disappear, and (10) shorter lead times. In the forthcoming paragraphs, these benefits are described and explained why they seem possible with the fixed cost model. Further, potential risks and cost savings possibilities are discussed.

The first potential benefit the fixed cost model can provide is *a simpler and faster quotation process* . The process will become simplified since the coordinators, who coordinate the repairs, will not have to calculate and estimate themselves how much the repair will cost for TCC. This will instead, with a fixed cost model, be provided more or less automatically, which will therefore also help speed up the quotation process. In addition, the process of establishing quotations will become more accurate since the coordinators will have historical data as reference when producing the quotations. This will also help the department's efficiency in general since a coordinator will not have to have the same knowledge of previous repairs, e.g. work experience, to make a reliable estimation.

The second potential benefit the fixed cost model can provide is *a continuous process with shorter breaks*. Today there are several problems connected to the issue that a repair is not treated as one single process without long breaks. The longer breaks can be up to several months and can create problems in several aspects. The project leader, both at TCC and the customer company, can have been replaced and therefore are not familiar with the repair order. The longer breaks can also result in a new quotation has to be made, due to the expiration date has passed. With the fixed cost model, the process will be handled as one process that will lead to fewer and shorter breaks within the process. Another aspect is that when creating a quotation with the fixed cost model, the product in need of repair does not have to go through the fault verification process before sending the quotation. This creates fewer breaks, that will lead to shorter lead times and fewer fault verification's in the process. In addition, as mentioned in Section 3.5 *Operations Management*, where the theory of waste elimination is describe, this theory can be associated with this benefit due to the desire to decrease the waste of waiting or queuing, which can be directly connected to a continuous process with shorter breaks.

The third potential benefit the fixed cost model can provide is *heavily reduced amount of follow-up questions connected with a quotation*. Since the quotation process currently includes long breaks, as mentioned in the description of the second benefit, multiple scenarios can occur. Firstly, the customer's project leader can have been replaced, and secondly, the time to accept the quotation could have expired. Since the coordinators do not close a repair case in the ERP-system if it has not been repaired or before the quotation has not been rejected, the previously stated scenarios lead to many follow-up questions. The follow-up questions leads to coordinators having to spend additional time on each repair case which of course is an in-house cost. In addition, the lead times increases with the amount of follow-up questions since it means that a project leader working for the customer needs to read up on the repair case. In addition, follow-up questions are also

an issue in regards to sub-contractors. By having long processes with a heavy amount of breaks, the sub-contractors question the desires of TCC multiple times during a project, since TCC does not give the approval to begin a repair or such, due to the customer not accepting a quotation within the given time frame. Thereby, the fixed cost model will reduce follow-up questions in terms of both customers and sub-contractors.

The fourth potential benefit the fixed cost model can provide is *shorter set-up time*. With less and shorter breaks, the set-up time will be shorter and therefore less risk that the employees forget information regarding the repair order. The set-up time in this issue involves the time period to prepare a device, machine, system, or process to be able to function for a specific job, in this case, a repair order. It will take much less effort by the employees to start up an existing repair order if not a large time span has passed compared to if it was a large time span since the employee worked with the order. Moreover, the short break will lead to less risk that an employee has quit who possesses the knowledge of repairing a product. This benefit can be connected to Section 3.5 *Operations Management*, were the elimination of waste, and minimization of unnecessary time is discussed. With shorter set-up time, less unnecessary time will occur.

The fifth potential advantage the fixed cost model can provide is *a smoother and less disrupted production flow*. In today's production environment repairs are non-planned activities as mentioned by the managers from the Production department. Since the repairs are non-planned they appear sudden which makes it difficult for the managers to plan the amount of time needed for repairs, this leads to production very often being disrupted. The fixed cost model have the possibility to make production flow smoother and less disrupted since only repairs with a quotation accepted by a customer will be handled within the production environment. Only handling products with an accepted quotation will make it easier to anticipate and construct the production plan. However, it is important to point out that it will still be hard to estimate the time of the repair. The model constructed with this thesis only take costs into considerations, see Section 5.4 *Future research* for a suggestion of a future research which would focus on the estimation of lead times.

The sixth potential advantage the fixed cost model can provide is *only orders that has been confirmed will be processed*. Today, each order which TCC receives for a repair will be put through the fault verification process before a quotation is sent. Therefore, a lot of time is spent without a guaranteed income. With the new fixed cost model, only confirmed repair orders will be processed and sent to the fault verification as previously mentioned with the second benefit. A quotation will, with the fixed cost model, be sent out more or less direct when TCC receives the product. Thereafter, only when the quotations has been accepted, will the product be sent to the fault verification process. This will lead to saved time in the fault verification process but also time invested in the repair order will be a guaranteed income, due to the fact that the quotation has already been accepted. This confirms that progress by trying to eliminate non-value adding activities and waste reduction that is explained in Section 3.5 *Operations Management*.

The seventh potential advantage the fixed cost model can provide is that *fewer products will require the fault verification process*. As mentioned above, with the sixth advantage, today all orders go through the fault verification process. With the new fixed cost model,

all the products will not be put through the fault verification process. Due to this, more time becomes available for other repair orders, to be processed in the fault verification process. Products that the customers decide not to repair do not have to be put through the process and therefore time will be saved.

The eighth potential benefit the fixed cost model can provide is that *repairs will not occupy physical space pending an accepted quotation*. All repairs are sent to TCC and after the fault verification process has been conducted, with the current process, the product need of repair will be placed somewhere inside of TCC's facility while pending an accepted quotation by a customer. Meaning, the product will occupy physical space which could be used to store other goods needed in production or such. With a more effective quotation process, and with a possible continuation of not receiving products spontaneously by customers, the physical space will not be occupied as long as today. By not occupying physical space will help optimize production since TCC will utilize their resources more efficiently. Especially in terms of eliminating the waste of inventory costs, which is described in Section 3.5 *Operations Management*. By not holding items which are not used the resources will be better utilized. In addition, if TCC can control their inputs, e.g. the incoming repairs, they will be able to yield a greater output as described in Section 3.5 *Operations Management* by Kumar and Suresh (2009).

The ninth potential benefit the fixed cost model can provide is that *material and products will have less chance to get lost*. It happens rarely, but sometimes material and products get lost at TCC due to the long lead times and longer breaks during the process. The employees put aside, in the wait for a repair, a small product or a part somewhere within TCC's facilities and when time passes it happens that the part gets forgotten on a shelf, or gets lost while cleaning. With the new fixed cost model, the chance that material and products disappear will be reduced even further. This is due to the second benefit and the creation of a continuous process with shorter breaks with the new model.

The tenth potential advantage the fixed cost model can provide is *shorter lead times*. Lead times will be shortened in several areas, as mentioned in previously explained benefits. This advantage aim attention at the lead time reduction which occurs when TCC does not need to wait as long for a customer to accept a quotation. Therefore, since the quotation is sent out much earlier, and a customer acceptance comes quicker, TCC will increase its cash flow. The cash flow will increase due to the customer has to pay the proposed quotation earlier with the fixed cost model compared to the existing method where the customer pays after the fault verification process has been performed. Another aspect that affects the longer lead times that exist today is the complex and time-consuming process to create a quotation. Long lead times are, as stated in Section 1.2 *Background*, affected by four different aspects; products, customers, sub-contractors, and in-house operations with the current work process. In terms of products, the central arguments why lead times are long is due to the repair being submitted comes in a wide range of variations as well as a long product life span. The main issue this lead to is that product expertise could be limited within TCC since only a few people might possess it. The fixed cost model will not solve this problem, but it could help reduce the problem. Mainly due to the fifth benefit of a smoother and less disrupted production flow. By having a different production flow it will become easier for the managers within production to plan production. The managers

will thereby have the possibility to pair an employee rich in expertise with a challenging repair or plan how to train a new employee to handle those challenging repairs. In regards to customers, the main issue why lead times are long is due to TCC having to await a reply regarding a sent quotation. With the fixed cost model, and as described with the second benefit and the continuous process, the belief is that the lead times will be reduced due to less and shorter breaks in the process. The other issue in the perspective of customers, where they send products to TCC without any information regarding the repair. This issue has not been solved with the fixed cost model, instead, the authors have recommended future research to handle this issue, see Section 5.4 *Future research* for further information. In the perspective of sub-contractors, the main issue is that sub-contractors might not produce a certain component any longer or that the long breaks within the process lead to many questions from the sub-contractor. Follow-up questions will be reduced, as said with the third benefit since a repair will only be repaired if the quotation has been accepted by the customer with the fixed cost model. Therefore, with a smoother and continuous process, as stated in the second benefit, the follow-up questions will be reduced as a result. The aspect of end-purchased components is a factor that TCC can not influence and therefore the fixed cost model will not be able to solve that issue. Important to state is that the issue of end-purchased components is not as large as the one with follow-up questions. The last area that affects lead times is in-house operations. The main issues within these operations that affect the lead times are that there is a fluctuation of incoming repairs, difficulties to perform the error verification process, and by TCC having a wide range of contracts to its customers. The fixed cost model will benefit the fluctuation and making the production flow more stable due to only processing order with a confirmed quotation, as described with the sixth benefit. Moreover, since fewer products will require the fault verification process, as described with the seventh benefit, due to only processing confirmed repairs, it will probably lead to fewer difficulties to perform the error verification process. This is due to fewer products being handled and the production could, therefore, focus on those repairs that have been accepted to become repaired. The issue of TCC having a wide range of contracts is an issue that the fixed cost model will not solve, but the model will be able to help automatize the process of establishing a quotation. Thereby, by having a more automatized process, the lead time will be reduced since it will help with establishing a quotation more rapid, leading to less consideration will need to be taken to the set time frame of the various contracts.

Further analysis in regards of the second research question, regarding how a fixed cost model can be designed, the authors have found a few risk and drawbacks with the model that has to be declared, the risks are as follow (1) no fault found, (2) not being able to repair the product, (3) unaware of the issue before a quotation is sent, (4) insight needed from some customers, and (5) uncertainty of not having enough historical data points. Each of the risks will be further analyzed and explain below.

The first potential risk with the fixed cost model is *no fault found*. In some rare cases, customers send in products that are working perfectly fine. If this scenario would occur, TCC will have sent a quotation to the customer and if the customer accepts the quotation the product will be sent to the process of fault verification were it would be classified as a “working” product. Thereafter, TCC will have to send back an updated quotation with a cost for the accrued expenses and transfer back possible differences between the two

quotations. However, for the customer, this will result in a cheaper repair than expected which will lead to a delighted and satisfied customer. On the contrary, TCC will lose an expected income and some extra costs could appear in admin expenses in a case like this, even though this is extremely rare and would not exceed the amount saved on shorter lead times.

The second potential risk with the fixed cost model is *not being able to repair the product*. It could occur that a product TCC has received from a customer could not be repaired. The reasons for this could be due to sub-contractors not producing certain parts any longer or if the product is too damaged. However, the chances of occurrence will not increase with implementation of the fixed cost model, but the consequences can become greater. The consequences can become greater since TCC will send a quotation to a customer quick after receiving the product without an understanding of the fault error. In a scenario were the customer has accepted the cost proposal, but TCC will be unable to repair the product, a feeling of distrust and disappointment might arise from the customer. However, it will be important for TCC to be transparent, in the quotation's description, regarding that they cannot guarantee that the product will be repaired due to the various cases stated above. In addition, and even more important, is that the customer should, and would be informed of, that they will only be charged for the accrued expenses connected to the repair order if the repair is not achievable. Important is, as a side note, that TCC includes a disclaimer to all quotations. That will allow TCC to update a sent quotation if the explained scenario would occur.

The third potential risk with the fixed cost model is the *unawareness of the issue before the quotation is sent*. In cases where the fixed cost model can be applied in, it will be risks connected to the unawareness of the product's problem. Sending a quotation in beforehand will lead to uncertainty in lead time and the actual cost for TCC. Because the model is based on averages from historical data, this implies that some cases will result in a higher cost and longer lead time than expected. On the other hand, some cases will likewise result in a lower cost and shorter lead times than expected, which will level up in the long run. An assumption made by the manager from Marketing, Sales, & Services, and which the authors agrees with.

The fourth potential risk with the fixed cost model is the *insight needed from some customers*. Some customers at TCC requires that the company declare how the costs for the repairs has been built up and what they include. The customers need a high level of transparency to analyze if the price is fair and reasonable. Therefore, it is demanded by TCC to declare the exact amount of hours spent in each phase and its hourly rate. Thereby, it can be hard to have a fixed cost model with a flat-rate for these customers. However, this level of transparency needed is not the case for all customers at TCC. Therefore, TCC should investigate to start to implement the fixed cost model with customers who can not demand the same level of transparency in their quotations, see Section 5.3 *Research Question 3* for further discussion regarding this.

The fifth potential risk with the fixed cost model is the *uncertainty of not having enough historical data points*. The drawback highlights the risk of what happens in the situation when there is not enough historical data available within a certain time frame, for a cer-

tain product, or during the circumstances of product in need of repair for the first time. There is also an aspect of analyzing and being certain of how many historical data points that TCC needs to have in order to make a valid and accurate estimation with the model. That aspect is interesting for future work and wanting to develop the model further. Assuming the perspective of not having enough data points, one solution is to integrate a warning in the model which has as aim to alert the coordinator when the history might not be sufficient enough. In these cases, the coordinator will have to address the repair manually and confirm if the amount displayed by the model seems valid. If not, the coordinator will manually have to calculate the cost, and if it seems valid, the coordinator can continue with sending the quotation to the division of Marketing, Sales & Service with the suggested estimation. With time, the number of repairs which have been processed will have reached a certain number where the estimation will become more accurate and valid. Further, it could be of interest to start of with implementing the model for certain products where there exists a great amount of data points and where there are not to great of a fluctuation. This aspect is of interest for further discussion within the scope of the third research question.

Further analysis in regards of the second research question, regarding how a fixed cost model can be designed, the authors have found several cost savings connected to the implementation of the model that has to be declared, the savings are as follow (1) shorter lead times, (2) fewer hours needed from admin, (3) less products take up space in the building, and (4) fewer hours needed in the fault verification process. Each of the savings will be further analyzed and explained below.

The first potential cost saving with the fixed cost model is the *shorter lead times*. Shorter lead times for the repair process would imply that TCC are able to cut costs in several areas. One cost saving connected to shorter lead time is the fact that the resources can be used in other projects, new labor time is therefore freed. Another aspect is that it will reduce inventory holding cost, it will result in lower stocking costs correlated to the inventory and also free invested capital in the inventory. Moreover, as mentioned above for the tenth benefit, the cash flow will increase because of increased order fulfillment and that will result in shorter lead times.

The second potential cost saving with the fixed cost model is *fewer hours needed from admin*. This would imply that with the fixed cost model, fewer hours by the employees would be needed to create a quotation or perform admin tasks. As mentioned when describing the first benefit, the process will be simpler and faster, which will lead to less time needed to create a quotation. Moreover, the process will have fewer breaks, shorts set-up time and fewer follow-up questions, as mentioned in the second, third and fourth benefit. The coordinators will work more efficiently and need fewer hours to handle the repair order. The result of this will be a saved cost in labor and will result in lower costs connected to the repair order.

The third potential cost saving with the fixed cost model is that *Fewer products take up space in the building*. As mentioned above in the eight benefit, repairs will not occupy physical space when pending an accepted quotation. The process will be handled as a continuous process with fewer breaks as a result of sending the quotation in beforehand.

This will result in having fewer products in the building or at TCC's warehouse, which will be a saved cost for TCC and more space will be available for other operations.

The fourth potential cost saving with the fixed cost model is *fewer hours needed in the fault verification process*. Due to that fewer products will require the fault verification process and only orders that has been confirmed will be processed. These two benefits, as mentioned above in the sixth and seventh benefit, will imply that costs are decreased in the repair process. TCC will also gain more resources from the time available that can be used in other cases.

5.3 Research Question 3

The findings of the third research question, regarding how could the fixed cost model be implemented, resulted in an eight-step implementation process. The process is, in a simplified way, based upon the following eight steps (1) build a case, (2) anticipate the emotions and conflicts, (3) create a guiding group, (4) create a vision, (5) communicate the vision, (6) empowering stakeholders, (7) plan the implementation and set short term goals, and (8) consolidate improvements.

The implementations process is not explained in detailed or with concrete proposals due to confidentiality reasons and secrecy regarding stakeholders. But in general the process of implementation is built on the core understanding by the authors that TCC will be able to learn a great amount by implementing the model in a small scale at first. Meaning, by implementing the model and using it on customers who can not demand a high level of transparency or on Part IDs where there exists a good amount of historical data points TCC could become a learning organization. A learning organization who would be able to learn how to improve the model and handle the challenges that exists as barriers in the current environment. Barriers such as customers demanding a high level of transparency or where some Part IDs are not repaired that often. In addition, TCC would, by implementing the model in a small scale, be able to understand better than the authors how to handle fluctuations of historical costs. Additional time and using the model hands on are conditions the authors do not have and therefore can not learn from. That it why the authors believe that a small scale implementation is beneficial for TCC and that it will result in good understanding in-house.

The process has been developed with the other divisions in mind. Meaning, the authors believes it is important that the implementations occurs in such a way that all divisions, e.g. Aftermarket, Production, Finance, and Marketing, Sales, & Services, has a say in the change initiative. All divisions need to be on board with the change and understand the benefits that the model can result in. Important is of course also an understanding regarding potential risks, as well as cost savings. If the various departments have those understanding they can together counteract the risks and work towards fulfilling the potential cost savings. The authors believe, if the divisions could collaborate to initiate this change, the fixed cost model would become beneficial for TCC's operations. Working toward minimizing time in the customer relationship, e.g. shorter waiting times and faster responses, as said by in the interview by the manager from Marketing, Sales, & Services,

is beneficial for the entire operation. An implementation of the fixed cost model would work towards that, minimizing lead times.

5.4 Future research

Throughout the work with the thesis the authors have developed ideas which could be seen as future research areas and areas that need further development. These ideas are (1) a model for lead times, (2) a customer portal, (3) investigation of amount of historical data points needed for a robust estimation, (4) investigation of optimistic and pessimistic values.

The first idea of future research is *a model for lead times*. This idea is developed based on the fixed cost model, and the idea is that this model would function the same way but with lead times. Meaning, a stakeholder would enter a Part ID and get an estimated lead time for the repair. Further, the idea seems relevant since it would help with planing the production. As mentioned in Section 5.2 *Research Question 2*, under the explanation of the fifth benefit, the fixed cost model will help the production flow become more smooth and less disruptive, but it lacks the possibility to estimate the lead time. Which leads to the fact that it is still hard to anticipate the time needed in production for a certain repair.

The second idea of future research is *a customer portal*. The main goal with such a portal would be that the customer would have to fill in the information regarding the repair, such as the product that needs repair, a fault description, and necessary information regarding the customer. As stated by the managers from Production in Section 4.2.1 *Qualitative Data*, there are not many other companies who allow a customer to send in a repair without any information about the fault or the customer. The authors believe that the development of such a portal would help the efficiency of the Repair Process even further. In addition, the model could also be developed so that the customer would be able, for some products, get an estimated quotation even before sending it to TCC. That would help the customers to come to a conclusion if they feel it is valid to repair or scrap the product.

The third idea of future research is *investigation of the number of historical data points needed for a robust estimation*. It needs to be researched the amount of data points needed to perform a robust estimation. Further research should also include an examination of how and when the warning of too few data points should occur. Moreover, the researchers need to make sure the model is valid and robust enough, therefore, this needs further investigation.

The fourth idea of future research is *investigation of optimistic and pessimistic values*. This research connects to the Beta Estimation that is a focal point for the development of the fixed cost model. By investigating further how these values could be calculated and how the results of the estimation are affected, based on the choice of calculation, it could help increase the reliability of the model.

5.5 Discussion of methods

2.1.2 & 5.5 In general, there is a width in the methodologies used to carry out the thesis. The width is evident through both using qualitative and quantitative methods, but also by combining primary and secondary sources. In addition, the case study approach results in efficient conclusions and results for TCC as well as more general conclusions for other organizations.

The chosen methodology relies on participants helping and guiding the authors in a certain direction. Therefore, the participant's attitudes and beliefs of the thesis subject will guide the outcome of the thesis. Further, cultures, organizational politics, habits of participants, and other norms will guide the outcome of the thesis. The authors believe, based on how they have been treated along the way, that in general, the culture within TCC is open-minded and curious for change. Participants have been eager to help and interested in the outcome of the thesis, as well as contributed with valuable and insightful tips for improvements. Therefore, the authors believe that the thesis has been influenced by the participants, but appropriately and positively. If the authors would have been treated with disbelief or negative attitude the outcome of the thesis would probably have been influenced differently in a negative way. But the authors believe, according to the prior statements, that it is not the case with this thesis.

Moreover, it can be concluded that due to Covid-19, the construction of the PID-question has taken much more time than expected. The time management could not have predicted the pandemic and the impact it had on the thesis. Further, it can be argued that the result of the fixed cost model would have been closer to completion if more time were available or in a different situation. Overall, it is hard to develop a fixed cost model for a company with a high level of confidentiality and were customer agreements vary as much as at TCC. Nevertheless, the authors have found that the fixed cost model will result in a more efficient Repair Process when fully developed.

5.6 Conclusion

The authors concluded that customers can demand different levels of transparency when TCC sends a quotation. This contributes to, in terms of the first research question, that categorization might still be necessary when sending a quotation. Although, the categorization does not have to be constructed as found in the empirical results of the first research question. Instead, a categorization with two different types of cost has been found preferable. These costs are the fault verification process cost and the cost of the whole repair.

Regarding the second research question, and the fixed cost model, the model was unfortunately not fully developed. The reason behind this was because of COVID-19 and could not have been predicted to affect the outcome as much as it did. The authors did analyze the fixed cost model and what was found was that the fixed cost model have the potential to lead to several advantages, as well as cost saving, but also risks. These are all summarized in Figure 5.1 below. For a more detailed description of the advantages, cost savings,

and risks, see Section 5.2 *Research Question 2*.

Potential advantages
1. A simpler and faster quotation process
2. A continuous process with shorter breaks
3. Heavily reduced amount of follow-up questions connected with a quotation
4. Shorter set-up time
5. A smoother and less disrupted production flow
6. Only orders that has been confirmed will be processed
7. Fewer products will require the fault verification process
8. Repairs will not occupy physical space pending an accepted quotation
9. Material and products will have less chance to disappear
10. Shorter lead times

Potential risks
1. No fault found
2. Not being able to repair the product
3. Unaware of the issue before a quotation is sent
4. Insight needed from some customers
5. Uncertainty of not having enough historical data points

Potential cost savings
1. Shorter lead times
2. Fewer hours needed from admin
3. Fewer products take up space in the building
4. Fewer hours needed in the fault verification process

Figure 5.1: A summary of the advantages, risks, and cost savings associated with the fixed cost model.

The main conclusion that could be drawn to the suggested implementation, of the fixed cost model, is that it is difficult to construct an implementation process when not having sufficient understanding of the culture and sub-cultures within TCC. Therefore, the authors have not had enough understanding to be able to formulate concrete actions in the implementation process. The concrete steps have therefore been left to the managers of the different divisions affected by a future implementation.

Overall, the findings of the thesis demonstrate a strong effect on the reduction of lead times and the complexity of establishing quotations. Aftermarket is, as established early on of the thesis, an important division for the longtime success of a company. Further, a company who focuses on after-sales services will benefit in the long run since it will generate a steady revenue stream. The empirical findings have shown that the fixed cost model will benefit TCC due to automatizing the quotation process and making the quotation process more efficient. The fixed cost model will, when implemented, help TCC become even more successful in their after-sales services.

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Appendices

A The Repair Process

The Repair Process that is currently used at TCC is described in Figure A.1 below. The light blue parts are processes conducted before the quotation has been accepted by the customer, and the dark blue parts are processes conducted after the quotation has been accepted by the customer. Further, the green parts highlights when a quotation is accepted either by the customer or by TCC. TCC accepts quotations if the product needs to be sent to a supplier in order to be repaired. The customer accepts the complete quotation, meaning that the quotation consists of parts calculated by both TCC and potential suppliers.

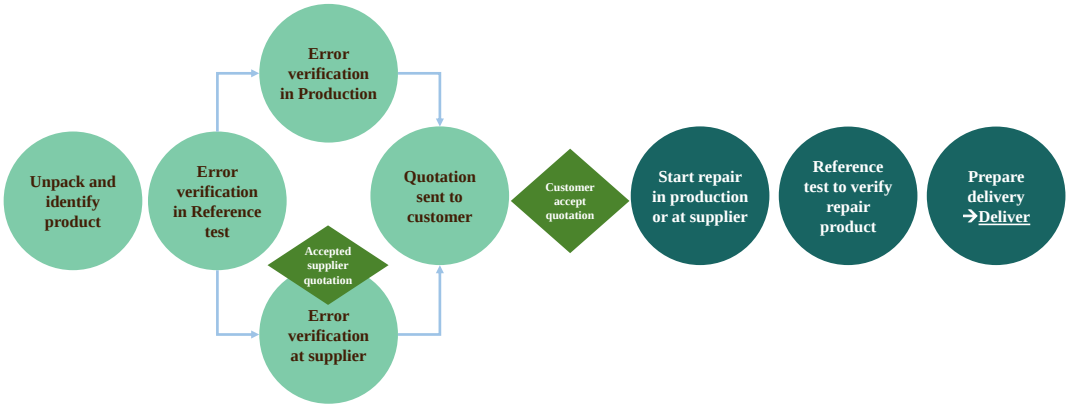


Figure A.1: The current Repair Process at TCC.

The Repair Process begins with TCC receiving, unpacking, and identifying a product sent from a customer. Thence, the product is sent to a Reference test were the error is verified. If not possible to identify the error the product could be sent to either Production or to a supplier for further verification. After error verification is completed a quotation is sent to the customer. If the customer accepts the quotation the repair starts either in-house at Production or at a supplier. After the repair has been completed, the product is sent to a Reference test to verify that the product has been repaired. Thence, TCC prepare the product for delivery and assure the quality of the product. The last step of the Repair Process is to deliver the product back to the customer.

B Organizational Chart

TCC could be explained, from the perspective from the Aftermarket division, by Figure B.1 below. The chart has been simplified due to confidential reasons.

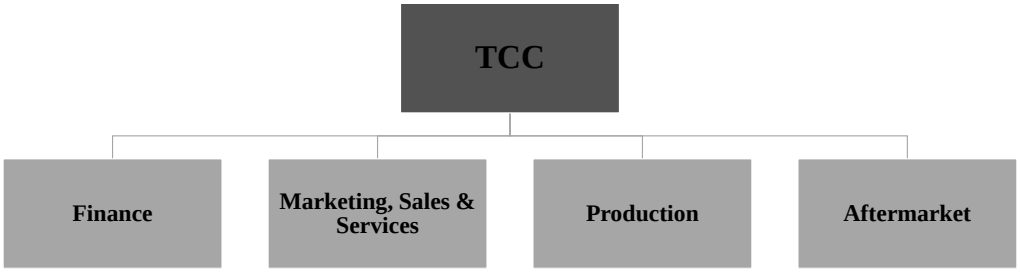


Figure B.1: A simplified overview of the organization of TCC.

The Finance department controls and accounts for TCC's finance. Includes organizational planning as well managing assets.

The Marketing, Sales & Services department manages all events associated with marketing and sales, such as establishing and handling customer contracts.

The Production department handles all sourcing and production connected with new production. Included are also the physical production, which can consist of producing new production, producing spare parts or repairing broken products.

The Aftermarket department manages two process, the Spare Part Process and the Repair Process. Included are planning, sourcing, and customer support associated with these processes.

C Conditions for the PID-question

Below follows the conditions set for a PID-question.

- Search a Part ID
- Filter based upon the following criterias
  - Only show repairs
  - Only show the last five years
  - Only show 'Case Closed'
  - Only show Order IDs which has one part connected to it
  - Exclude Order IDs which is used as a collection for PL-services to a specific customer
- For each part
  - Find the most optimistic cost (1 piece)
  - Find the most pessimistic cost (1 piece)
  - Calculate the average cost for all Order IDs
  - OBS! If 'Obtained Material from Stock' is < 0 SEK add to the total cost for that part
- Calculate Beta Estimation
- Show the estimated cost
  - OBS! If less than a secure amount of Order IDs is connected to the Part ID warn the Coordinator!

D Cost Data

The tables in this section show the information that was extracted from the ERP-system for each of the parts between A to G. All costs that are shown in the figures below have been modified due to confidentiality reasons. Below follows a description of each term.

Beta Estimation is the estimated cost that have been calculated with help from historical data points.

Average cost is the average cost for the specific Part ID.

Cost incl. stock is the final cost that has been generated. It includes the cost for obtaining material from stock.

Cost excl. stock is the cost where material obtained from stock is viewed as a negative cost item. Some of these costs is therefore negative.

Cased closed shows if the case is closed or not. The model only views cases that are closed.

Start date is when the repair begins.

Part A

Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
94 093 kr	94 093 kr	●	2015-04-20
102 281 kr	102 281 kr	●	2015-04-20
103 147 kr	103 147 kr	●	2015-04-20
125 032 kr	125 032 kr	●	2015-04-20
139 109 kr	139 109 kr	●	2015-04-20
32 321 kr	32 321 kr	●	2015-05-07
43 747 kr	43 747 kr	●	2015-05-07
153 201 kr	153 201 kr	●	2015-05-07
101 992 kr	101 992 kr	●	2015-11-10
131 716 kr	131 716 kr	●	2016-04-22
13 873 kr	13 559 kr	●	2016-05-31
116 501 kr	116 501 kr	●	2016-06-28
13 050 kr	-50 253 kr	●	2016-07-26
81 741 kr	15 975 kr	●	2016-07-27
100 171 kr	45 761 kr	●	2016-08-01
40 125 kr	40 125 kr	●	2016-10-19
111 492 kr	111 492 kr	●	2016-11-25
13 556 kr	13 556 kr	●	2016-12-02
111 460 kr	111 460 kr	●	2016-12-02
145 694 kr	90 012 kr	●	2016-12-14
39 999 kr	39 999 kr	●	2017-03-20
79 807 kr	79 807 kr	●	2017-03-20
84 302 kr	84 302 kr	●	2017-03-20
96 095 kr	96 095 kr	●	2017-03-20
100 113 kr	100 113 kr	●	2017-03-20
127 138 kr	127 138 kr	●	2017-03-20
94 790 kr	94 790 kr	●	2017-09-06
132 160 kr	132 160 kr	●	2017-09-06
23 769 kr	-31 913 kr	●	2018-02-09
88 496 kr	88 496 kr	●	2018-02-09
155 329 kr	155 329 kr	●	2018-02-14
172 268 kr	172 268 kr	●	2018-02-14
167 091 kr	167 091 kr	●	2018-05-21
176 951 kr	176 951 kr	●	2018-05-22
34 379 kr	34 379 kr	●	2018-05-24
37 469 kr	37 469 kr	●	2018-05-24
38 808 kr	38 808 kr	●	2018-05-24
38 808 kr	38 808 kr	●	2018-05-24
41 355 kr	41 355 kr	●	2018-05-24
50 234 kr	50 234 kr	●	2018-05-24
53 543 kr	53 543 kr	●	2018-05-24
56 219 kr	56 219 kr	●	2018-05-24
56 219 kr	56 219 kr	●	2018-05-24
56 621 kr	56 621 kr	●	2018-05-24
62 782 kr	62 782 kr	●	2018-05-24
66 411 kr	66 411 kr	●	2018-05-24
106 901 kr	106 901 kr	●	2018-05-24
51 877 kr	51 877 kr	●	2018-06-05
51 272 kr	51 272 kr	●	2018-06-07
63 018 kr	63 018 kr	●	2018-06-07
113 934 kr	113 934 kr	●	2018-06-08
101 266 kr	101 266 kr	●	2018-08-22
20 452 kr	20 452 kr	●	2018-09-20
219 989 kr	219 989 kr	●	2018-12-10
224 625 kr	224 625 kr	●	2018-12-10
62 434 kr	-996 kr	●	2019-07-10
21 225 kr	-42 206 kr	●	2019-08-26

Beta estimation	97 419 kr
Average cost	86 710 kr
Difference between Beta estimation & Average cost	10 709 kr

Part B

Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
70 608 kr	70 608 kr	●	2015-01-14
98 958 kr	98 958 kr	●	2015-02-16
163 064 kr	163 064 kr	●	2015-06-05
55 314 kr	55 314 kr	●	2015-06-08
42 134 kr	42 134 kr	●	2015-06-17
102 891 kr	102 891 kr	●	2015-06-26
89 333 kr	89 333 kr	●	2015-08-27
34 964 kr	34 964 kr	●	2015-09-18
211 516 kr	211 516 kr	●	2015-10-28
123 241 kr	123 241 kr	●	2015-10-29
16 614 kr	16 614 kr	●	2016-01-29
126 751 kr	66 869 kr	●	2016-02-26
56 933 kr	56 933 kr	●	2016-05-26
213 665 kr	213 665 kr	●	2016-05-26
103 558 kr	103 558 kr	●	2016-06-13
25 340 kr	15 372 kr	●	2016-07-12
30 662 kr	-76 551 kr	●	2016-09-12
83 853 kr	83 853 kr	●	2016-10-17
97 188 kr	97 188 kr	●	2016-10-17
73 759 kr	73 759 kr	●	2016-11-25
67 584 kr	67 584 kr	●	2016-11-28
104 496 kr	104 496 kr	●	2016-11-28
144 863 kr	144 863 kr	●	2016-11-28
117 152 kr	117 152 kr	●	2017-01-17
87 633 kr	87 633 kr	●	2017-02-06
94 485 kr	94 485 kr	●	2017-02-06
72 481 kr	72 481 kr	●	2017-02-08
183 111 kr	183 111 kr	●	2017-02-20
28 120 kr	-87 646 kr	●	2017-03-08
166 388 kr	46 177 kr	●	2017-03-08
109 688 kr	-46 078 kr	●	2017-08-04
117 324 kr	-2 886 kr	●	2017-10-13
284 426 kr	284 426 kr	●	2018-01-03
47 581 kr	47 581 kr	●	2018-01-23
50 741 kr	50 741 kr	●	2018-01-23
51 690 kr	51 690 kr	●	2018-01-23
139 092 kr	18 881 kr	●	2018-03-07
55 619 kr	55 619 kr	●	2019-02-18

Beta estimation	115 837 kr
Average cost	98 495 kr
Difference between Beta estimation & Average cost	17 342 kr

Part C

Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
83 867 kr	83 553 kr	●	2016-02-20
89 612 kr	89 298 kr	●	2016-02-20
63 160 kr	-790 kr	●	2016-05-16
27 750 kr	27 750 kr	●	2016-11-25
110 205 kr	110 205 kr	●	2017-03-15
141 203 kr	141 203 kr	●	2017-03-16
161 015 kr	161 015 kr	●	2017-04-13
11 483 kr	-51 113 kr	●	2017-06-29
49 619 kr	457 kr	●	2017-06-29
106 346 kr	106 346 kr	●	2017-08-07
69 026 kr	69 026 kr	●	2017-09-29
87 931 kr	38 770 kr	●	2017-12-13
113 370 kr	64 209 kr	●	2017-12-13
118 455 kr	69 293 kr	●	2017-12-13
29 017 kr	29 017 kr	●	2018-10-17
35 170 kr	35 170 kr	●	2018-10-17
229 557 kr	229 557 kr	●	2018-10-17
21 862 kr	21 862 kr	●	2018-12-13
22 577 kr	22 577 kr	●	2018-12-13
25 883 kr	25 883 kr	●	2018-12-13
49 028 kr	49 028 kr	●	2019-04-29
50 523 kr	50 523 kr	●	2019-04-29

Beta estimation	91 587 kr
Average cost	77 121 kr
Difference between Beta estimation & Average cost	14 466 kr

Part D

Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
535 853 kr	471 286 kr	●	2015-01-14
126 270 kr	-219 448 kr	●	2015-03-11
140 829 kr	140 829 kr	●	2015-03-18
274 266 kr	274 266 kr	●	2015-03-19
134 278 kr	-211 441 kr	●	2015-03-23
78 313 kr	13 746 kr	●	2015-10-12
257 097 kr	22 760 kr	●	2015-10-13
248 028 kr	248 028 kr	●	2015-11-17
224 391 kr	224 391 kr	●	2016-02-09
49 912 kr	49 912 kr	●	2016-09-01
746 911 kr	746 911 kr	●	2016-09-01
104 984 kr	104 984 kr	●	2016-09-09
130 821 kr	130 821 kr	●	2016-09-26
121 336 kr	121 336 kr	●	2016-11-29
49 951 kr	49 951 kr	●	2016-12-14
112 665 kr	-233 054 kr	●	2016-12-14
334 193 kr	334 193 kr	●	2017-01-10
617 770 kr	617 770 kr	●	2017-04-13
97 166 kr	97 166 kr	●	2017-05-24
85 651 kr	85 651 kr	●	2017-09-04
153 973 kr	-298 185 kr	●	2018-09-20

Beta estimation	279 618 kr
Average cost	220 222 kr
Difference between Beta estimation & Average cost	59 396 kr

Part E

Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
274 659 kr	274 659 kr	●	2015-06-26
127 316 kr	127 316 kr	●	2016-02-09
48 853 kr	48 853 kr	●	2016-03-15
39 368 kr	39 368 kr	●	2016-06-21
50 545 kr	50 545 kr	●	2016-06-22
61 196 kr	61 196 kr	●	2016-09-01
355 209 kr	355 209 kr	●	2016-09-01
113 261 kr	113 261 kr	●	2016-09-23
237 631 kr	237 631 kr	●	2018-11-06
125 890 kr	-412 117 kr	●	2019-03-11
66 572 kr	66 572 kr	●	2019-04-03

Part F

Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
41 438 kr	41 438 kr	●	2015-06-25
20 458 kr	12 299 kr	●	2016-01-21
98 600 kr	84 349 kr	●	2016-03-29
91 152 kr	18 294 kr	●	2016-03-29
73 179 kr	50 393 kr	●	2016-06-29
45 208 kr	-103 858 kr	●	2016-07-08
59 015 kr	-90 051 kr	●	2016-07-15
49 612 kr	-99 453 kr	●	2016-07-15
54 390 kr	54 390 kr	●	2017-02-10
150 829 kr	150 829 kr	●	2017-06-01

Beta estimation	74 140 kr
Average cost	68 388 kr
Difference between Beta estimation & Average cost	5 752 kr

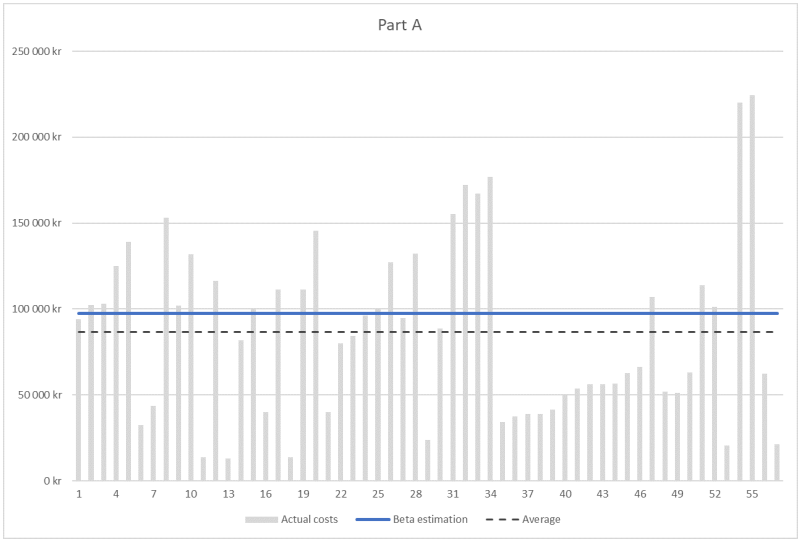
Part G

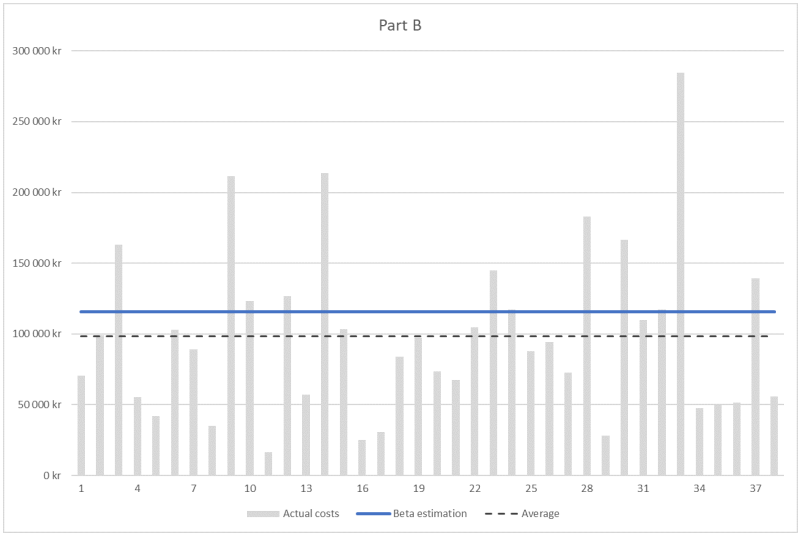
Cost incl. Stock	Cost excl. Stock	Case Closed	Start Date
118 114 kr	118 114 kr	●	2015-12-23
171 863 kr	171 863 kr	●	2017-06-27
130 292 kr	130 292 kr	●	2018-03-13

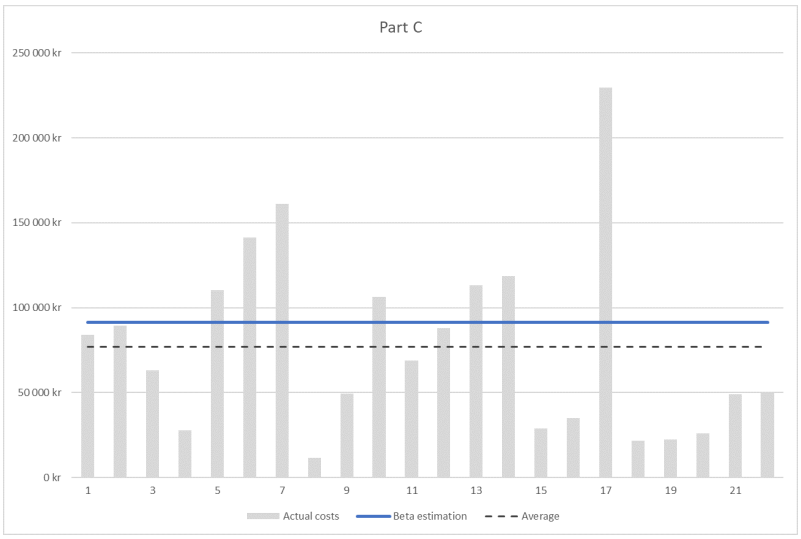
Beta estimation	141 724 kr
Average cost	140 090 kr
Difference between Beta estimation & Average cost	1 634 kr

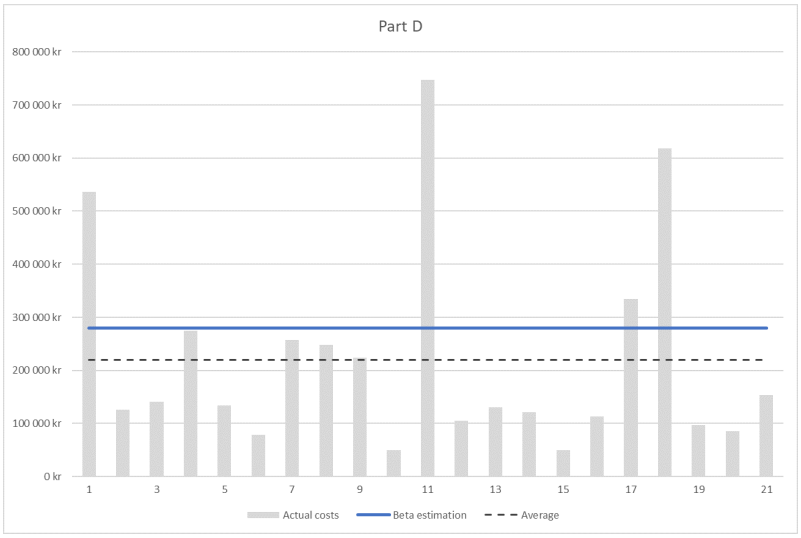
E Cost Charts

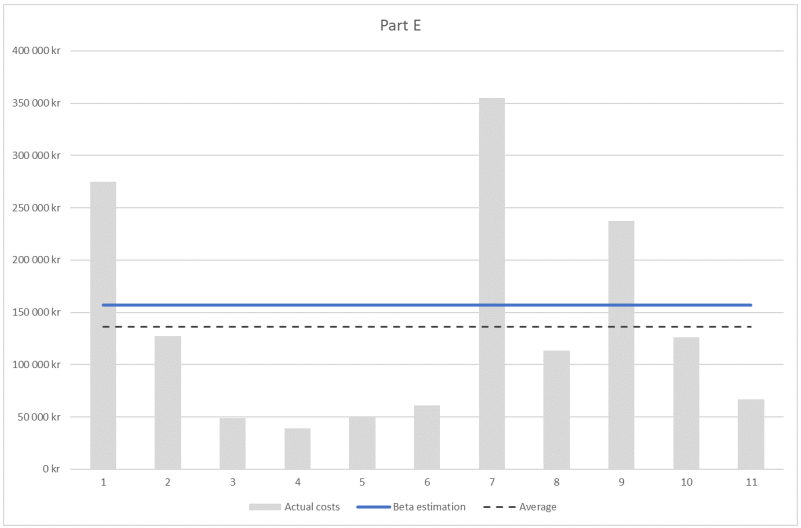
The Charts displayed below visualizes the Actual Cost, the Beta Estimation and the Average cost for each Part Number between A to G between the years of 2015 to 2019. Each grey bar represents one Order ID and the actual cost of that specific repair. The Beta Estimation is explained in depth in section 3.2.5.

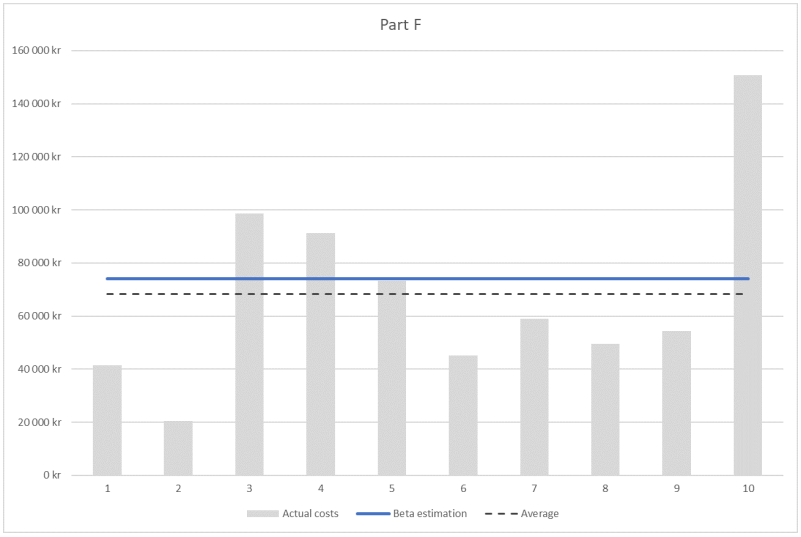


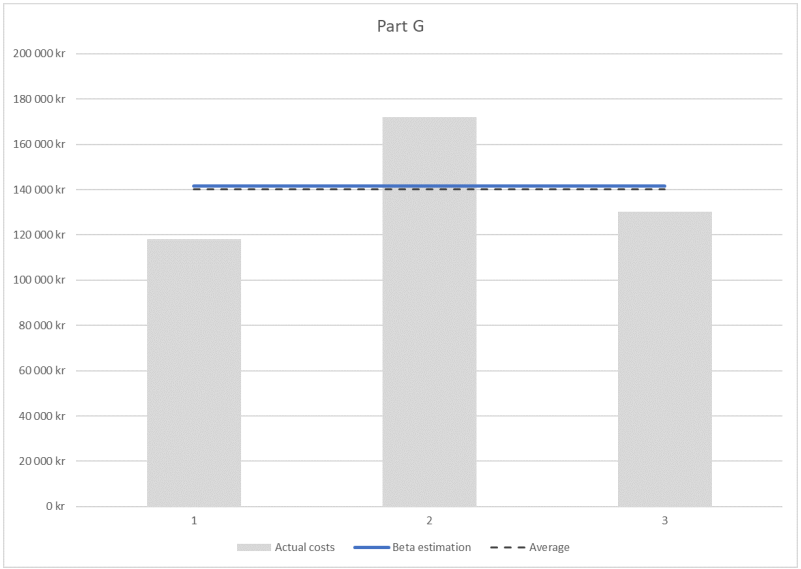



Part C
250 000 kr
200 000 kr
150 000 kr
100 000 kr
50 000 kr
0 kr
1
3
5
7
9
11
13
15
17
19
21
Actual costs
Beta estimation
Average


Part D
800 000 kr
700 000 kr
600 000 kr
500 000 kr
400 000 kr
300 000 kr
200 000 kr
100 000 kr
0 kr
1
3
5
7
9
11
13
15
17
19
21
Actual costs
Beta estimation
Average


Part E
400 000 kr
350 000 kr
300 000 kr
250 000 kr
200 000 kr
150 000 kr
100 000 kr
50 000 kr
0 kr
1
2
3
4
5
6
7
8
9
10
11
Actual costs
Beta estimation
Average


Part F
160 000 kr
140 000 kr
120 000 kr
100 000 kr
80 000 kr
60 000 kr
40 000 kr
20 000 kr
0 kr
1
2
3
4
5
6
7
8
9
10
Actual costs
Beta estimation
Average


Part G
200 000 kr
180 000 kr
160 000 kr
140 000 kr
120 000 kr
100 000 kr
80 000 kr
60 000 kr
40 000 kr
20 000 kr
0 kr
1
2
3
Actual costs
Beta estimation
Average

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