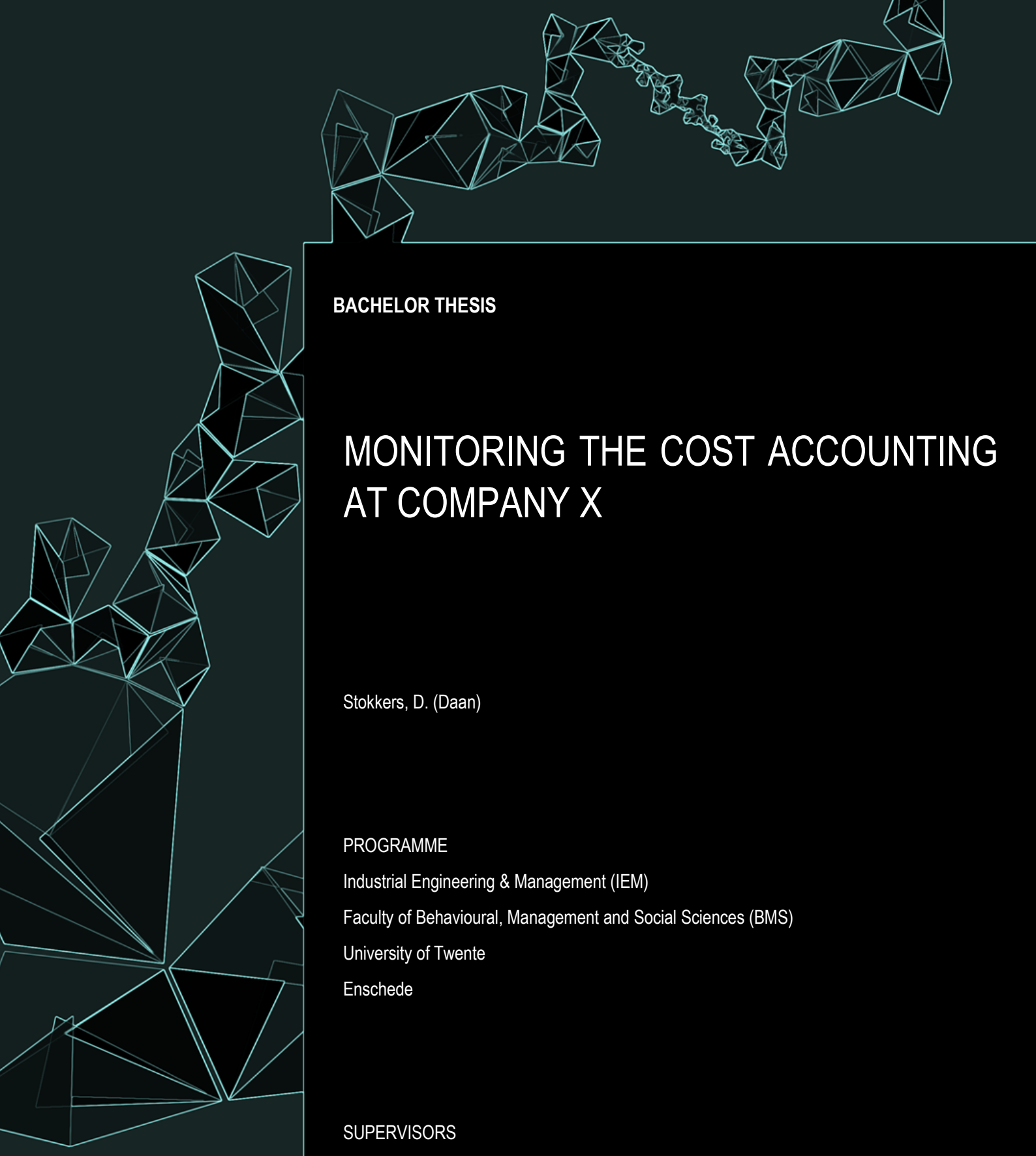

BACHELOR THESIS

MONITORING THE COST ACCOUNTING AT COMPANY X

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Industrial Engineering & Management (IEM)

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PREFACE

Dear reader,

Hereby I present my Bachelor Thesis: “Monitoring the cost accounting at Company X.” This thesis is written to complete my bachelor programme Industrial Engineering and management at the University of Twente. This thesis focusses on monitoring the performance of Company X its costing model.

First of all, I would like to thank my University supervisors Wouter van Heeswijk and Reinoud Joosten for guiding me through this thesis, their valuable feedback and always helping me when I encountered a problem. Next I would like to thank Company X for giving me the possibility to see a very interesting, innovative and still growing company from the inside during my bachelor thesis. I especially want to thank [removed due to confidentiality], my supervisor at Company X, he helped me a lot during the process and despite his busy schedule he made time for me when needed. Even though I was not allowed to work at the company a lot due to the COVID-19 pandemic I have learned a lot from him. I also want to thank my fellow student David for always helping me when I thought I got stuck and making sure that I did not lose my motivation. Last, I would like my family for allowing me to work on my Bachelor Thesis from home and supporting me when needed.

During this thesis I got a great opportunity to apply the knowledge I gained during my Bachelor’s programme in practice and learned a lot the along the way. I am looking forward to start my Master Financial Engineering and Management at the University of Twente.

Enjoy reading my Bachelor’s Thesis.

Daan Stokkers

MANAGEMENT SUMMARY

Company X is a production company and subsidiary of the Company Y. The management of Company X suspects the current costing model does not give a realistic image of their product costs. The underlying problem is a lack of structure in the available data, making it very hard and time-consuming to gain an overview of how the cost accounting of Company X is performing. This report elaborates on how Company X can gain insight into whether the cost accounting for their products is accurate. The main research question for this report is the following:

"How can Company X monitor the performance of its costing model?"

Company X uses its costing model to determine product costs and prices. Currently there is a lot of unclarity regarding the accuracy of the costing model due to a lack of insight in how the costing model performs. Before developing a method to track the accuracy of the costing model, we evaluated the costing model itself using literature. We used a literature review to determine whether the current costing method, the traditional costing method, is an appropriate one for Company X. In our literature review, we reviewed several costing methods. On paper, activity based-costing seemed like a good fit since it is known for giving a more detailed insight into how much time and resources are involved by all activities in the process (Kumar and Mahto, 2013). The problem with activity-based costing is that it is way more complex than the traditional method. Combining the complexity of activity-based costing with the fact that Company X has ±25 different programmes which often contain several products with different production process, we concluded that an activity-based approach would end up in a costing approach that is too time-consuming to set up and maintain. Therefore we chose to take the traditional costing, as it is in the current costing model as a starting point and set the basis to properly monitor the current costing model to allow Company X to apply targeted improvements to the costing model in the future.

To visualise the accuracy of the costing model, a dashboard is developed using the stages of Kernzer (2017). First, four key performance indicators are defined: (i) cost variance, (ii) average hourly rate, (iii) sales price variance and (iv) project cost coverage, are defined. All chosen KPIs have been measured against the criteria of Carlucci to determine whether they have the characteristics of appropriate KPIs. The dashboard automatically calculates and visualises these KPIs for programmes selected by the user.

Using this dashboard, we can monitor the accuracy and performance of the costing model at Company X. Although the dashboard works and gives results, these are often biased because of errors in the data stored in the company's ERP system. Therefore it is crucial that before using the dashboard, the data collection and storage within the company has to get better structure. Here it is most important to (i) implement a generic way to divide production costs for all products, (ii) divide all activities within programmes correctly in production related and service related projects, and (iii) make sure the most recent costing model information is available. When these three are taken care of, the dashboard can be used to its full potential. The dashboard can be connected to the ERP system to automatically update data and allow stakeholders to continuously keep overview of all programmes within the firm.

To conclude, this research points out how Company X can gain the overview of the cost accounting at the company. To start properly monitoring the cost accounting at Company X, the company first has to improve its data provision. When this is done, the company can use the dashboard described in this research to bring targeted improvements to enhance the accuracy of the costing model efficiently.

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1. INTRODUCTION

This section introduces the company, stakeholders, motivation and the observed problem. The core problem is described and displayed in a problem cluster in section 1.5. The relation between the core problem and underlying problems is explained, and translated in the main research question and a list of deliverables. Next, this section elaborates the methodology we used to answer the main research question. Because this research carried out at the Company X, some company specific terms are key to understand the storyline. Section 1.9. explains the important company-specific definitions used in this research.

1.1. The company

[removed due to confidentiality]

1.2. The problem

The management of Company X suspects that their current costing model, used to calculate product prices based on their costs, does not represent the actual costs of products anymore. For example, some costs are currently likely to be underestimated or not represented in the model at all. Besides, it is hard to verify whether expected costs according to the costing model align with the costs actually made during the process. This makes it a time consuming process to figure out whether and where the company is performing under or over the expectation in the costing model for certain products. The costs expected to be unrepresented in the model can be described as overhead costs which cannot directly be connected to manufacturing.

1.3. Stakeholders

The research is mainly carried out in the management department of the company. This is also the place where the problem was observed. In the end the managing director of Company X is responsible for what happens, and thus he is the problem owner.

The project managers of Company X are also important stakeholders. They use the costing model to determine prices of products for the customers, and therefore responsible for the costed prices of products. When the costing model misses certain factors it has direct consequences on how accurate the project managers can determine product prices.

1.4. Motivation

Accurate cost accounting is critical within a company. The company's management suspects the current costing model does not represent the actual costs accurately. This brings risks Company X should not take. Currently, a lot of unclarity on the different cost-elements in the costing model exists. This is shown in the problem cluster in Section 1.5, Figure 1. This leaves room for differences between costs budgeted in the costing model and actual costs. If there is discrepancy between the model and reality, this discrepancy is strengthened by the use of cost-plus pricing to calculate profit. To determine the sales price, cost-plus pricing is used to add a percentage of the costs as a profit margin (Schneider, 1985). This means that all inaccuracies in the costs directly affect the profit. When elements in the costing model are inaccurate, the product's price will be inaccurate too. On the one hand, this can result in product prices that are not competitive and cause customers to look for alternative manufacturers with a more competitive price. On the other hand, this can lead to prices that are too low and affect profitability. When budgeted costs contain inaccuracies, this might result in decisions being made on inaccurate information. To prevent this from happening, we must gain more overview and transparency in the relation between the company's costing model and actual costs.

Next, some costs are made indirectly, but they do contribute to the production process of products. It is important to know what these costs are for and where in the company they are made. If this is unknown, all these costs are all ‘unspecified costs’, and it will become complicated to keep the overview, especially when there is a lot of variety in the production processes. This again leaves exposure for potential discrepancy between the expected and actual situation.

It is currently a time-consuming process to gain an overview of how certain production programmes perform in terms of costs compared to expected costs. When it becomes easier and faster to overview this, it will also improve the responsiveness. For example, when a certain production process structurally takes more hours than planned, this will be noted faster if processes are monitored better. When a problem is known faster, it can be resolved quicker.

1.5. Core problem

Our research started when the management of the company suspected issues with the costing model. However, this suspicion is not the problem itself. The problem cluster in Figure 1 displays the underlying issues, causing inaccuracies in the costing model. We used the input of project managers of Company X to determine these underlying problems. On the right is the problem which is suspected by the management of Company X, and on the left, the core problem outlined in bold.

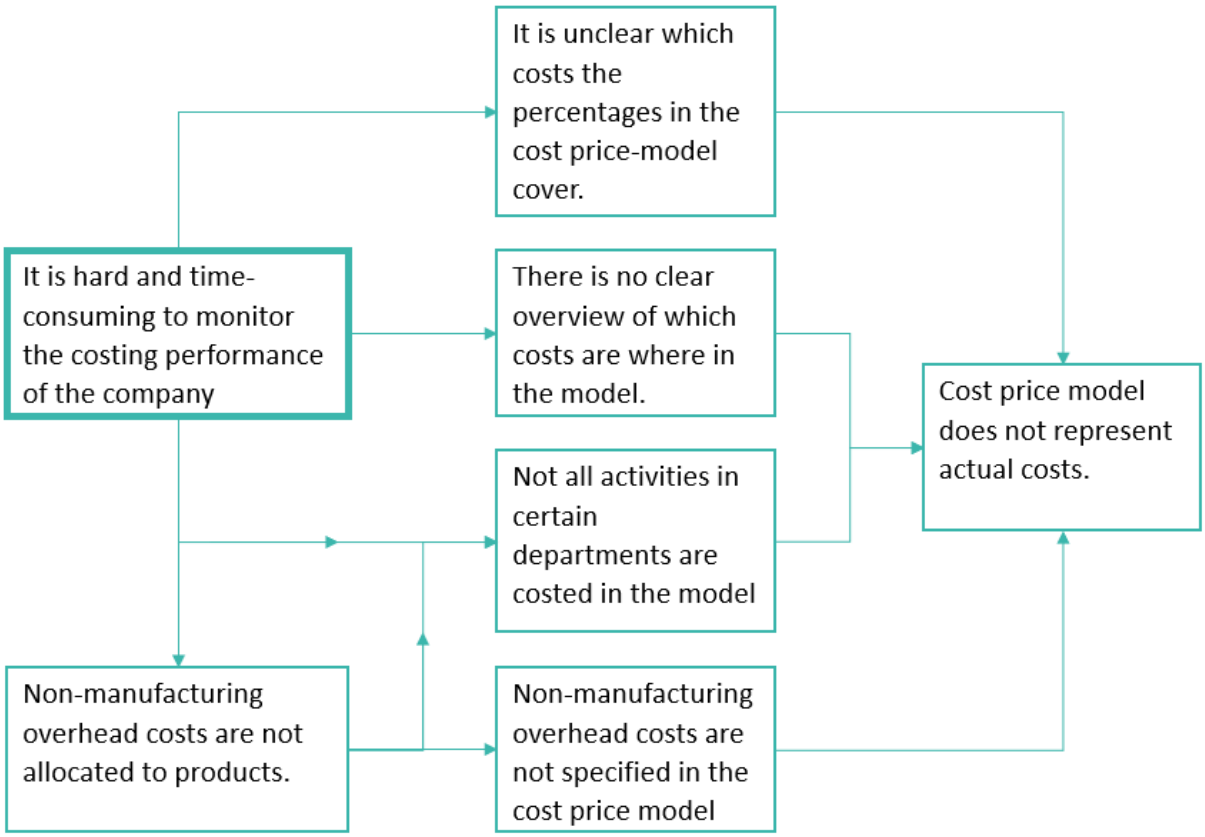


Figure 1, Problem cluster, the core problem is highlighted with a bold outline.

Based on the problem cluster in Figure 1, we have worked out the problem observed by the management into the following core problem:

"It is hard and time-consuming to monitor the costing performance of the company."

According to project managers at Company X, there is doubt whether the current cost price model covers the actual costs in several aspects. This is the case for some of the percentages and calculated numbers in the current model. Furthermore, there is no clear overview of what costs are part of particular cost items in the model. The core problem causes this lack of overview. It is hard and time-consuming to monitor actual costs, which are tracked in the ERP system, and compare them to the budgeted costs according to costing models. Currently, this is very difficult since there is no direct connection between the costing model and the way actual costs are tracked. This is caused by discrepancies between the elements of the costing model and the elements in which actual costs are registered. When there is no proper comparison made, the actual performance and accuracy of the costing model compared to actual costs in the ERP system remains unknown. Another problem caused by the core problem is the non-manufacturing overhead costs which are not allocated to products. These costs are not specified in the current model as a cost item, which implies that these costs have to be paid from money budgeted for financing another cost item, e.g. the overhead costs.

Chances are that inaccuracies in the cost price model occur because it becomes unclear what is paid from where. The core problem does not directly cause this problem, but it does stand in the way of solving it. In short, we can state that solving the core problem 'opens the door' to solving underlying problems. Therefore our goal is to find a solution to the core problem.

1.6. Research Goal and Main Research Question

This research aims to solve the core problem and build a foundation to solve the other problems given in Figure 1 (Section 1.5). We can achieve this by allowing stakeholders to easily monitor the performance of the costing model for certain products in production at the company. According to stakeholders in the company, the ideal scenario to monitor the performance of the costing model would make them able to overview the situation 'in one click'. This 'one click' can be in a performance evaluation tool or dashboard and should provide accurate and relevant information about the performance of the costing model compared to reality. Further, the tool should showcase KPIs which allow the user to see at a glance whether the calculated costs in the costing model are accurate, or whether a correction is needed. The main research question is stated:

"How can Company X monitor the performance of its costing model?"

1.7. Deliverables

The goal is to deliver the following:

- An overview of findings in the data-analysis on the output of the current costing model and data provision behind it.
- KPIs to monitor the performance of budgeted costs compared to actual costs
- A tool/dashboard to gain overview on the costing performance of active programmes
- An advice for possible adjustments in what data is gathered, and how it is stored to keep improving the costing accuracy.

1.8. Methodology

To create structure in this research we use the Managerial Problem Solving Method (MPSM) (Heerkens & van Winden, 2017). This method describes a generic seven stage framework designed to solve action problems. An action problem is a situation which is not as desired and requires action to be resolved. Our problem matches this description, since there is a difference between the actual and desired situation. The seven phases will be the framework through this research.

1. Defining the problem
2. Formulating the approach
3. Analysing the problem
4. Formulating solutions
5. Choosing a solution
6. Implementing the solution
7. Evaluating the solution

These stages should be applied to the main research question and within these steps sub-questions will be answered.

The research will be executed following the 7 stages MPSM. In every stage we answer sub-questions that jointly answer the main research question. In Table 1 the research questions are given per stage.

MPSM Phase	Research Question(s)	Section
Phase 1: Defining the problem	What is the problem?	1
Phase 2: Formulating the approach	Which research method will we use to solve the problem?	1
Phase 3: Analysing the problem	How does the current cost price model work? Is the current costing method appropriate for the company? Which costs are currently (not) represented in the cost price model? How do the amounts in the costing model of a product compare actual costs?	2, 3
Phase 4: Formulating solutions	What information is relevant to track the performance of the costing model? How can we get insight in this information in a fast and efficient manner?	4
Phase 5: Choosing a solution	Does the solution fit for Company X?	4
Phase 6: Implementing a solution	How can the chosen solution be implemented within Company X?	5
Phase 7: evaluating the solution	Does the chosen solution improve the current situation? How can the chosen solution be improved?	6

Table 1, Research questions per MPSM phase

Phase 1 Defining the problem

Most important in this phase is obtaining background information about the company, the people and talking about the suspected problem with stakeholders. In this phase we have been talking to people at the company to gain more knowledge about the whole situation and how the company currently works.

Phase 2 Formulating the approach

The main goal of this phase is to get a clear overview of what will be researched, and in which way this research is tackled. This contains defining research questions, research design and a clear vision on the scope of the research. We chose the MPSM as problem solving approach in this research.

Phase 3 Analysing the problem

This is the phase where the research 'really' starts. First theory is used to check whether the current costing method is appropriate (Section 2). Next, as seen in Table 1, the current situation is analysed using the available data. The data is gathered from the ERP system of Company X. This is the only place where data of the made costs is already available. It is too time consuming to analyse all data, therefore we chose a selection of production programmes, which represent a wide variety of programmes in the company. The goal is to obtain a clear overview of the situation, which should make clear how the current costing model performs, and make clear what the weaknesses are. Besides this data analysis, information can be collected by looking into production plans, production workflows and other available documents. Furthermore information will be gained by talking to people who contribute directly to the production process and observing what is happening on the work floor. Also project managers of Company X can bring important information, since they used the current costing model to cost the products in their portfolio. From all this information we can decide on which cost items, or costing processes to focus and criteria for possible solutions can be set. Besides it is important to gain knowledge about the different datasets and how these are, or can be,

connected to each other. This is crucial to be able to develop an efficient tool which allows us to get the right data within a click, as described in Section 1.6.

Phase 4 Formulating solutions

In this stage the theoretical framework and the data analysis come together. The goal is to create a conceptual solution which is in line with the conclusions from Phase 3, the desired scenario described in Section 1.6. and substantiated by the theoretical framework. Besides, this phase introduces new theory about KPIs to substantiate the solution design. The formulated solution in this phase is a monitoring dashboard. Within this phase the goal and criteria of the dashboard should become clear.

Phase 5 Choosing a solution

In this phase we choose a solution and finetune the chosen solution. This choice is made in cooperation with stakeholders, since the outcome of this research has direct impact for them. Within this step there is also space for adjustments desired by the stakeholders. This is likely to contribute to support for the new solution within the company. Within this research this phase is not exactly in line with the MPSM. Since the solution is the dashboard, most important within this phase is to use input of stakeholders to improve the dashboard and make sure it is useful for the company.

Phase 6 Implementing a solution

In this phase the goal is to get an overview of everything required to implement the chosen solution within Company X. The solution will be applied, important to notice is that the current data and costing models within the company contain exceptions which cause the model to not work as accurate as possible in certain cases. Therefore this phase contains an advice on paper how to improve this data provision to make the desired situation as described in Section 1.6. work in all cases. This advice should contain defined action points and the employees responsible.

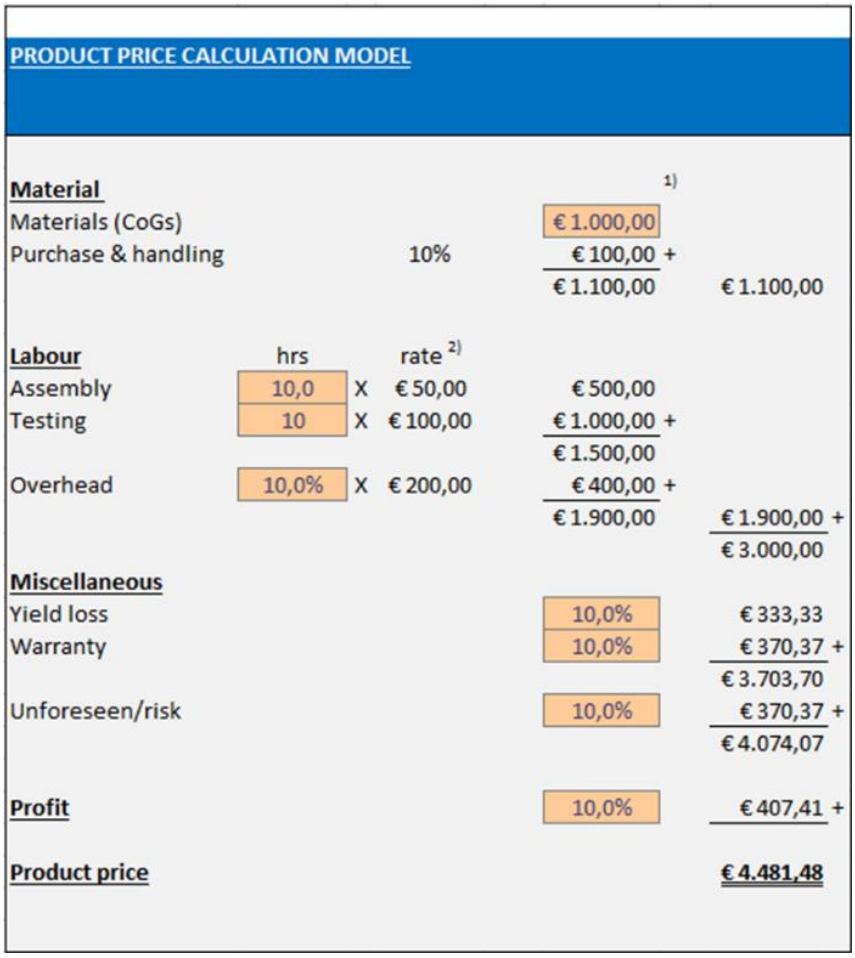
Phase 7 Evaluating the solution

In this phase the chosen solution should be evaluated. The whole process of how we came to the solution should be critically overlooked by mentioning and discussing all kinds of errors which may have been made. Possible improvements of the solution or for further research opportunities should be mentioned. Also possible shortcomings of this research have to be discussed. In this phase it is important to look at possibilities to further improve the situation according to cost accounting and the costing model within Company X.

1.9. Defining core concepts

This research is about the cost accounting and product costing at Company X. Since it is company-specific it contains concepts which are known within the company, but hard to understand outside the company. Therefore this subsection describes a number of definitions which are essential to understand this research.

Costing model: When writing about the costing model we mean the current tool used by Company X to calculate product prices. This tool can be seen in Figure 2. When the term *'cost item(s)'* is used, we mean the different items in the costing model (materials, assembly, etc.).



PRODUCT PRICE CALCULATION MODEL					
Material				1)	
Materials (CoGs)				€ 1.000,00	
Purchase & handling			10%	€ 100,00 +	
				€ 1.100,00	€ 1.100,00
Labour	hrs		rate 2)		
Assembly	10,0	X	€ 50,00	€ 500,00	
Testing	10	X	€ 100,00	€ 1.000,00 +	
				€ 1.500,00	
Overhead	10,0%	X	€ 200,00	€ 400,00 +	
				€ 1.900,00	€ 1.900,00 +
					€ 3.000,00
Miscellaneous					
Yield loss				10,0%	€ 333,33
Warranty				10,0%	€ 370,37 +
					€ 3.703,70
Unforeseen/risk				10,0%	€ 370,37 +
					€ 4.074,07
Profit				10,0%	€ 407,41 +
Product price					**€ 4.481,48**

Figure 2, Example of current costing model.

NACA: NACA is the dataset which contains all worked hours put into certain programmes. These hours can be coupled to costs to determine the Actual costs.

Actual costs: By actual costs we mean the costs which are already made. The actual costs for a certain product are calculated by taking the sum of all hours which are in the administration for that product, multiplied by the hourly rate of the employee who worked those hours. For instance, 1 product is produced. Important to note is that in this research we look at man hours, and not material costs. Employee 1 spent 4 hours with a rate €50 for that product and employee 2 spent 3 hours with a rate of €75 for that product. The actual cost for that product would be as follows:

$$Actual\ cost\ of\ product = 4\ (hours\ employee\ 1) * €50 + 3\ (hours\ employee\ 2) * €75 = €425$$

Budgeted costs: When talking about budgeted costs we mean the expected costs. In this research we use the costing model to determine these expected costs. E.g. the costing model for product x states that there is €100 for purchasing & handling and 100 products x are sold, that means the budgeted costs for purchasing & handling for product x are as follows:

$$Budgeted\ costs\ purchasing\ \&\ handling\ product\ x = 100\ (products) * €100 = €10.000$$

When doing this for all cost elements of the costing model we get the expected cost for producing 100 products x in a certain period of time. This expectation can be compared to the actual costs, as previously described, to determine the accuracy of the costing model is.

Programme: A programme contains all production and projects for a certain customer. Basically a programme can be seen as the whole of all production and project activities for a customer.

Production (costs/revenue): production costs/revenues are all production related costs and revenues within a certain programme.

Projects (costs/revenue): projects costs/revenues are all costs and revenues which are not regarding the production process. These projects contain activities within programmes which are not routine production. Examples are service and warranty for products, but also incidental projects like improving the production processes within programmes.

Project number: projectnumbers are used for the administration. They are an important aspect to distinguish production and projects within a programme. This is also where the name project number gets confusing. Therefore it is important to note: every product in production has a unique project number for its production and also all non-production related projects have their own unique project number.

Project manager: project managers at Company X are responsible for programmes. All project managers have a number of programmes under their responsibilities.

1.10. Summary

This research is carried out at Company X, a high tech production company. The management of Company X suspects the current costing model does not represent the actual costs. The underlying problem is the fact that It is hard and time-consuming to monitor the costing performance of the company's costing model. To improve this we will answer the main research question for this research:

"How can Company X monitor the performance of their costing model?"

We will tackle this question by going through the seven phases of the Managerial Problem Solving Method (MPSM).

2. THEORETICAL FRAMEWORK

In the theoretical framework the concept of cost accounting and its different methods are discussed. These are important subjects for this research since everything they are about comes together in the cost price model of Company X. If we compile sufficient solutions for the problem it is important to know what the literature says about cost accounting in general, and different methods.

This section will start with a more general part about cost accounting and types of costs to give some background what cost accounting is and wat it includes. For the second part a systematic literature review will be done to find the answer to the following knowledge question:

"Which costing methods are available and which fit company's like Company X?"

This knowledge question will be answered in this section. The outcome is used to determine the further direction of this research, which is either to set the basis towards improving the current costing model, or start from scratch and use a different approach.

2.1. What is cost accounting

According to Hilton (2011) accounting can be divided into managerial accounting and financial accounting. The main difference between these two is where it is used. Managerial accounting is used within the organisation and financial accounting is intended for use outside an organisation. Another important difference is that for financial accounting government regulations apply and for managerial accounting not, since it is intended for in-house use only.

Cost accounting is a part of managerial accounting. Where managerial accounting is overarching everything about accounting within a firm, cost accounting is about capturing the total production costs made by a company. Cost accounting is used by the internal management team of a company. Cost accounting records the costs and compares expected costs to actual results to make it possible to measure financial performance. The concepts of cost accounting are useful in managerial accounting and financial accounting (Tuovila, 2020).

Cost accounting is part of the accounting system of an organisation. It is the part of the system which is responsible for accumulating the cost information. According to Lew (2019), cost accounting is recognised as the most important instrument to manage a company. Therefore it is important that a company uses a costing model which combines the most efficient features of management accounting tools. This is logical since cost accounting is the basic accounting tool used to optimise costs in companies or organisations.

2.1.1. Cost types

Costs in companies can be divided into in different types. Some can directly be appointed to a product, and other costs are more general costs which contribute to products or services in an indirect manner. Literature describes this distinction by using the terms 'direct costs' and 'indirect costs'.

Direct costs can directly be assigned to a specific and exclusive cost object (Drury, 2012). This cost object can be anything, in the case of Company X they are the products they produce. These kind of costs can directly be measured, for example material, or assembly costs for a product.

According Drury (2012), indirect costs cannot be assigned specific and exclusive to a cost object. In manufacturing companies these costs often contain the personnel not directly responsible for manufacturing, the indirect labour costs. Other examples are maintenance or repair costs for machinery. All of these costs are often presented as 'overhead'.

2.2. Costing methods

In literature several costing methods and strategies can be found. This section describes three costing methods, namely: traditional costing, target costing and activity-based costing. These three methods were found in the systematic literature review (appendix A) when searching for costing methods at manufacturing companies. When searching for literature which compares different methods, most of the articles found also contained these three costing methods. Therefore we chose to evaluate traditional, target based, and activity-based costing. The goal is to provide some background information on these costing approaches. In the end of this section, in Table 2 an overview of pros and cons of different costing are summarised. The chosen costing method determine how the different elements of the total product cost measured. The formula which combines the different elements to calculate a final price can be defined as the costing model.

2.2.1. Traditional costing

Traditional costing is the method used in the current costing model of Company X. According to Drury (2012), the traditional costing method is the most basic method and works with only one cost driver per pool. A cost driver is the direct cause of a cost. Alami & ElMaraghy (2020) state, the traditional costing method uses direct material, labour and overhead costs, but does not allocate the overhead to specific products. The overhead costs are divided using average allocation. According to Fisher & Krumweide (2015) the traditional costing methods' biggest advantage is the simplicity. It is easy to use and implement. The method seems to work well when all products contribute to indirect costs at the same rate. The disadvantage of this method is the accuracy in which it calculates overhead costs. This is often considerably lower than when using other methods. According to Meyers (2009) this method can lead to undercosting in complex processes.

2.2.2. Target costing

Zengin & Ada (2009) states target costing is a reverse engineered costing method which determines the cost for a product through its lifecycle. When this method is used a 'target cost' is set by taking a competitive price, e.g. €100 and subtracting the desired profit, e.g. €30. In that case the target cost would be €100-€30, so €70. The goal of target costing is to achieve a situation where the target cost is realised. Important to mention is that target costing is often not the best method for manufacturers who produce innovative or unique products.

2.2.3. Activity Based Costing

In Cooper & Kaplan (1998) introduced Activity Based Costing (ABC). Their idea was that every activity in a company supports the production and delivery of goods or services, and therefore should be considered product costs. Cooper and Kaplan (1988) states that company's where production facilities have high cost want a system enabling them to trace manufacturing overhead to products.

Drury (2012) explains ABC in 4 steps: (i) identifying the major activities that take place in an organisation; (ii) assigning the costs to cost pools/cost centres for each activity; (iii) determining the cost driver for each major activity and (iv) assigning the cost of activities to products according to the product's demand for activities. According to Kumar & Mahto (2013) ABC gives better insight how much time, resources and costs are involved by all activities throughout a production process. The downside of ABC is its complexity.

A form of ABC worth mentioning is time-driven activity based costing. This is a form of ABC which uses the time of activities as the cost driver. According to Öker & Adigüzel (2016) this form of ABC tackles part of the complexity that traditional ABC brings. The reduced complexity of time-driven ABC compared to ABC is mainly in the cost drivers. Since time-driven ABC always uses time as cost driver determining a certain activity's cost is more generic, and therefore less complex.

2.2.4. Comparing different methods and conclusions

When analysing the different costing methods in the paragraphs above and looking at the kind of company Company X (Company X) we can draw a few conclusions. First, the traditional costing method. This method is currently used by Company X. Because this method currently used it is important to keep this method in mind, since it is the current situation and the basement measurement. Also it is important to mention that according to managers at Company X there are improvements possible in the current method, so it is worth looking at further optimalisations within this method. Next, we have target based costing. On paper this is not a good fit to Company X, since Company X manufactures mostly complex and innovative products. Nevertheless, according to project managers this method is used sometimes at Company X. Last there is activity based costing. According to Bharara & Lee (1996) ABC provides accurate costs for complicated processes. Also tracking time as used in time driven ABC improves the accuracy. An overview of pros and cons of the evaluated costing methods is given in Table 2.

Costing method	Pros	Cons
Traditional costing	Easy to implement.	Inaccurate, unclear allocation of overhead costs
Target based costing	Allows you to lower costs while maintaining the level of quality.	Unrealistic target costs can influence profitability in a negative way.
Activity based costing	High accuracy, overhead cost are allocated to products and well tracked.	Hard to implement and maintain. Relatively complicated and time consuming way of costing.
Time driven activity based costing	Easier to implement than regular ABC. Allows firm to track cost of unused capacity	Time is not always the same and will be an estimation sometimes. Not as accurate for costs which are not time-driven.

Table 2, Pros and cons of different costing methods

2.2.5. Conclusions for Company X

After evaluating different costing approaches, we can conclude that according to literature one of the different ABC approaches would be a good fit for Company X. As described in Table 2, section 2.2.4, the pros of ABC are high accuracy and well tracked overhead costs which are easy to allocate to products. These benefits of ABC seem to have the potential to solve the problems (see Figure 1, section 1.5.) the management of Company X defines with their current costing model. However the different ABC methods also bring cons for Company X. Currently it is already hard and time consuming to monitor whether the costing model, which uses the traditional approach, is accurate. In combination with ±25 programmes containing several products which often have different versions, we can state that implementing ABC will be a drastic and very intensive change. Due to the large number of products usually in production, maintaining an accurate ABC costing approach will also be a time-consuming and expensive process. We need to weigh up these pros and cons to decide whether ABC is a good idea for Company X. The current situation is the decisive factor here. Due to big variety in a lot of

different production processes the cost of implementing and maintaining ABC is likely not worth it, since ABC would require extensive research for every single product in production. Despite the fact that traditional costing is less accurate than ABC, we can state that given how bad the current insight in how accurate the current costing model is it is likely that a lot of improvement within the traditional costing method is possible. Therefore we choose to start from the current costing model, using the traditional costing method. In this research we focus on how to monitor the current costing model to gain insight in how accurate the current costing model is. When this model can be properly monitored, the current costing model can be improved using targeted adaptations. An example of these targeted adaptations could be a certain hourly seems higher than it was budgeted at. This can be adjusted to improve the accuracy of the costing model. In this way the costing accuracy can still be improved without implementing a new, time-consuming and expensive method.

2.3. Summary

Accounting can be divided in managerial and financial accounting. Managerial accounting is for in-house use, financial accounting is intended for use outside the organisation and has governmental regulations. Cost accounting is an important tool within accounting and is about recording the costs made by a company. Costs can be divided in (i) direct costs, which can directly be assigned to a cost object, and (ii) indirect costs which cannot be assigned to a specific and exclusive cost object.

Within cost accounting different methods with their pros and cons are available. Traditional costing is the simplest method, but also lacks accuracy in various areas. Target costing is a reverse engineered costing method, mostly beneficial for less innovative products. Activity based costing (ABC) is a more complicated costing method. It is difficult to implement and maintain, but very accurate. ABC has different forms, e.g., time driven ABC, where all costs are tracked measured by time as cost driver.

Using the literature review in this section we concluded that is most likely to be better to improve the current model using the traditional costing method, instead of developing a new activity-based model. This conclusion is mainly based on the fact that implementing and maintaining an activity-based costing model will be time consuming, expensive, and probably not worth the increased accuracy it could bring for Company X. Therefore this research focuses on monitoring and gaining insight in the performance of the current, traditional, costing model to allow the company to implement targeted improvements to optimise the current model.

3. CURRENT SITUATION

This section describes the current situation. The current costing model and data collection regarding the costing model are discussed. We also discuss what is currently done in terms of monitoring costs. Last, we discuss a two case-analysis, which was carried out to gain more insight in the current situation. The most important findings of this analysis are elaborated in this section. The goal of this section is to gain more insight into how it is 'hard and time-consuming to monitor the costing performance of the company' as the core-problem in section 1.5 states.

3.1. Costing model

The current costing model (see Section 1.9 Figure 2) uses a traditional and simplest form of cost pricing (explained in Section 2.2.1.). The model breaks down the cost price of products into four components:

(i) Material costs
(ii) Labour costs
(iii) Overhead costs
(iv) The miscellaneous costs.

These different cost items are built up in different ways. For the material costs, the price of material per product is calculated, and a percentage over that number estimates the cost for purchasing and handling. For labour costs, the number of hours an employee is busy assembling and testing one product is multiplied by the costs per hour to determine the costs. A percentage of the labour hours multiplied by the overhead rate determines the overhead costs for producing a product. The current model uses percentages over the material and labour costs to calculate the miscellaneous costs. This is done in three different cost factors: yield loss, warranty costs and unforeseen costs. The model uses a percentage of all calculated costs to determine the profit margin per product. This is a popular method to add a profit margin which is called 'cost plus pricing' (Schneider, 1985). An example of the generic costing model of Company X can be found in Appendix B.

Project managers use the costing model to determine product prices within their programme. The situation in which this is done is different per case. For some programmes, there is a maximum target cost set by the customer, and for other programmes determining the product price is 'guesswork' according to project managers. After the price for a product is calculated using the model, a final price is set in consultation with the customer.

3.2. Cost monitoring and Data

Company X stores its data about costs and earnings in their AFAS ERP system. Within this research, the datasets of all actual hours (also called 'NACA', as introduced in Section 1.9.) and the datasets which contain information about sent invoices are the most important.

The NACA dataset contains a row for every time an employee writes hours on a programme. These rows contain all relevant information about the worked hours. Here the most crucial is the project number and the phase. The project number represents the programme and the concerning production line or project within that programme the employee worked on. The phase is a number that represents the specific activity the employee has performed. The last important factor in the NACA data is the employee code. This code represents the function of the employee and can be connected to an hourly rate. The invoices are divided into two datasets. The one dataset contains information about all invoices sent for sold products. The other dataset contains information about all invoices sent for projects.

To improve the insight in how accurate the cost accounting at Company X needs to use the NACA and invoice datasets to monitor the situation. The data should be used to test the costs in the NACA data against the expected costs. Currently, it is not easy to do this properly. This is mainly caused by differences in the administration of actual hours (NACA) and how the expected costs in products costing models are determined. The phases which are used in the NACA differ from items that are budgeted in the costing model. Besides, there are also differences in how costs of different programmes are registered in the ERP system. This makes it very difficult to test whether the costing model is accurate and makes it very hard to find a generic way to test the costing performance. This difficulty is likely to be why the accuracy of the costing model is currently not being monitored. Worth mentioning is that there currently is some performance tracking concerning the costing model. This tool tracks the number of hours put into producing a certain number of products in one week. This tool tracks whether this number of hours exceeds the number of production hours for certain products according to the costing model. The overall accuracy of the costing model is not tracked. Here we mean that there is currently no system or connection which allows stakeholders to check whether the actual costs made for a specific product vary from what those costs were expected to be according to that product's costing model.

It is hard to improve the current costing model since the current costing model's performance is unknown in general and on a cost-item level. Therefore, as described in section 1.6, the main goal of this research is to make the relation between the costing model and actual costs visible and allow stakeholders to monitor the accuracy of the costing model.

3.3. Studying two cases.

This research is based on the suspicion of the company's management. To find out whether this suspicion is correct and what can be done about it we need to analyse date. Doing an analysis for all approximately 25 programmes in the company is too time-consuming. Therefore we carry out a case study and analyse two programmes based on data to gain more insight in the current situation. For these two programmes, the available data is used to understand how the costing model relates to the stored data of actual costs. This data analysis has two goals. The first goal is to validate whether the suspicion of the management, as explained in section 1.2, is correct and the current costing model is indeed inaccurate. The second goal is to find out how we can connect the data from different sets. When the right datasets (given in Table 3) can be linked, it will become easier to test the accuracy of the costing model.

3.3.1. Data

As mentioned in the introduction of Section 3.3, analysing all (usually 15-25) production programmes in which multiple products are produced would take too much time. Therefore we chose two major programmes within the company, namely Programme A and Programme B. These two have been selected since they are long-running programmes at the company, which means there is enough data available. The other reason is that these two programmes differ in a lot of aspects. Programme A is just one product where the assembly of that product is sold as a service. Programme B consists of various products where the entire production process is outsourced to Company X.

To find connections between the costing model and actual costs, we need several sets of data. The data sets used are in Table 3, including the reasons why we require them. In Table 3, the used datasets, including the reason for using them, are given.

Required Data	Reason
Costing models of selected programmes	Needed to determine the expected costs for the products produced.
Recalculation of written hours per year	To determine how many hours are written on different phases in certain programmes.
Hourly rates	To calculate the costs of the hours in euro's.
Product Sales	To determine how many products are sold in a certain period. Combined with the costing models we can calculate the budgeted costs.
Service Sales	Hours are written for products and for service. For service there also are invoices to customers. These should be taken into account.

Table 3, Used datasets in data-analysis

3.3.2. Analysis

Using the datasets described in Table 3, we put together an overview that shows how the costing model relates to the actual costs of the programmes. Programme A and Programme B. The result of these overviews can be found in Appendix C Figures 12 and 13. How we made this overview can be explained in 5 steps, these are the following:

1. Determine budgeted costs for all cost items by multiplying the cost items in the costing model by the number of products produced and sold in a certain period. Do this for all products within the programme.
2. Assign the actual costs to cost items using the phase. Do this for all products within the programme.
3. Calculate the difference between to get the costing variance.
4. Calculate the result for projects (costs vs. revenues) within the programme you are analysing.
5. Determine the total result of the programme (production and projects comnined).

Appendix C explains these five step in more detail. While making this overview we made assumptions in most of the steps. The assumptions per step are given in Table 4.

Step	Assumptions
1	1. Material costs are not included in this analysis. We assume that the cost for material in the costing model and in practice is the same (for Programme A this does not matter since the Programme A provides material)/ 2. Sales invoices for only parts are seen as material, and thus not included. 3. When a Programme B Product A is sold this Product A also contains other products which are not in the sales. Therefore we assume the following: for every Product A sold one nanocore is produced and for every nanocore (including the ones for a Product A) 3 products B and 1 Product C are produced.
2	1. Some costs are written as general costs, and cannot be connected to a specific product. These are not taken into account. For 2020 some costs are written using general numbers, but specified per programme. These are taken into account as 'other product costs'. 2. We distinguish hours from the actual costs in 'assigned to product' (Step 2) and 'other costs'. (Step 4) 3. For hours connected to products we used the commercial hourly rate, these differ per year, so for 2019 and 2020 different rates are used.
3	-
4	1. Hourly rates for service may be different then the commercial rate, therefore for service we use the rate used on the invoice. 2. We calculate per year, if e.g. there are costs in year 1 and the revenue comes later, there is a loss in year 1 and a profit in year 2. In Step 5 there will also be an overview for 2 years.
5	-

Table 4, Assumptions in 5 step method

3.3.3. Findings

This subsection describes the findings of the 2 programme study described in the previous section. First, we discuss the accuracy of the costing model compared to reality. This is done for production costs and projects. Second, we discuss an interesting finding: the difference in budgeted sales prices and used sales prices. Third a group of costs that is not currently in the costing model is described. Fourth and last, the relation between the different datasets used in this case study is discussed.

In Figure 3, the difference in budgeted costs and actual costs for production of the programmes Programme B and Programme A is given in tables. These tables are part of the full final result of analysing the two programmes. The full overviews of both Programme B and Programme A are given in Appendix B, Figures 12 and 13. In Figure 3 the result is difference between budgeted and actual costs is of the two programmes is given for the years 2019 and 2020. The diff% in the picture shows the percentual difference between budget according to costing model and reality.

We can see that most of the cost items vary more than 20% from the budgeted amount in the tables. The most extreme are values for testing and yield loss and the overhead costs for Programme B, which all vary between 139% and 216% from what they are expected to be according to the costing model. Compared to these big variances, the overall variance of the two programmes reviewed are relatively small, with 0.40% for Programme A and 17.08% for Programme B.

DIFF	Programme B	2019 total	diff%	2020 total	diff%	Total	diff%
Purchase/handling		€ 31,298.37	33.39%	€ 46,998.13	64.01%	€ 78,296.50	46.84%
Assembly		€ 24,131.45	9.45%	-€ 72,093.62	-36.94%	-€ 47,962.17	-10.64%
testing		-€ 1,329.41	-5.02%	-€ 5,938.55	-29.06%	-€ 7,267.95	-15.50%
overhead		-€ 110,364.94	-216.43%	-€ 66,919.24	-171.95%	-€ 177,284.17	-197.18%
yield loss		€ 24,094.09	83.04%	€ 22,287.69	98.27%	€ 46,381.78	89.73%
other production costs		€ 0.00	0.00%	-€ 29,849.77	0.00%	-€ 29,849.77	0.00%
Diff before profit		***-€ 32,170.44***	-7.06%	***-€ 105,515.35***	-30.09%	-€ 137,685.79	-17.08%

DIFF	Programme A	2019	diff%	2020	diff%	Total	diff%
Purchase/handling		€ 8,852.27	21.49%	€ 11,218.89	38.16%	€ 20,071.16	28.43%
Assembly		-€ 14,128.41	-7.30%	€ 1,361.48	0.99%	-€ 12,766.93	-3.85%
testing		-€ 20,405.00	-152.39%	-€ 4,177.95	-43.73%	-€ 24,582.95	-107.14%
overhead		-€ 8,369.09	-8.72%	€ 55,219.09	80.62%	€ 46,850.00	28.48%
yield loss		-€ 9,784.49	-139.29%	-€ 5,192.30	-20.09%	-€ 14,976.79	-124.42%
other production costs		€ 0.00	0.00%	-€ 17,019.09	0.00%	-€ 17,019.09	0.00%
Diff before profit		***-€ 43,834.71***	-12.48%	***€ 41,410.11***	16.52%	-€ 2,424.61	-0.40%

Figure 3, Difference in budgeted and actual costs Programme B & Programme A

For the project costs, there is not much to worry about, according to this analysis. For most costs, invoices can directly be connected to registered costs and cover the costs. Again, details for the project costs and expenses can be found in appendix B, Figure 12 and 13.

The second point of interest is the difference between the price calculated using the costing model and the average amount for which a product is sold. In Table 5 difference between the product price according to the costing model (budgeted sales price) and the average sales price in 2019 is displayed for all products within the Programme A and Programme B programme. In most 8 out of 9 cases, the product is sold for less than it was budgeted at using the costing model. This means that part of the calculated profit margin never gets to the company due to lower prices. Another fact worth mentioning is the hourly rates. Hourly rates which can be assigned to hours of work are commercial rates, which already contain a profit margin and therefore do not represent the actual cost of the hours.

Product	Budgeted sales price	Average sales price	Diff percentage
Product 1	€ 8081,26	€ 7220,71	-11,92%
Product 2	€ 8708,65	€ 7840,14	-11,08%
Product 3	€ 8512,62	€ 7479,00	-13,82%
Product 4	€ 9138,81	€ 8271,75	-10,49%
Product 5	€ 2324,77	€ 2324,77	0,00%
Product 6	€ 188,13	€ 148,33	-26,83%
Product 7	€ 213,61	€ 148,00	-44,33%
Product 8	€ 191,08	€ 253,00	24,47%
Product 9	€ 2223,58	€ 2112,41	-5,26%

Table 5, Comparison budgeted sales price according to costing model and actual sales price for 2019. 8 out of 9 cases show a significant variation between average sales price and budgeted sales price.

Third, we have a group of costs that we cannot directly appoint to specific processes within the company. Since 2020 these are costs written using general numbers. These are, for example, programme management costs, which cannot directly be assigned to specific production processes, but do contribute to them. These costs are not in the current costing model.

Last we want to discuss the findings on relations between the datasets. In this case study, we make a few links between these datasets. The most important links are the following three:

i. The data of products sold are combined with the data the costing models from products provide. This is what we call the 'budgeted costs' in this research.
ii. Hours of the actual costs in the ERP system are divided into the same cost items the costing model uses to connect the actual costs to the costing model.
iii. Actual costs in the ERP system for service are connected to invoices meant to pay for those costs.

These three links combined allow us to connect the costing model to reality and measure its accuracy. Important to note is that we cannot make the connection between these datasets directly. The problem here is a difference between how data is given in one place and stored in another place. In this case, the actual costs in the ERP system are divided into other activities than the costing model uses. Thus, if we want to compare expected costs from the costing model to reality, we must first carry out an additional conversion before the data becomes usable.

Despite the fact that the different datasets do not align perfectly, we did encounter common factors in the datasets. These factors can help connect data, making the performance and accuracy of the costing model easier to monitor. In Table 6, the desired connections and variables in the data that can be used to establish the connection are given. In some cases, there is no variable available to link them.

Connection	Available variables to connect
Actual hours to service sales	Project number, customer-relationship
Actual hours to product sales	Project number, customer-relationship
Costing model to product sales	Product-code
Phases in actual hours to costing model	Currently unavailable

Table 6, Data assets which can be used to connect the different datasets.

3.3.4. Conclusions

In the introduction of Section 3.3. we set two goals for the case analysis explained in section 3.3. in this paragraph, we check whether the goals are achieved, and conclusions are drawn based on the findings.

Goal 1: validate whether the suspicion of the management is correct.

The first goal has been met. However, the overall discrepancy between budget and actual costs is only 0.4% and 17.08%. We can state the discrepancy for certain cost items is way too big, sometimes even far over 100%. Therefore we can conclude that the suspicion of the management is correct. The costing model does indeed not reflect the actual costs.

Goal 2: find possibilities to connect different datasets to determine the accuracy of the costing model.

The second goal is also met. The conclusion here is that there are possibilities to connect the data of the costing models to the actual cost to monitor the accuracy of the costing model. Most of them can already be made using existing variables, as given in Table 6. Important to note is that it is difficult and time-consuming to put these different datasets together. This is in line with what has already been said in Section 1.5, it is hard and time-consuming to make visible whether and on which facets the costing model is accurate or not, and that stands in the way of solving the issues the costing model has.

To solve this problem we are building a dashboard which allows users to monitor the costs for certain products and programmes. This should help to gain better insight in the costs, and give Company X insights to improve the costing model itself. The goal of this strategy is to allow Company X to keep their costing model simple, but go in detail when needed for certain costs. This should keep the cost of setting up and maintaining costing models for products relatively low, and get the accuracy of the costing model as high as possible. How this dashboard is built and what exactly is showcased in the dashboard is explained in Sections 4 and 5.

3.4. Summary

This section explained the current costing model and what data is tracked. By studying 2 cases, we found out that it is hard and very time consuming to put the correct data together and create a good overview of the costing models accuracy. We found out that data confirms the suspicion of the management, the current costing model does indeed not represent actual costs accurately. Data show that overall the costing model is not too bad, but when looking at specific cost items variances are too high in most cases. Further, we discovered some other inconveniences, like products being structurally sold under its budgeted sales price and use of incorrect hourly rates, which make the outcome biased. Last we found possible data links which can allow us to monitor the costing model against reality. These links are given in Section 3.3. Table 6. Most of these are connections that are not utilised yet. The conclusion is again that it becomes hard and time-consuming to gain an overview due to messy data. This stands in the way of improving the costing model. To fix this a monitoring dashboard will be built. The process and outcome of building this dashboard are explained in Sections 4 and 5.

4. FORMULATING THE SOLUTION

In Section 2 we concluded that choosing a more complex costing method is likely to make the core problem even more extensive and not a good idea. From Section 3, we concluded that in the current situation, the data is messy, which makes it very hard to gain an overview and measure how accurate the costing model is. This is the core problem described in Section 1.5 in practice. To solve this, we came up with a solution in line with the desire of the company's management as described in Section 1.6: 'gaining overview in one click'. When this is achieved Company X can gain insight in their cost management and work towards improving their current costing model. This solution is a dashboard that lets users track the accuracy of the costing model. This section provides a theory on how a dashboard is established and KPIs (key performance indicators) are chosen and explains the selected KPIs.

4.1. Dashboard

The purpose of a dashboard is to display all required and relevant information in one overview. This should allow users to overview the situation of certain processes or project in a glance. Dashboards allow users to monitor the performance of key business process.

According to Kernzer, 2017, there are three types of performance dashboards, operational, tactical and strategic dashboards. Operational dashboards are used to monitor specific core operational processes, and used by front-line workers directly responsible for e.g. production. Strategic dashboards often monitor the bigger companywide objectives. For this research tactical dashboards are most relevant. Tactical dashboards are used by business analysts and managers to compare performance of their projects to forecasts, budget plans or recent results (Kernzer, 2017). The concepts of a dashboard are a good fit to what the company desires. As stated in Section 1.6. the ideal situation according to project managers is gaining overview 'in one click'. To solve the core problem and give better insight and clarity in the accuracy of the costing model we will develop a tactical dashboard to monitor the costing mode against the actual situation.

Kernzer (2017) divides the process of designing a dashboard in the following four periods:

(i) Defining Key Performance indicators
(ii) Defining supporting analytics
(iii) Choosing the correct KPI Visualisation components
(iv) Supporting analytics

The first stage contains choosing the right measures which give insight in whether your process is performing as it should. These measures are displayed in the final dashboard. The second stage is about what is behind the KPIs. These stages contain setting up the data provision to calculate the KPIs, but also whether you want this data available to the user by e.g. clicking the KPI to get insight in why the KPI has a certain value. The third stage is about visualising the KPIs. For this stage Kernzer 2017, describes 5 types of visualisations. These are given and explained in Table 7.

Visualisation	Description
Alert icons	Icons or colour scales which define the state of a KPI.
Traffic light icons	An extension of the alert icon, mostly uses green orange and red like a traffic light to communicate whether the KPI is in a ‘good’, ‘warning’ or ‘bad’ state.
Trend icons	Used to represent how a KPI behaves over a certain period of time.
Progress bars	Used to show progress. Often used to track progress of e.g. overall completion in combination with a colour scale to give an extra dimension to the KPI.
Gauges	Usable for KPIs with dynamic data which changes over time in relationship to other variables.

Table 7, 5 types of visualisation according to Kernzer, 2017

Last, the fourth stage contains setting up extra visualisations to support the KPIs. Most commonly this is done by using specific charts. Examples are pie charts, bar charts or line charts.

We will work out these four stages to develop a usable dashboard to compare the budgets set in Company Xs costing model to the actual costs. The first stage can be found in Section 4.2, the other stages are explained in Section 5: developing a dashboard.

4.2. Defining Key Performance Indicators

4.2.1. Criteria

Section 4.1. introduced four stages to create a dashboard. Kernzer describes the selection of KPIs for the dashboard as the first step. These KPIs are the basis of the dashboard. Literature gives plenty of different ways to identify KPIs. According to Carlucci (2010), the four most important criteria which come back in most methods are (i) relevance, (ii) reliability, (iii) comparability and consistency, (iv) understandability and representational quality:

(i) Relevant performance indicators should provide information to make a difference in a decision. They help the user to form predictions about the future, or help to correct or approve previous forecasts. The information the KPI provides should be available before it loses its capacity to influence decisions.

(ii) Reliability of performance indicators has to do with the quality. This means the indicator should not be biased by factors used to determine it. The availability of data has high impact on the reliability. Here it is also important that the data is verifiable and free of errors.

(iii) Comparability and consistency relates to whether the indicator allows the user to identify contradictions or similarities between two sets and whether an indicator can remain unchanged over a certain period of time.

(iv) The understandability and representational quality of a performance indicator contribute to the user friendliness. The indicators have to be easy to interpret and understand. It should be easy to communicate them if needed, and the indicators have to be understandable not only inside, but also outside the organisation.

The key performance indicators for our dashboard should meet these criteria, with the goal of our dashboard in mind: giving easy access to information about how accurate the costing model is compared to reality.

4.2.2. Choosing KPIs

Cost Variance

The key performance indicators for our dashboard should give insight in the accuracy of the costing model. Therefore the first and most important indicator is costing variance. According

to Bragg (accountingtools.com, 2021), cost variance can be defined as the difference between the cost actually incurred and the budgeted amount. This KPI will be measured for all components of the costing model. when adding all values we get the overall costing variance. In Table 8 is given why the KPI costing variance complies with the criteria for KPIs by Carlucci given in Section 4.2.1.

Criteria	Criterion met	Description
Relevance	Yes	Approves forecasts, and helps user to determine whether it is necessary to adapt.
Reliability	Yes	Data is available, and can be verified. Important not is that minor mistakes in administration may cause small errors.
Comparability & consistency	Yes	KPI compares two situations, however the components of the costing model may change the final measure of the total costing variance stays the same.
Understandability & representational quality	Yes	Costing variance is a well-known concept. Therefore this KPI is likely to be understandable for most people and also outside the company.

Table 8, KPI Cost Variance against Carlucci's criteria

The costing variance for cost items will be calculated using the following formulas:

$$Variance\ cost\ item\ i = \frac{Budgeted\ costs\ (i) - Actual\ costs\ (i)}{Budgeted\ costs\ (i)}$$

$$Total\ cost\ variance = \frac{\sum_{i=1}^{i}(Budgeted\ costs\ (i) - Actual\ costs\ (i))}{\sum_{i=1}^{i} Budgeted\ costs\ (i)}$$

Within this formulas the budgeted costs and actual costs are determined as follows:

$$Budgeted\ Costs\ (i) = budgeted\ on\ costing\ model\ cost\ item\ (i) * number\ of\ products$$

$$Actual\ costs\ (i) = \sum (hours\ written\ on\ cost\ item\ (i) * Hourly\ rate)$$

Here the cost items *i* are all cost items used in the costing model. These formulas give the costing variance as a percentage. According to Spencer (2007), an acceptable total costing variance has a maximum of 10%. This value will be used as the benchmark. Using the total variance as benchmark implies that the costing variance for individual cost items may exceed 10%, however when this is the case the dashboard should warn the user.

Average hourly rate

The costing model uses hourly rates to calculate the costs for assembly, testing and overhead, as described in Section 3.1. These factors are important in the costing model, since there are also other cost items determined as a percentage of these costs. Therefore it is important that the rates used are accurate. To monitor this we implement the average hourly rate as a KPI in our dashboard. By average hourly rate we target at the average cost per used hour for activities within a certain cost item. The goal of this KPI is to prevent the production, testing and overhead cost being too high. Table 9 explains the criteria described in 4.2.1. for the average hourly rate.

Criteria	Criterion met	Description
Relevance	Yes	Approves whether the used hourly rates are accurate or need adjustments.
Reliability	Yes	Data is available, and can be verified.
Comparability & consistency	Yes	Rates in the costing model can be compared to the average actual rate. Rates in costing model may increase due to inflation, the measure remains the same.
Understandability & representational quality	Yes	KPI is easily understandable, the actual average hourly rate is either higher or lower than the one in the costing model.

Table 9, KPI Average Hourly Rate against Carlucci's criteria

For all cost items; assembly, testing and overhead the average hourly rate is calculated as follows:

$$Average\ Hourly\ rate\ cost\ item\ (i) = \frac{\sum(number\ of\ hours\ cost\ item\ (i) * hourly\ rate\ employee\ code)}{Total\ number\ of\ hours\ cost\ item\ (i)}$$

This relative difference is then calculated using the following formula:

$$Discrepancy\ hourly\ rate = \frac{(Average\ hourly\ rate - Hourly\ rate\ costing\ model)}{Hourly\ rate\ costing\ model}$$

Here the cost items *i* are assembly testing and overhead. Employees with different hourly rates may work within the same activities, therefore we calculate the total cost for all hours by a summation of the number of hours an employee has written at a certain moment times the rate which applied at that given time. For the average hourly rate we use the same threshold as for the total discrepancy, maximum 10%.

Sales price variance

The third KPI is the sales price variance. The choice for sales price variance as KPI has to do with average sales prices being lower than calculated sales prices in the costing model, as explained in section 3.3. By sales price variance we mean the difference between the final price in the costing model and the average price a product is sold for. This factor is important to keep in mind, because when this difference becomes too big the profitability can get in danger. Table 10 checks the sales price variance for our chosen criteria.

Criteria	Criterion met	Description
Relevance	Yes	Compares the calculated sales price to the actual sales price, gives insight in whether the price could be lower or should be higher which can help in decisions.
Reliability	Yes	Data is available, and can be verified. Also the data are very accurate, actual sales prices are based on reality, costed sales prices are based on calculations.
Comparability & consistency	Yes	The KPI is a difference between two values, therefore a comparison. The measure never changes, and can always be applied to new data.
Understandability & representational quality	Yes	Straightforward KPI, difference between two values. Easily understandable for users, both insiders and outsiders.

Table 10, KPI Sales Price Variance against Carlucci's criteria

We calculate the sales price variance using the following formula:

$$Sales\ price\ variance = \frac{Average\ sales\ price - Budgeted\ sales\ price}{Budgeted\ sales\ price}$$

The benchmark for this level is the limit of profitability. This implies that the variance cannot be higher than the amount of profit in the budgeted sales price. How much this is varies per product. Usually the profit calculated for products is between 10% and 15%. Therefore, the user should be warned when the sales price variance get above 10%, since that is the point where profitability might get in danger. When actual sales prices are higher than budgeted the user should be alerted as well, since it is important to keep prices competitive.

Project service cost coverage

The fourth and last KPI is the project cost coverage. This is the percentage of costs for projects (service and warranty), covered by direct billings. When this percentage gets too low the reserved budgets for unforeseen, warranty and yield loss may not be enough to cover the costs, which means money needs to be added from somewhere else. The project cost coverage will be tested against the four criteria of Carlucci as well. This is shown in Table 11.

Criteria	Criterion met	Description
Relevance	Yes	Gives insight in whether the service and warranty costs are covered enough.
Reliability	Yes	Data are available, and can be verified. Determined based on actual invoices and costs, therefore as accurate as the administration.
Comparability & consistency	Yes	KPI tests how far the costs of service and warranty can be covered by billings and budgets reserved for them. The data used need to get refreshed over time, the measure itself stays the same
Understandability & representational quality	No	To understand this variable inside knowledge on the programmes and how the administration is organised, is required. Therefore this box cannot be checked. However, since this KPI represents a whole group of costs and income it is taken into account. On top of this, most users of the tool will be project-managers, and have the required knowledge.

Table 11, KPI Project Cost Coverage against Carlucci's criteria

The service cost coverage will be calculated as follows:

$$Service\ cost\ coverage = \frac{(total\ service\ invoices + budget\ warranty + budget\ unforeseen)}{Total\ service\ related\ cost}$$

For total service related cost we take into account all costs categorised as service and warranty cost in the ERP system. The desired value for this KPI is at least 90% and preferably 100% or higher. When the value is between 90% and 100% the user should be warned that not all expenses are covered, for values under 90% action is required as soon as possible.

4.3. Summary

To solve the core problem, we will develop a monitoring dashboard. This section introduced four stages by Kernzer to create a dashboard, (i) defining key performance indicators, (ii) defining support analytics, (iii) choosing the visualisation of the key performance indicators, and (iv) supporting the data by, e.g. graphs in your dashboard. To develop a dashboard, we will go through these four stages. To complete the first step of this stage, we chose four KPIs according to the criteria of Carlucci. The KPIs are (i) cost variance, (ii) average hourly rate, (iii) sales price variance and (iv) Project cost coverage.

5. DEVELOPING THE DASHBOARD

Section 4 introduced four stages of developing a dashboard. In Section 4.2.2. the first stage is completed by defining our KPIs. These KPIs stay central in our dashboard. This section contains the other three stages, according to Kernzer (2017). This sectoin first defines and explains the data provision behind the dashboard, and second describes how the KPIs will be visualised and supported to allow the user to overview the situation at a glance. Finally this section describes what is needed to implement the dashboard and set the framework to work towards improving the costing model of the company.

5.1. Data model

To calculate the KPIs for different programmes within the company a data model is needed. Most KPIs compare data from different sources, therefore the different data-sources have to be connected through common variables. This is done using a data-model built using Microsoft Excels PowerPivot data-model compatibilities. PowerPivot is an Excel functionality which allows the user to connect different datasets and combine them to gain insights using the different datasets simultaneously. Excel is chosen because the company's ERP system has possibilities to directly connect with and automatically update data to Excel files. This offers great opportunities for implementing the dashboard within the company.

All data required in the KPIs was also used for analysing the Programme A and Programme B programmes in Section 3.3. These are the following datasets:

- Costing model values for all products
- All written hours in the ERP system including hourly rates
- All product sales invoice data
- All service related invoice data

From these sets we can get all the necessary data to calculate the values of our chosen KPIs. In Section 1.6. the ideal scenario is described as the possibility to gain overview in one click. To achieve this the data model has to overcome the challenges and inconveniences described in Section 3. These are given in Table 12.

Challenge	Solution
Costs in the ERP system have to be classified in the same cost items the costing model uses.	An extra rule is added to assign hourly costs to an item from the costing model.
Hourly rates may not contain profits.	Before multiplying hours by hourly rates the rates are changed for non-commercial hourly rates.
To calculate comparisons all datasets need to be filtered simultaneously on certain factors.	Sources which only contain the unique values of certain variables are created. Datasets are filtered through these sources, this allows us to filter more datasets on the same criteria at once.
All material costs need to be filtered out.	Material cost is not taken into account. All percentages usually calculated over material are calculated over non-material cost items only.

Table 12, Challenges and solutions while building the data model

The datamodel used in the final dashboard is displayed in Figure 4. All different objects in the data model are explained in Table 13. The relationships between the data models objects are explained in Table 14.

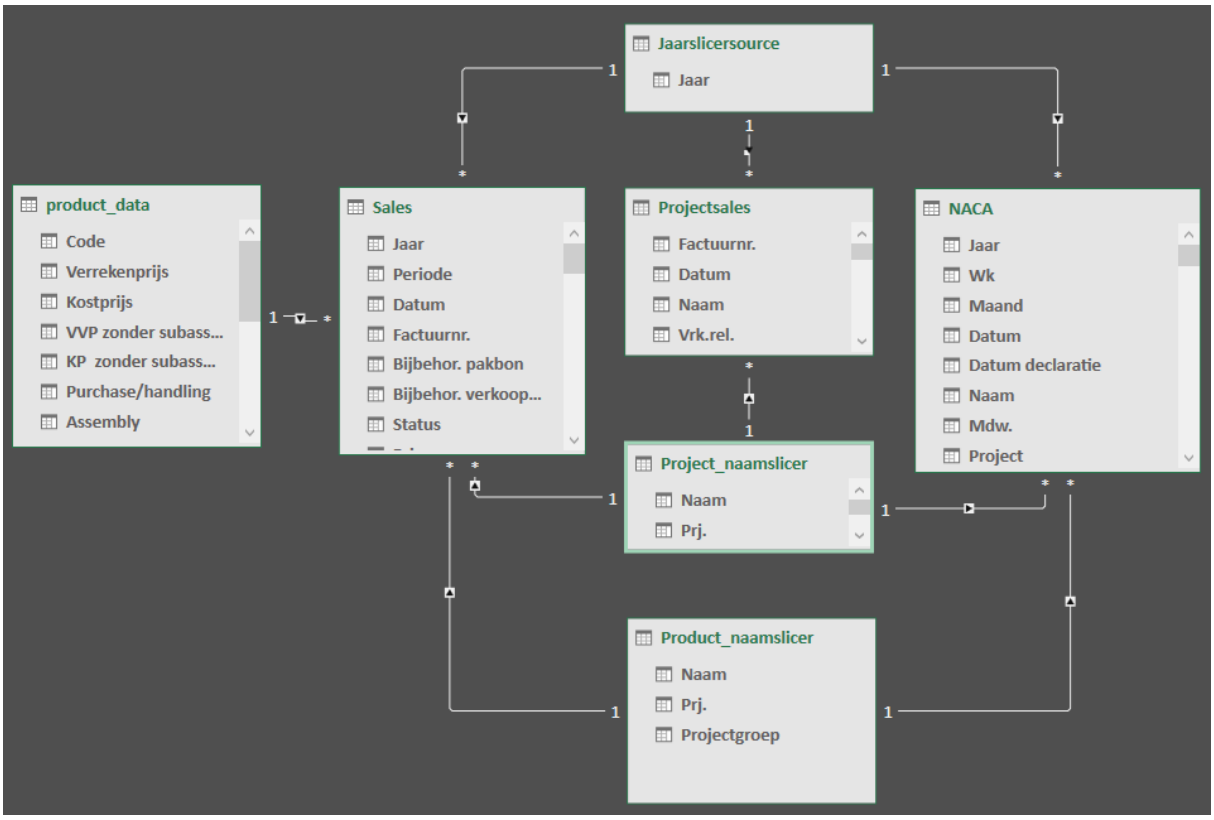


Figure 4, Screenshot of the final data model

Datamodel object	Description
Sales	Dataset containing all sales invoices.
NACA	Dataset containing all actual costs.
Projectsales	Dataset containing all service related sales.
Product_Data	Dataset containing all information regarding products costing models.
Jaarslicersource	List to filter different datasets at once on year
Product_naamslicer	List to filter different datasets at once on projectnumber
Project_nnaamslicer	List to filter different datasets at once on projectnumber

Table 13, List of objects and their function in the data model

From	To	Description
Product_Data	Sales	Connect costing model data to products sold to determine budgeted costs.
Jaarslicersource	Sales, Projectsales, NACA	To filter all data on year in one click.
Product_naamslicer	Sales, NACA	Connect sold products to actual production costs from NACA
Project_naamslicer	Projectsales, Sales, NACA	Connect sold services to actual service costs from NACA

Table 14, Data connections in the data model

This data model now allows us to create pivot-tables containing information from all different datasets and return the outcomes to calculate the KPIs for the dashboard. The slicer-objects in the data model do not contribute to calculating the KPI values, but are necessary to improve the user-friendliness of the dashboard.

5.2. Visualising and supporting key performance indicators

The third and fourth steps in Kernzers framework (2017) of developing a dashboard are the visualisation of KPIs and visualising supporting data. This subsection describes how all KPIs introduced in Section 4.1. are be visualised and supported in the dashboard.

Cost variance

The cost variance is displayed for all different cost items. This is done using colour scales. The rules used for colouring the values of this KPI are given in Table 15.

Item	KPI Value	colour
Individual cost items	Between -10% and 10%	Green (good)
	Between ±10% and ±15%	Orange (warning)
	Bigger than ±15%	Red (bad)
All cost items combined	Between -10% and 10%	Green (good)
	Bigger than ±10%	Red (bad)

Table 15, Colour scales KPI cost variance

When the absolute value of one cost item is relatively low compared to the total amount within a programme, this may give a flattened image. Therefore we use some supporting analytics. The costs and budgets used to calculate the variances are in the dashboard. Besides, these costs are displayed as a bar chart, which also contains the total budget against the total costs. This allows the user to see certain cost items in perspective. Figure 5 shows an example of this bar chart. Here, the yield loss has a massive variance of over 200%, which is a lot higher than the 15% which will turn the value red. The bar chart gives the user of the dashboard a reference to see extreme values in perspective. In the case of Figure 5 a user can see that the high variance for the yield loss is relatively small when it is compared to the overall cost.

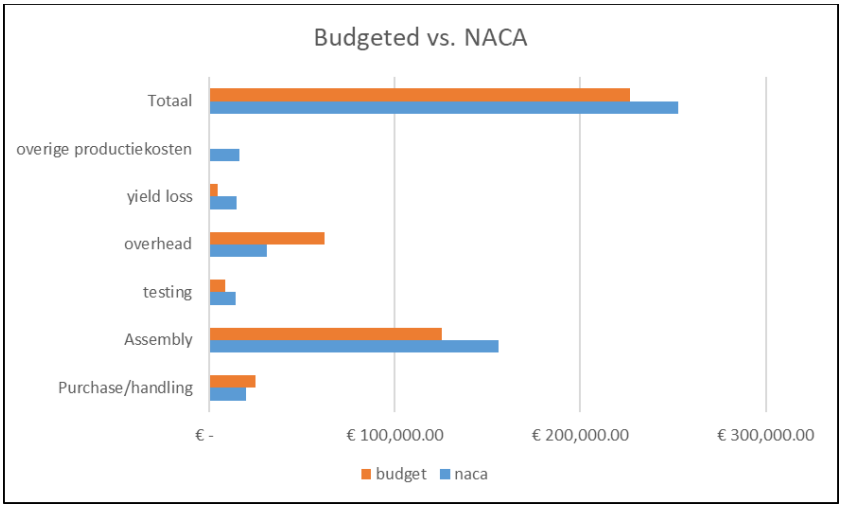


Figure 5, Example of bar chart for cost variance. This specific bar chart shows how a big percentual variance for the yield loss is relatively small in the bigger picture.

The last supporting analytic used for the costing variance is a traffic light indicator. This indicator tracks whether there are costs for the programme you are analysing which cannot be assigned to certain cost items. When these costs are higher than €20k the indicator goes on red to alert the user the dashboard may give inaccurate results for this case.

Average hourly rate

The average hourly rate is displayed as a percentage. Again, a colour scale shows the user whether a correction may be needed. When the average hourly rate differs more than 10% of the rate used in the costing model, the KPI colours red (bad). In case of a discrepancy less

than 10% the colour is green (good). To support this analytic the rate and average rate are given. Further a graph is used where the average hourly rate is displayed per month. This allows the user to see when differences are made, and over longer periods patterns may be discovered.

Sales price variance

The sales price variance is displayed as a percentage, again visualised using a colour scale. The scales used are described in Table 16.

KPI Value	colour
Between -10% and +10%	Green (good)
More than 10% under budgeted price	Red (bad)
More than 10% above budgeted price	Orange (warning)

Table 16, Colour scale KPI sales price variance

When the KPI gets above 10% over budgeted price we have chosen an orange colour. This is because for the financial of the company selling for a higher price is not always bad. The orange colour shows the user on the fact that sales price may get to a point where competitiveness of the pricing gets in danger. For the sales price variance, no supporting analytics are displayed on the dashboard. If a user wants to gain more insight in where the value comes from a double click on the value opens the data used to calculate, which contains the sales price variance for different products within the programme.

Project service coverage

The project service coverage contains is displayed as a percentage using a colour scale. The rules for this colour scale are given in Table 17.

KPI Value	colour
100% or higher	Green (good)
Under 90%	Red (bad)
Between 90% and 100%	Orange (warning)

Table 17, Colour scale KPI Project service coverage

At 100% all costs are covered, which means no problems in terms of project/service costs. When the cost coverage drops under 100% the user is warned, and below 90% the indicator gets red. This means that action has to be taken quickly. To support this KPI the total costs for projects/services, total billings for projects/services, and the total budgets for warranty and service (excluding material) are given in the dashboard. This allows the user to get more insight in where the problem is if the indicator gets orange or red.

5.3. The Dashboard

The final dashboard, built using Microsoft Excel, is shown in Figure 6. At the left are three buttons to select the programme for which the dashboard displays data. Unfortunately, due to PowerPivot limitations this cannot be reduced to the ‘one click’ the management desired. Nevertheless, three clicks is already a lot less effort to gain insight in how programmes perform compared to budgeted amounts. This dashboard allows users to gain overview in how certain programmes within the company perform compared to costing models designed for them. This is possible by just inserting data from the actual cost of hours, sales invoices and project invoices. When new data are added the dashboard considers these new data by refreshing the data model once.

However, the dashboard does what the management desired there are limitations. These mostly come from the administration. For example, in some cases products are sold and billed on the wrong project number. The data-model cannot address such mistakes. This causes mistakes in the numbers and calculations the dashboard provides. Besides, there are production programmes, which do not report costs as accurately on the right phases. Here the data-model cannot address a big part of the costs, which follows in part of the costs not taken into account. That said the dashboard does show a way in which a lot of unclarities, as described in Section 1.5. can be taken away. When using the dashboard we indeed see that part of the programmes do not give good results due to not using the standardised way of administration. For programmes which do, often part of the results are a bit biased, due to expenses or earnings e.g. being on a wrong project-number. To conclude we can say that the dashboard does give insight, but due to errors in the available data it is not ready to use yet. This conclusion is confirmed by project managers in the company. According to two project managers the dashboard gives insight in the costing model from a new angle, and sets a basis to work towards improving the costing model itself.

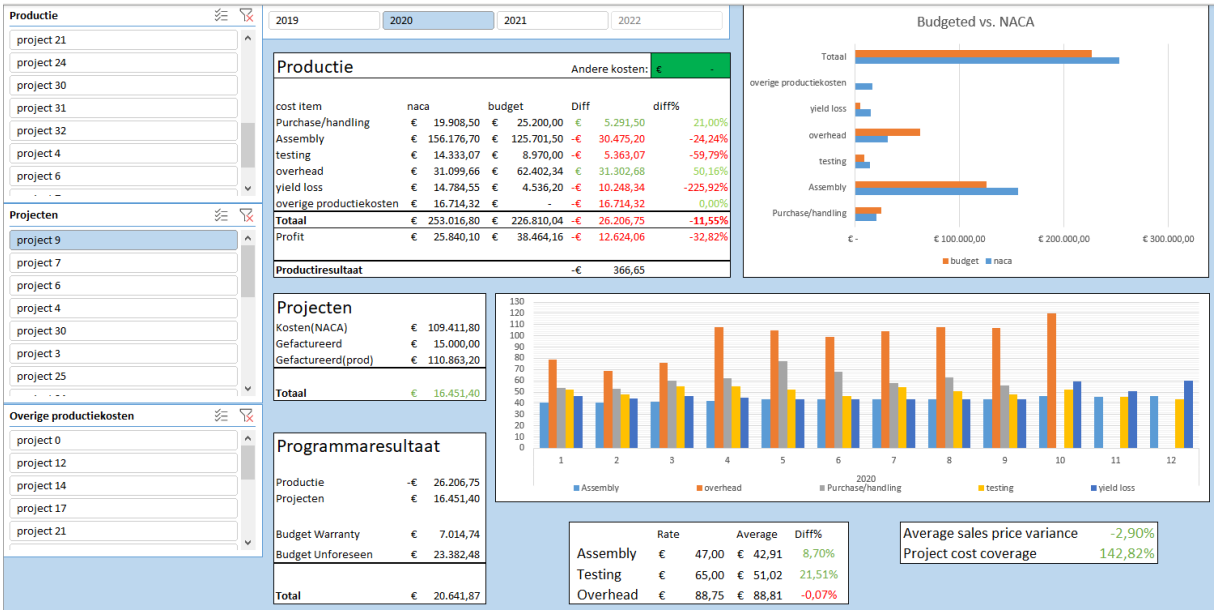
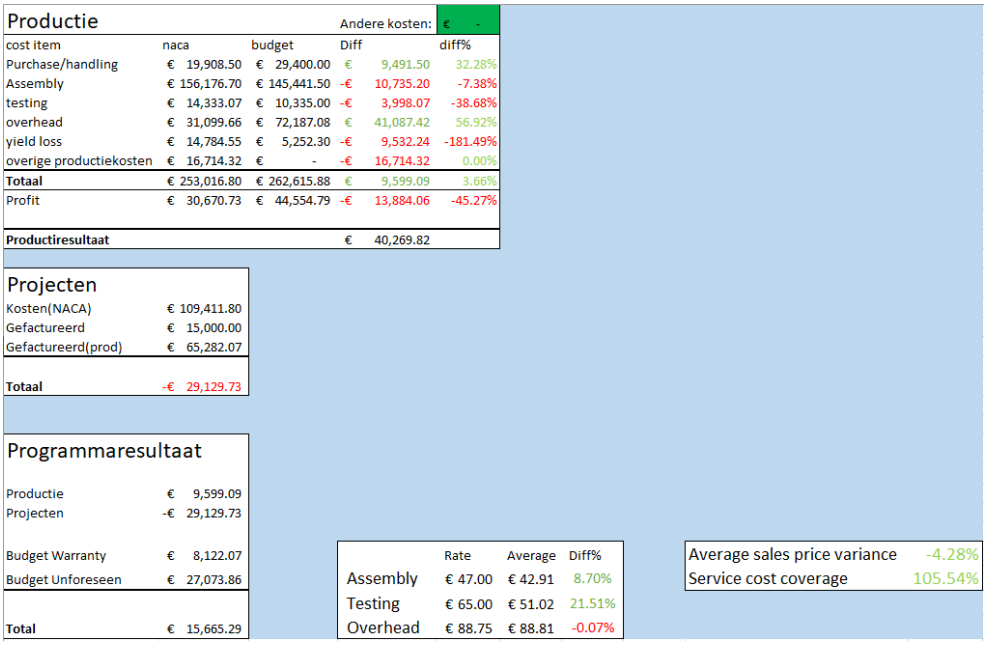


Figure 6, The final dashboard

5.3.1. Example of Data Errors

As described in section 5.3. the data contains a lot of errors. This section describes an example of how this affects the outcome. In the data shown in Figure 6, we see the overview and KPI values for Programme A. However in the data in Figure 6 there are products on the same administration. When this administrational error in the data is corrected, the €45k worth of products on the wrong number gets divided over the cost items in the production table, and is not in the projects table anymore. We now get the image as shown in Figure 7. This example of some products registered using a wrong number perfectly shows how errors in the data bias the outcome of the KPIs.



Productie — Andere kosten: € -

cost item	naca	budget	Diff	diff%
Purchase/handling	€ 19,908.50	€ 29,400.00	€ 9,491.50	32.28%
Assembly	€ 156,176.70	€ 145,441.50	-€ 10,735.20	-7.38%
testing	€ 14,333.07	€ 10,335.00	-€ 3,998.07	-38.68%
overhead	€ 31,099.66	€ 72,187.08	€ 41,087.42	56.92%
yield loss	€ 14,784.55	€ 5,252.30	-€ 9,532.24	-181.49%
overige productiekosten	€ 16,714.32	€ -	-€ 16,714.32	0.00%
Totaal	€ 253,016.80	€ 262,615.88	€ 9,599.09	3.66%
Profit	€ 30,670.73	€ 44,554.79	-€ 13,884.06	-45.27%
Productiresultaat			€ 40,269.82	

Projecten

Kosten(NACA)	€ 109,411.80
Gefactureerd	€ 15,000.00
Gefactureerd(prod)	€ 65,282.07
Totaal	-€ 29,129.73

Programmaresultaat

Productie	€ 9,599.09
Projecten	-€ 29,129.73
Budget Warranty	€ 8,122.07
Budget Unforeseen	€ 27,073.86
Total	€ 15,665.29

	Rate	Average	Diff%
Assembly	€ 47.00	€ 42.91	8.70%
Testing	€ 65.00	€ 51.02	21.51%
Overhead	€ 88.75	€ 88.81	-0.07%

Average sales price variance	-4.28%
Service cost coverage	105.54%

Figure 7, Example of biased data through administration errors

	Before manual correction		After manual correction	
cost item	Diff	diff%	Diff	diff%
Purchase/handling	€ 5.291,50	21,00%	€ 9,491.50	32.28%
Assembly	-€ 30.475,20	-24,24%	-€ 10,735.20	-7.38%
testing	-€ 5.363,07	-59,79%	-€ 3,998.07	-38.68%
overhead	€ 31.302,68	50,16%	€ 41,087.42	56.92%
yield loss	-€ 10.248,34	-225,92%	-€ 9,532.24	-181.49%
overige productiekosten	-€ 16.714,32	0,00%	-€ 16,714.32	0.00%
Totaal	-€ 26.206,75	**-11,55%**	€ 9,599.09	3.66%
Profit	-€ 12.624,06	-32,82%	-€ 13,884.06	-45.27%

Figure 8, Values before and after manual correction

After fixing this data error manually we see the total cost variance change from 11.55% over budget to 3.66% under the budget. This difference is displayed in Figure 8. Here we see the variance between all cost items getting less extreme after fixing the data error. Besides the service cost coverage (right bottom corner of Figure 6 and 7) is reduced from 148.82% to 105.54%. This is just one example of how registering a few sold products on the wrong number biases the outcome of our KPIs.

5.4. Implementation

As mentioned in Section 5.3. the dashboard does not fully function yet. This section describes what is needed to implement the dashboard and let it utilise its full potential.

We can state that two things are crucial before fully implementing the dashboard, namely: (i) regularity in the data and (ii) time. First we discuss what is meant by regularity in the data. Here we target at the general structure in how the administration for programmes, existing of production and projects, is used. As mentioned earlier this is currently not done properly for all programmes. When this general structure is applied correctly on a certain programme combined with recent information of that programmes costing model(s), the dashboard will calculate appropriate results. The core principles in the data which are necessary to make this work are the following three:

(i) Actual production costs are carefully divided over the correct phases in an generic manner for all programmes.

A generic structure in the administration of all production work is very important before the dashboard can be fully used. To make sure the dashboard provides accurate results for all programmes it is crucial to use the same phase-codes within the administration of all different production processes. A good starting point are the currently used phases for the Programme A and Programme B production processes. The activities belonging to these phases can be assigned to cost-items to allow the dashboard to track the accuracy of the costing mode (an example of this division is given in Appendix B, Table 19). When this structure is implemented for all production processes within all programmes the dashboards data-model can divide all cost over the right cost items correctly.

(ii) There is a clear overview of all project numbers within a programme, and these are correctly divided over production and projects.

Second, a clear overview of all projects numbers per programme is crucial to implement the dashboard. Here it is important to make a division between projects and production. This is required to allow the data-model to distinguish the costs from the NACA and connect them to the right earnings. Currently some production related numbers are identified as projects and vice versa. This causes inconsistencies in the results the dashboard gives. Therefore it is important to create one list with all production related project numbers and their corresponding programmes. and one list with all project related project numbers and their corresponding programme.

(iii) The most recent costing model data is available.

Third, a frequently updated datasheet with all costing model information has to be created. This list should be checked and updated by the project managers for their own programmes. It is important to do this in the same format as the list with product data in the dashboards data-model.

After these three points are evaluated and implemented for all projects and applied in the administration, the results the dashboard generates will become better and more accurate over time. For this task the responsible stakeholders are the project managers. They all overview a number of programmes, and are the ideal person to implement a general administration structure within their programmes. How exactly this general structure should look can be adjusted by the project managers, as stated an example of usable phases and how they can be assigned is given in Appendix B Table 19.

When the data for all programmes have gathered correct the dashboard can be fully used. To make sure the dashboard is always up to date it is important that it is connected to the company's ERP system. The tables behind the dashboard which contain all data of sales, actual hours and costing models need to be connected to the correct tables in the ERP system. This should not take extra conversion steps, since the data-tables used in the data-model are directly from the ERP system. When this is done Excel can automatically update the dashboard when it is opened. The program manager BIS is the responsible stakeholder for this final task before full implementation.

After this last connections to the ERP system are implemented the dashboard can be used to its full potential. It will give appropriate results for all programmes and allow users to get a detailed insight in how accurate different cost items in the costing model were budgeted. This will make it easy for project-managers to see where the costing model is lacking and allow them to improve it using targeted adaptations to improve the accuracy of the costing model, and general cost accounting within the company.

Step	What	Who
1	Set up a generic structure for the administration of all hours. All projects must register certain activities using the same phase structure. (Note: if this structure differs from the one in Appendix C Table 20 it has to be updated in the dashboard.)	Project managers, Programme manager BIS
2	Create an overview of all production and service project numbers within all projects.	Project managers (for their own projects)
3	Check whether the sheet containing all costing model data is up to date for all projects, if not, update the sheet.	Project managers (for their own projects)
4	Connect the dashboard to the ERP system to automatically update the data-sets.	Programme manager BIS
5	Use the dashboard to overview the costing performance of Company X	Project managers, programme manager BIS, BIS employees.

Table 18, Overview of implementation plan for the dashboard.

5.5. Summary

To complete the dashboard, as explained in Section 4, the final three steps of Kernzer are executed. First, a data model is set up using Excel. This data model provides all essential information to calculate our KPIs. Second, this section explained how the KPIs are implemented in the dashboard using visualisations and supporting analytics in graphs. Last, the final dashboard is given, including a description. The dashboard does provide an easy overview of how the costing model compares to the actual costs. Nevertheless, some limitations make the dashboard, not 100% ready to use for all programmes, primarily due to errors in the administration that cannot be addressed nor corrected by the data model. Last, this section describes what is still needed to be done before the company can implement the dashboard. The most crucial task before implementation is structuring the data collection of all programmes. Next, it is a matter of connecting the dashboard file to the companies ERP system and start using the dashboard to monitor and improve the accuracy of the costing model and cost accounting within the company.

6. CONCLUSION, RECOMMENDATIONS AND DISCUSSION

This section summarises the results and answers the main research question. These results are translated to conclusions. Further, recommendations are given on improvements for the dashboard and cost accounting within the company. Further the developed dashboard and implementation possibilities to start using the dashboard are discussed.

6.1. Conclusion

We started this research with a suspicion of the costing model not representing the actual costs. Here we concluded that the core problem was a lack of insight into what the costing model actually does, the fact that it is hard to measure whether the costing model is accurate stood in the way of improving it. Therefore we set the goal for this research to create a solution that allows project managers to quickly gain insight into whether the costing model is still representative of their programmes. To find this solution, we answer the following research question:

"How can Company X monitor the performance of their costing model?"

When this question is answered, Company X can start working towards improving the costing model itself.

To answer this question, we first carried out a literature study. The main goal of the literature study was to see which costing methods would be best for Company X. In this literature research, we found that on paper, activity-based costing could be beneficial. However, the disadvantages of activity-based costing are more prominent than the advantages for Company X. Due to on average 25 different programmes, which all function slightly different and given that the current, simpler costing method already brings unclarity, implementing a more difficult costing method is likely to make the problem of unclarity worse. We can conclude that in practice ABC is not the most suitable method, because implementing ABC for the amount of different products Company X offers will be very hard. Therefore we decided to keep the current costing model, make it easy to keep an overview and improve from there. The idea behind this strategy is to keep the costing model simple, but make it more detailed where needed. This should make the costing model more accurate without making it a very time-consuming process to determine costs for new products.

Next, we studied two programmes in the company. Here the problems with the current situation became clear. Data which should give insight in the situation of the cost accounting within Company X contains lots of errors and is stored in an inconsistent manner. This makes it very hard and time-consuming to overview the situation. To be able to improve the costing model itself, it is crucial to know how the current situation is. Therefore we can conclude that the first step towards improving the costing model itself is to improve the ability to monitor the performance of the costing model.

To set the basis towards improving the costing model itself, we created a monitoring dashboard. This dashboard allows users to gain insight into how accurate the costing models within a specific programme is compared to reality. This dashboard uses KPIs giving project managers easy and fast insight in how cost are in reality compared to the costing model. On paper, this dashboard provides the critical information to start improving the actual costing model, however in reality, again, the messy data keeps the dashboard from providing accurate results. Therefore we can conclude that Company X has to improve the structure of their data-provision before they can improve their costing model. To do this a generic data-structure has to be implemented for the administration of all programmes within the company. This can either be an existing one which is currently used within a programme (For example the structure in Appendix C Table 20) or a completely new structure. When this is implemented, it becomes possible to overview the situation within different programmes and apply targeted adaptations

to the costing model which improve the accuracy at the cost item level without increasing the complexity of the costing model too much.

To summarise, according to our findings, the answer to the research question is as follows: Company X can monitor their actual costs compared to budgeted costs using KPIs in a dashboard. To do so and work towards improving their costing model, Company X first has to improve its data provision. When a generic structure, as described in Section 5.4. is brought into the data for all different programmes, the designed dashboard can be used to its full potential and give stakeholders an overview of a programme within a few clicks. Combining this, we can summarise the route to improving the costing model itself in three stages; (i) structuring the data over all programmes as described in Section 5.4, (ii) implement the monitoring dashboard and (iii) use the monitoring dashboard to bring targeted and data-based improvements to the costing model. These improvements should make the costing model more accurate without making it too complex.

6.2. Recommendations and further research

To improve cost accounting within Company X the first step is to get a more structured and universal way of storing data. When this is improved accurate information on how the current costs are compared to the costing model will be available. This would first of all prevent situations like the example in Section 5.3.1, and make it possible to use the dashboard to its full potential. Furthermore this would enable the company to further improve the cost accounting and costing model within the company, since data with fewer errors and exceptions enables stakeholders to actually see what costs are made, and whether the costing model is accurate. Therefore we recommend to implement a better structure in the data as described in Section 5.4. When this is implemented it will become way easier to monitor the accuracy of the product costing and cost accounting within the company. When the data are structured better, the dashboard described in Sections 4 and 5 can be used to start detecting and implementing targeted adjustments based on data to actually improve the accuracy of the costing model. Improving the costing model and its accuracy is also the main subject for further research. When the findings and recommendations of this research are evaluated and implemented the costing model can not only be improved, but also evaluated. For example it could be interesting to test the current costing model against other models to evaluate whether costing models using different strategies function better. Unfortunately this was not possible within this research due to bad data.

6.3. Discussion

First, the course of this research is a point of discussion. When this research started, the goal was to improve the costing model itself. Along the way the course of this research changed towards monitoring the cost accounting at Company X, and in the end this research tends in the direction of data gathering. We can state that during this research the goal has changed. When we started looking to improve the costing model, we found out that it was very hard to gain insight into the costing accuracy in the current situation, so this became the main goal. When we started working towards improving the insight in the accuracy of the cost accounting, we were again confronted with messy data which brought us to the conclusion described in Section 6.1: the data gathering has to be structured and improved. The continuous change in goals and strategy within this research have made the outcome less satisfying and profound than we would have liked.

The next point of discussion is the dashboard itself. This is an example of how the performance of the costing model compared to the actual costs can be monitored. As stated in our conclusion, the current data are not reliable and does bias the outcome of the KPIs, as explained in the example in Section 5.3.1. Since there are no reliable data available we cannot

be sure whether the dashboard does indeed give the information we expect it to give when newly structured and reliable data are available. This is something we cannot test in this research since gathering new data takes time. This uncertainty is strengthened by the assumptions made along the way. For example, the material costs, which are not taken into account could prevent the dashboard from giving an accurate image of a programme's financial situation.

Another point of discussion is the overhead costs which are in the dashboard. It is debatable whether overhead costs should be in a dashboard which is going to be used to make to base decisions for the costing strategy on. This is debatable since it is common knowledge that a company should not base its decisions on indirect costs. Therefore it should be questioned whether it is a good idea to put the overhead (indirect) costs in the most important list of cost items in the dashboard.

Next, the KPIs and its target values are not based on scientific research, but on the current costing model and observed problems in the current situation at the company which seem to have the most financial impact. This implies that the solution presented in this research is company specific and not generally applicable.

Another big impact on this research is the situation in which it is carried out. The research is carried out for Company X, but due to the pandemic the time spent at the company is minimal. Because of this there has been less contact than usual with the company. This has been a bad influence on the outcome of the research and caused the outcome being different and not as good and less in depth than it could have been.

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APPENDIX

Appendix A: Systematic literature review

research question

As mentioned in the introduction of section 3 the systematic literature will be used to answer the following knowledge question:

"Which costing methods are available and which fit company's like Company X?"

The findings of this systematic literature review can be found in section 3.2.

Selection criteria

For the systematic literature review inclusion and exclusion criteria have to be set to determine if a source should be used or not. In the table below the inclusion and exclusion criteria are given.

Inclusion criteria	Exclusion criteria
Article compares different costing methods.	Article is not available in Dutch or English.
Article is about costing in manufacturing company's.	Articles contents are not usable in company's
Article defines strengths and weaknesses of costing methods.	Article does not cover strengths and weaknesses of certain methods
Article talks about effectiveness of costing methods.	

Databases

The following databases will be used for this literature research:

1. Business Source Elite
2. UT Library (Find UT)
3. Google scholar

Search terms

Constructs	Related terms	Broader terms	Narrower terms
Costing		Cost accounting	Cost pricing
Costing methods	Costing strategy		Activity-based costing Traditional costing Target costing
Manufacturing company	Production company		

Search results

The determined search terms will be combined and used in different databases to find proper source to answer the knowledge question stated in 3.3.1.

Search term	Database	Articles found	Articles selected
"Costing methods" and "manufacturing company"	EBSCO	42	1
	Google Scholar	685	1
	FIndUT	93	0
"activity based costing" and	EBSCO	54	1

“manufacturing company”			
	Google Scholar	3440	1
	FindUT	34623	0*
“Target Costing” and “manufacturing company”	EBSCO	13	0
	Google Scholar	851	1
	FindUT	17049	0*
“traditional costing” and “manufacturing company’s”	EBSCO	10	0
	Google Scholar	3400	1
	FindUT	17178	0*
Total			**6**

*too many to overlook all sources, most usable sources are likely to overlap with EBSCO and Scholar.

Key findings

#	Title	Author	Year	Key findings
1	Product Costing Systems: Finding the Right Approach	Joseph G. Fisher and Kip Krumwiede	2015	Summarises 5 different costing methods with pro’s and cons.
2	Implementation of an activity-based costing system in a small manufacturing company.	Bharara, A. Lee, C.-Y.	1996	ABC provides accurate product costs and estimated costs for complicated processes. Tracking the time spent by activities also improves accuracy.
3	Time-driven activity-based costing: An implementation in a manufacturing company.	Öker, Figen Adigüzel, Hümeyra	2016	Article demonstrates an implementation of Time driven ABC in a manufacturing company and shows that the TDABC is more relevant and accurate than traditional costing.
4	Traditional versus activitybased product costing methods: a field study in a defense electronics manufacturing company	Meyers	2009	This paper shows that traditional costing leads to undercosting and inaccuracy. It states that the traditional method seems to be outdated.
5	Cost management through product design: target costing approach	Yasemin Zengin & Erhan Ada	2009	Target costing is a reverse costing methodology which also includes the design process. Important to know is that for manufacturers who produce new or innovative products target costing usually is not very effective.
6	A comparative analysis and implementation of	Nitin Kumar & Dalgobind Mahto	2013	ABC defines costs in certain area’s better, giving it better overall insights in the costs than

	ABC and TCA methods in an automobile parts manufacturing company: a case study			TCA. Article shows that TCA can lead to inaccuracy.

Appendix B: Example of costing model

PRODUCT PRICE CALCULATION MODEL

Material				[1]		
Materials (CoGs)				€ 1.000,00		
Purchase & handling			10%	€ 100,00	+	
				€ 1.100,00		€ 1.100,00
Labour	hrs		rate [2]			
Assembly	10,0	X	€ 50,00	€ 500,00		
Testing	10	X	€ 100,00	€ 1.000,00	+	
				€ 1.500,00		
Overhead	10,0%	X	€ 200,00	€ 400,00	+	
				€ 1.900,00		€ 1.900,00 +
						€ 3.000,00
Miscellaneous						
Yield loss				10,0%		€ 333,33
Warranty				10,0%		€ 370,37 +
						€ 3.703,70
Unforeseen/risk				10,0%		€ 370,37 +
						€ 4.074,07
Profit				10,0%		€ 407,41 +
Product price						**€ 4.481,48**

Appendix C: Data analysis

Data preparation

To be able to start the five steps the data has to be prepared. This concerns the recalculation of all written hours, product sales, and project sales.

For the recalculation first add two extra columns ‘rate’ and ‘ hours * rate’. For the rate column, use an Excel vlookup function to assign the correct hourly rate to the correct employee-codes. Next the ‘hours * rate’ column contains the product of the hours (already in the data) and the rate which was just added. Now we have connected the hours made by employees to the correct costs. Product and project sales data already contains all information required. Next pivot tables have to be prepared to access the correct data easier. The properties of these pivot tables are in Table 19.

Data	Filters	Rows	Values
Recalculation hours	Prj., Year	Project, phase, Code, Rate	Sum of ‘hours * rate’
Product sales	Name, year, adm.	Prj., description, price	Sum of amount, sum of rule.
Project sales	Adm., year	Project group, name, project, description.	Sum of amount.

Table 19, Data analysis: pivot Table properties

Data corrections

Before getting started with the data two data corrections need to be carried out to get more accurate results. First we have the hourly rates which are used. According to the company’s program manager BIS these are commercial rates which contain a 10% profit. To get the actual costs this 10% profit margin is subtracted from the hourly rates.

Next we found a variation in the budgeted and actual sales price. In Table 5, Section 3.3. this difference is shown for the products in the analysed projects, Programme B and Programme A. The average sales price differs from the calculated price in the costing model 9 out of 10 times and is lower than the the costed price 8 out of 10 times. If we would only use the theoretical transferprice (costing model) this causes us to calculate incoming money which never came in due to a lower sales price. Therefore we should correct the profit margin from the costing model. This is done as follows:

$$corrected\ profit\ margin = profit\ margin - (theoretical\ transferprice - average\ sales\ price)$$

Step 1: Calculate budgeted costs

First the budgeted costs need to be calculated. This is done by taking the current costing model. Here the estimated costs per unit are calculated for i. material, ii. Purchasing/handling, iii. Assembly, iv. Testing, v. overhead, vi. Yield loss, vii. Warranty and viii. Unforeseen. After putting these in a list the number of products sold for that costing model have to be derived from the sales invoices and multiplied by the budgeted costs per product. An example of the result of this step is given in Figure 8.

Costing model 1pcs	
Purchase/handling	€ 200.00
Assembly	€ 940.00
testing	€ 65.00
overhead	€ 465.94
yield loss	€ 34.10
warranty	€ 52.73
unforeseen/risk	€ 175.78
profit	€ 290.03
Corrected budgeted profit	€ 234.65
Number Sold	147
Budgeted costs	
Purchase/handling	€ 29,400.00
Assembly	€ 138,180.00
testing	€ 9,555.00
overhead	€ 68,493.18
yield loss	€ 5,012.70
warranty	€ 7,751.31
unforeseen/risk	€ 25,839.66
Profit	€ 42,634.41
Corrected budgeted profit	€ 34,493.70

Figure 9, Calculation of budgeted costs.

Step 2: Connect actual costs to products

In this step the actual costs are calculated. First costs have to be linked to actual men hours made in the projects. Here we distinguish hours for production and hours for projects. Now we have all the data containing hours in the whole company. Filter these using pivot Tables to see the hours divided over the different phases in the administration of the company. These phases are assigned to items from the costing model as given in Table 20. Warranty and unforeseen risk budget do not have direct costs against them and is seen as 'reserved.' Add the costs for phases assigned to the same cost item to calculate the actual production costs per cost item.

Cost item	Phases assigned
Purchase/handling	011, 012, 013
Assembly	020
Testing	014, 021
Overhead	030, 031, 032, 033
Yield Loss	040

Table 20, Phases assigned to cost items

Next the indirect production costs have to be calculated (this data is available from 2020 and after). Here we add the costs assigned to 5 different cost items which are indirectly connected to production. The result of this step is given in Figure 10 including the 5 unique numbers these costs are written on.

Hours Costs NACA				
Purchase/handling	€ 19,999.23			
Assembly	€ 150,500.38			
testing	€ 15,106.25			
overhead	€ 14,601.50			
yield loss	€ 11,225.50			
warranty	€ 0.00			
unforeseen/risk	€ 0.00			
Other production costs	Prj	cost NACA	type factuur	cost
Production Engineering Oper	1388.00	€ 7,113.00	-	*-€ 7,113.00*
Project Management Operat	1390.00	€ 7,710.75	-	*-€ 7,710.75*
Procurement Operationeel	1393.00	€ 445.50	-	*-€ 445.50*
QLE Operationeel	1401.00	€ 3,229.00	-	*-€ 3,229.00*
Ondersteuning Operationee	1402.00	€ 222.75	-	*-€ 222.75*

Figure 10, Calculated actual costs and calculated other prodcution costs

Step 3: Calculate the difference

In this step the result for production is determined. This is done by subtracting the actual costs from the budgeted costs. This gives insight in the difference between the budgeted costs and the actual measured costs. Now we have the absolute difference, however in the case of large amounts this could give a misleading image. Therefore, we divide the difference by the budgeted cost to display the result as a percentage to see the result in perspective. Now we have calculated the difference between the budgeted and actual costs. Last in this step, the profit margin is taken into account to determine the production result. An example of the result of this step is given in Figure 11.

DIFF		%
Purchase/handling	€ 11,218.89	38.16%
Assembly	€ 1,361.48	0.99%
testing	-€ 4,177.95	-43.73%
overhead	€ 55,219.09	80.62%
yield loss	-€ 5,192.30	-20.09%
Other production costs (+corr. Profit in hours)	-€ 17,019.09	
Diff before profit	*€ 41,410.11*	*16.52%*
		profit margin
budgeted profit	€ 42,634.41	10.00%
Budgeted profit margin		
Corrected budgeted profit	€ 34,493.70	8.09%
Budgeted profit - diff before profit	*€ 84,044.52*	19.71%
profit percentage		
Corrected profit - diff before profit	*€ 75,903.81*	17.80%

Figure 11, Difference between actual and budgeted costs

Step 4: Calculate other hours

Here we calculate costs besides the product-related costs. These are all hours not calculated in step 2, mostly hours written for extra service or warranty within the programme. List all other cost items with their project number (prj.) and costs. Go through all project invoices using an Excel lookup to check for possible revenue on the project number, if there are any subtract the amount of the invoice from the costs for Company X. Doing this results in an overview with the net costs or profits of the services provided and sold for the certain programme. An example of this is shown in Figure 12.

If the analysis is over multiple years, repeat step 1-4 per calendar year.

Other costs and revenues	Prj	cost NACA	facturen	cost
Service/RMA	392.10	€ 42,086.50	€ 65,282.07	*€ 23,195.57*
CCB	392.100	€ 90.75	€ 0.00	*-€ 90.75*
Omzetten	392.106	€ 447.50	€ 0.00	*-€ 447.50*
Result		€ 42,624.75	€ 65,282.07	*€ 22,657.32*

Figure 12, Calculating other costs and revenues

Step 5: Result

Now we have results from production (step 3) and projects (step 4). In this step all results are put together to determine the programme result. First, put down the Production result, calculate through the profit correction and calculate the production result. Next add the warranty and unforeseen/risk budget which was seen as reserved in step 1. Last we add the different production years to get an overall overview. For service/projects the same has to be done. The results are put together and different years are added. The final step is adding the production result and the projects/service result to get the programme result. In appendix B Figure 13 and Figure 14 the result for both analysed programmes are given.

[Removed due to confidentiality]

Figure 13, Result data analysis Programme A 2019/2020

[Removed due to confidentiality]

Figure 14, Result data analysis Programme B 2019/2020