Waltteri Yliranta

Data-Driven Performance Optimization and Reporting in the Supply Chain Management of the Case Company

Unleashing the Power of Power BI

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Author: Waltteri Yliranta
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ABSTRACT:
There is still a lot of untapped potential when it comes to achieving the full potential of data usage. There are many barriers that prevent businesses from transitioning to a more data-driven organization. The barriers include things like lack of data strategy, unprofitable yield for data related investments as well as the organizational capabilities in data usage. There is also a barrier regarding the potential use cases as previous research suggests that people and organizations lack the ability to imagine potential use cases. Moreover, it is hard to achieve the potential of data usage when organization do not even know that to ask for. Therefore, this thesis provided a concrete way of data-driven implementation which improves the performance and reporting of the supply chain. In addition, the key success factors in implementing a data-driven approach were indicated.

This thesis is an abductive mixed method case study. This thesis has qualitative and quantitative dimensions. Surveys were used as a method for data collection. The purpose of the first survey was to evaluate the baseline to which the results from the second survey could be compared to. The first survey was also used to gather the list of requirements and needs for the data-driven implementation. The implementation of the data tool was performed by using the information system design method. The implementation resulted in a Power BI tool.

Main findings of this thesis indicates that if a business intelligence tool is built in close collaboration with the users and if it is aligned with the management methods and strategy of the case company, the Power BI tool improves performance and reporting of the supply chain in the case company. Key success factors for implementing a data-driven approach in supply chain are identifying the requirements of the users, close collaboration with the users, data culture in the organization, and alignment of the data usage with the management methods and strategy of the organization. In other words, building what users want results in successful implementation of data-driven approach in supply chain development. However, the tricky part of building what users want is to find out what they want. Therefore, finding what users want is also a key success factor.

This thesis provides contribution in relation to identified research gap which was the untapped potential of data usage in the case company. Despite the delimitations and limitations, this thesis provides a concrete way for successful implementation of a Power BI tool which improves performance and reporting in the business. This thesis also provides many recommendations for future research in relation to this topic as there remains a lot of untapped potential in this area of research.

KEYWORDS: business intelligence, supply chains, management by objectives, balanced scorecard, lean manufacturing

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TIIVISTELMÄ:
Datan ja datan käytön osalta on edelleen valtavasti potentiaalisia käyttökohteita, joita ei ole vielä laajemmin hyödynnetty. On olemassa monia esteitä, jotka estävät organisaatioita muuttumasta datavetoisiksi ja datan avulla johdettaviksi organisaatioiksi. Esteitä on muun muassa puutteelliseen data strategiaan, kannattamattomiin dataan liittyviin investointeihin ja organisaatioiden kyvykkyyksiin liittyen. Aikaisempi aiheeseen liittyvä tutkimus osoittaa, että esteenä on myös organisaatioiden puute ymmärtää mahdollisia käyttökohteita datalle, koska dataan liittyviä mahdollisia käyttökohteita ei osata edes kuvitella. Tämän takia tässä tutkielmassa osoitetaan kuinka datavetoinen lähestymistapa toimitusketjun suorituskyvyn ja raportoinnin parantamisessa voidaan konkreettisesti tehdä.

Tässä tutkielmassa yhdistyy sekä kvalitatiivinen, että kvantitatiivinen ulottuvuus. Tämän lisäksi tämä tutkielma on myös case-tutkimus. Kyselyt toimivat datan keruun pohjana. Ensimmäisen kyselyn tarkoitus oli selvittää lähtötilanne, johon toisen kyselyn tuloksia voidaan verrata. Ensimmäisen kyselyn tarkoituksena oli myös selvittää käyttäjien vaatimukset ja ajatus Power BI työkalun osalta. Power BI työkalun implementointi suoritettiin tässä tutkielmassa tietojärjestelmän suunnittelumenetelmän avulla.

Tutkielman löydökset osoittavat, että Power BI työkalu parantaa case yrityksen toimitusketjua, kun se rakennetaan tiiviissä yhteistyössä tulevien käyttäjien kanssa. Tämän lisäksi on oleellista, että rakennettu työkalu on linjassa case yrityksen johtamismenetelmien ja strategian kanssa. Keskeiset menestystekijät onnistuneessa datavetoisessa toimitusketjun suorituskyvyn ja raportoinnin parantamisen osalta ovat käyttäjien tarpeiden selvittäminen, tiivis yhteistyö tulevien käyttäjien kanssa, yrityksen datakulttuuri sekä datavetoisen lähestymisen tavan sulauttaminen organisaation johtamismenetelmien sekä strategian kanssa. Oleellista on myös selvittää, että mitä käyttäjät oikeastaan haluavat.

Tämän tutkielman panos on liittyen identifioituun tutkimusaukkoon eli hyödyntämättä olevaan potentiaaliin datan käyttökohteiden osalta. Rajauksista huolimatta tämä tutkielma tarjoaa konkreettisen tavan toteuttaa onnistunut Power BI työkalun implementointi tavalla, joka parantaa yrityksen suorituskykyä ja raportointia. Tämä tutkielma kertoo myös monta mahdollista tulevaa tutkimuskohdetta aiheeseen liittyen, sillä hyödyntämättä olevaa potentiaalia datan käyttökohteiden osalta on vielä runsaasti jäljellä.

AVAINSANAT: business intelligence, supply chains, management by objectives, balanced scorecard, lean manufacturing

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Abbreviations

BI	**Business Intelligence**
SCM	**Supply Chain Management**
BSC	**Balanced Scorecard**
MBO	**Management by objectives**
KPI	**Key Performance Indicator**

1 Introduction

Data has become ubiquitous. In 2010, there were 2 zettabytes of data generated during the whole year whereas in 2023 the estimated amount of data generated for the whole year is 120 zettabytes (Duarte, 2023). Diplock et al. (2018) say that not too long ago, in 2015, there was a higher supply of data scientists than there was a demand for them. However, the tables turned just a few years after that and suddenly there was more demand for data scientists than people with sufficient skills for those roles.

To this end, Reeves et al. (2023) remind that the digital revolution started already at the end of the 20th century. Moreover, they say that the digital revolution has changed the world ever since and the constant change keeps getting faster and faster. McAfee and Brynjolfsson (2012) explain how the use of data has improved over the years. They say that businesses have always been able to make decisions about restocking based on the demand for the goods. However, after e-commerce became more popular, businesses got access to a much larger amount of data. In practice, this means that every single click on the online store by customers can be analyzed and used to make more informed and better decisions.

Glazer (2020) says that all companies aim to make decisions that have a positive impact on the business rather than negative impact. To this end, he says that the highly developed BI data of the 21st century can provide the necessary information to make highly informed decisions. However, he adds that even though the winning formula for a successful business sounds simple, it can be hard to achieve this in practice.

Despite the developed BI data, Glazer (2020) points out that many businesses underutilize data. Moreover, McAfee and Brynjolfsson (2012) say that the businesses that are data-driven outperform businesses who are less data-driven. Considering these statements, businesses could gain competitive advantage in the market by simply having a more data-driven approach in their business. However, Berndtsson et al. (2020) explain that there are many barriers preventing businesses from transitioning to a more data-

driven organization. To that end, if businesses cannot find a way to breach these barriers, they might get in trouble in the future since Hagiu and Wright (2020) say that efficient usage of data will be the minimum required in order to stay in business.

Berndtsson et al. (2020) say that the different barriers can be divided into three categories: analytics versus business, management, and data. The first category includes barriers like lack of skills regarding data analytics, resistance against change, and inadequate alignment towards data-driven culture in the organization. The second category includes barriers related to poor performance of management in driving a data-driven change. The third category only has one barrier which is that people are not able to get the data they would need.

The previous paragraphs explain that there still is lot of untapped potential when it comes to achieving the full potential of data usage. Therefore, this thesis conducts a case study which creates a concrete way of how data usage can be improved in a company. Furthermore, a thorough literature review is conducted which provides a strong theoretical background for the case study where the *Power BI* tool is created. The aim is not simply to build the best possible *Power BI* tool from the technical point of view. The aim is to build it in a way that the tool improves the performance and reporting of the case company. Moreover, the aim is that the tool is aligned with the management and leadership principles of the case company.

1.1 Research Gap

Berndtsson et al. (2020) say that the inadequate alignment towards data-driven culture in the organization can, for example, mean that there is no strategy towards data-driven change. To this end, they say that there might not be a strategy for how data should be used in the organization and therefore individual employees do not know how to work in data-driven ways. Moreover, Berndtsson et al. (2020) say that the top management

does not necessarily see the transition towards data-driven organization profitable enough to create supporting strategies.

Similarly, Ross et al. (2013) claim that the investments towards data usage and big data do not yield a profitable return. However, they also say that in many cases the reason is that the organization lacks the required qualities to achieve the full potential of data usage. They justify this argument by saying that often organizations do not even know how they could efficiently utilize the current data they have so it is quite difficult to utilize big data. Hagiu and Wright (2020) support this argument by saying that organizations tend to think that the more data you have, the better you will perform even though the focus should be on the ways of how the data is used.

Considering the previous paragraphs there is a research gap in this area. Detwal et al. (2022) conducted a thorough literature review regarding data-driven techniques in SCM and concluded that there is still a lot of untapped potential for research in this area. To this end, Urcioli and Hintsa (2018) mention that some organizations lack the ability to use data as support since they cannot even imagine the potential use cases. It is hard to implement data tools if you do not even know what to ask for.

To this end, the case company is a manufacturing company which the assignment from the case company for the case study is to explore data-driven solutions that could improve the performance and reporting of the company. This merely highlights the previous paragraphs and the need for studies that show potential use cases for data and how they can be implemented in a company. Therefore, the identified research gap is the untapped potential of data usage in the case company.

1.2 Case Company and Background of the Study

Danfoss is a 90-year-old family-owned multinational corporation which has a total of 42000 employees in over 100 countries (Danfoss, 2023). In 2022, the revenue of Danfoss

surpassed ten billion euros (Danfoss, 2023). The innovations of Danfoss provide technologies that can be used as solutions to perform green transitions by, for example, improving energy efficiency (Danfoss, 2023).

The case company is called *Danfoss Drives Oy,* and it is part of the Danfoss Drives segment. *Danfoss Drives Oy* is located in Vaasa, and it is a drives manufacturer. Even though the case company is called *Danfoss Drives Oy*, the case study focuses on and is conducted for Danfoss operations Vaasa which is responsible for managing the supply chain in the case company. Therefore, it is important to note that Danfoss operations Vaasa is referred to when talking about the case company in the thesis.

As said, Danfoss operations Vaasa is responsible for the supply chain management which, for example, includes sourcing, quality, and production related processes. The assembly of drives takes place in the Vaasa plant and therefore many vendors and subcontractors are being used for raw materials. Therefore, an efficient supply chain is vital.

Data plays a big role in the decision making of the case company and that is why the case company is continuously looking for ways to improve the data usage in order to gain competitive advantage. Therefore, the assignment for the thesis is to explore data-driven solutions to improve the performance and reporting of the supply chain in the case company. The case company supervisor for this thesis is the Production Director, Anssi Ladvelin.

1.3 Research Questions, Purpose, Objectives, and Delimitations

The purpose and objectives of this thesis are straightforward. The purpose of the thesis is to improve the performance and reporting of the supply chain in the case company. The purpose is achieved by completing three objectives that are as follows:

- To find out the core elements of enhancing user experience in data systems and in data-driven decision making.

- To explore data-driven solutions to improve the performance and reporting of the supply chain.
- To identify the key success factors for implementing a data-driven approach to improve the performance and reporting of the supply chain.

RQ1: How can data be used to improve the performance and reporting in the supply chain of the case company?

RQ2: What are the key success factors for implementing a data-driven approach to supply chain performance optimization and reporting?

To achieve the main objective as well as the steps explained, this thesis conducts a case study about improving the performance and reporting in the case company with a data-driven approach. Moreover, a comprehensive literature review regarding SCM and data usage is conducted. In addition, the thesis has two research questions which are presented above.

Both research questions are aligned with the purpose and objectives of the thesis. However, the first research question is directly related to the assignment since it only considers the data usage from point of view of the case company. On the other hand, the second research question is more general since it aims to provide an answer that could be generalized. To this end, Schell (1992) points out that in some cases it can be challenging to generalize a case study. Therefore, the second research question is one of the ways this thesis aims to tackle this challenge regarding generalization.

The case study of this thesis is delimited to the supply chain of the case company. Furthermore, this thesis is delimited to focusing on how the performance and reporting of the supply chain can be improved by utilizing data more effectively. Moreover, the data collection of the case study is delimited since the surveys are only sent out to the supply chain leadership team of the case company. In addition, there is a delimitation

regarding the best BI tool selection for a such objective since the case company wanted the tool to be built with *Power BI*. Lastly, there is also a delimitation regarding the result evaluation as the evaluation of the potential improvement of the reporting and performance will be conducted by using a survey that is sent out to the factory leadership team.

1.4 Research Structure

After the introduction of this thesis, there will be four main chapters. The chapters are literature review, methodology, results, and conclusion. The literature review is divided into three chapters that are *Supply Chain Management*, *Performance Measurement in Supply Chain* as well as *Data and Business Intelligence*. Furthermore, these two chapters are divided as well. The chapter about Supply Chain Management is divided into three chapters that are *Lean*, *Hoshin Kanri*, and *MBO*. These concepts were selected as part of the literature review because the case company uses these concepts to manage its' supply chain.

Furthermore, the chapter about performance measurement has two sub-chapters that are *Strategy Maps* and *Balanced Scorecard*. BSC is the way the case company tracks its performance. The third part of the literature is about *Data* and *Business Intelligence* and there are three sub-chapters that are *Data Culture*, *Data and Supply Chain Performance*, and *Building of a Business Intelligence Tool*.

After the literature review, the used methodology is presented. This part talks about the selected method, Information System Method, and explains the case in more detail. Also, mixed method study and case study is discussed. Moreover, this part of the thesis describes the process of how the data was collected. Lastly, this part of the thesis will discuss the reliability and validity of the thesis.

After the methodology the results are presented. This part includes a demonstration of the BI tool that this thesis aims to build. Moreover, the results of the surveys are presented. Lastly, there will be a conclusion where the findings of the thesis are discussed and presented. Moreover, the conclusion part of the thesis will provide future research ideas, discuss managerial implications, and limitations. References and appendix can be found at the end of the thesis. There are two appendixes. Appendix 1 is survey 1 and appendix 2 is survey 2.

2 Literature Review

Booth et al. (2012) says that literature review is a vital part of research since without it, the topic cannot comprehend thoroughly. They explain that it is vital because how would the researcher otherwise know what is already researched and what is not. Moreover, they say that by conducting a thorough literature review, the researcher avoids a situation where they make findings that have already been made. In this thesis, the artificial intelligence-based tool, *Elicit*, is used in finding relevant articles for this thesis. However, it is important to note that the tool does not do writing. It only supports finding relevant articles as it allows you to search multiple databases at the same time.

As stated, the purpose of the thesis is to improve the performance and reporting of the supply chain in the case company. Moreover, the aim is to build a *Power BI* tool and with a data-driven approach. Therefore, the literature review of this thesis consists of three parts which are *Supply Chain Management*, *Performance Measurement in Supply Chain* as well as *Data and Business Intelligence*. To improve the performance of the supply chain in the case company, one must understand the concepts of how the supply chain of the case company is being led. Moreover, to improve the reporting of the case company, one must understand different reporting methods. Lastly, to build the *Power BI* tool, theoretical concepts related to building and implementing a BI tool are required to be understood.

The first part, *Supply Chain Management*, consists of chapters about *Lean*, *Hoshin Kanri*, and *MBO*. The second part, *Performance Measurement in Supply Chain*, consists of *Strategy Maps* and *Balanced Scorecard*. Lastly the third part, *Data and Business Intelligence*, consists of *Data Culture*, *Data and Supply Chain Performance*, and *Building of a BI tool*. The aim of the literature review is to cover the topics to the extent that is required to achieve the objectives of the research. In addition, literature review supports answering research questions. Moreover, the aim is to find connections between the topics covered in the literature review and the case study assignment.

2.1 Supply Chain Management

SCM refers to managing activities needed to convert raw materials into finished goods for customers (Roy & Roy, 2013). Drake (2012, p.2–3) clarifies that that the activities managed are, for example, procurement, production, inventory management, and transportation. Moreover, he says that forecasting of the activities mentioned is also part of the SCM.

Therefore, it can be said that the people managing the SCM have a lot of different activities to oversee, manage, and lead. To this end, to improve the SCM, many concepts and theories have been developed. There are many ways of managing the SCM, so only some of the concepts were selected to be part of the literature review. These concepts were selected because these concepts are the ones which case company uses in its' SCM. Considering the purpose and the objective of the thesis, this is a logical approach.

2.1.1 Lean

Drake (2012, p.20) says that there will always be variability and unexpected events regarding SCM. Therefore, he says that there are two ways organizations can manage the uncertainty of future demand. Organizations can either carry an excess inventory or have a highly responsive and agile supply chain operations to avoid loss of production. However, Drake (2012, p.20) points out that from the operational point of view, carrying additional inventory to tackle this problem is the easier way. On the other hand, additional inventory has a negative impact on cash-flow. Therefore, if the organization is able to have highly responsive supply chain operations, it can have a competitive advantage against those who choose to carry the additional inventory.

Highly responsive supply chain operations can be achieved by implementing principles of lean into practice. Liker and Ross (2017) explain that the inspiration for lean came

from Toyota Production System. They add that the Toyota Production System house consists of operational stability, operational excellence, Just-in-Time -concept as well as Jidoka. Operational stability is about having people and equipment which reliably perform the necessary tasks. On the other hand, operational excellence refers to safety, quality, delivery, cost, and morale. Just-in-Time refers to completing every single activity just when it is required to be completed. Jidoka refers to fixing occurring problems. Another key thing to remember is that continuous improvement is an essential part of the Toyota Production System.

Womack and Jones (1996) say that there are five principles of S which are value, value stream, flow, pull, and perfection. In addition to five principles, Womack and Jones (1996, p. 15) say that identifying waste is the essence of lean philosophy. To this end, they say that conducting tasks that create no value are considered waste and should not be conducted in the first place. All these principles relate to SCM. Therefore, the next paragraphs will explain these principles in more detail.

Womack and Jones (1996, p.16) state that the customer is the one who defines the value of the product or the service. To this end, they add that the producer of the product or the service provider is the one who creates the value. Therefore, Womack and Jones (1996, p.19) say that defining the value is the starting point of lean thinking and that is where one should start when starting to implement lean thinking into practice. Moreover, they highlight that the precise definition of the value can only be achieved by having a dialogue with the customer.

In light of the previous paragraph, Womack and Jones (1996, p. 31) challenge the way value is usually defined by the producer. They explain that often producers only make minor changes to products based on the feedback of the customer. Having said that, they add that the product should be created from scratch in close collaboration with the customer since that is to only way to ensure that the value is identified by producer and attached into the product.

From the SCM point of view, identifying waste is the most important factor when trying to improve SCM. Womack and Jones (1996, p. 15) define waste as an activity that results in no value. Waste can, for example, mean excess inventories, poor quality, and activities that really are not even needed. Therefore, one should aim to completely remove waste. It is hard to argue with that statement but in practice it can be extremely difficult to have zero waste because that would mean that there would never be any kind of errors. On the other hand, the goal of aiming to zero waste also means that waste is tried to be minimized which can be an effective approach when improving the performance of supply chain.

Womack and Jones (1996, p. 19) say that value stream includes all steps that are required to transform an idea of a product or service to a concrete output that is then delivered to the customer. They clarify that there are three main tasks in value stream which are problem-solving, information management, and physical transformation. Information management and physical transformation are the ones out of the three that are most related to SCM so let's focus on those. Womack and Jones (1996, p. 19) say that the task of information management includes the necessary information flow from receiving the order to scheduling the delivery. On the contrary, they say that the task of physical transformation includes the steps from procuring the raw materials all the way to the concrete output that is delivered to the customer.

Figure 1 shows an example of a simplified value stream. It looks straightforward but there are many factors affecting it. Womack and Jones (1996, p. 43) argue that often the processing times, for example, in the production phase can only last for a short time but warehousing between steps can consume a lot of time. Therefore, they say that the total processing time in value stream should include all steps from start to finish. To this end, they explain that often this kind of approach shows the inefficiencies in the value stream and that for most of the time there is no flow. Therefore, the concept of Just-in-Time is

so important when optimizing flow of the value stream. To that end, Womack and Jones (1996, p. 21) say that to achieve that, waste should be removed from all steps.

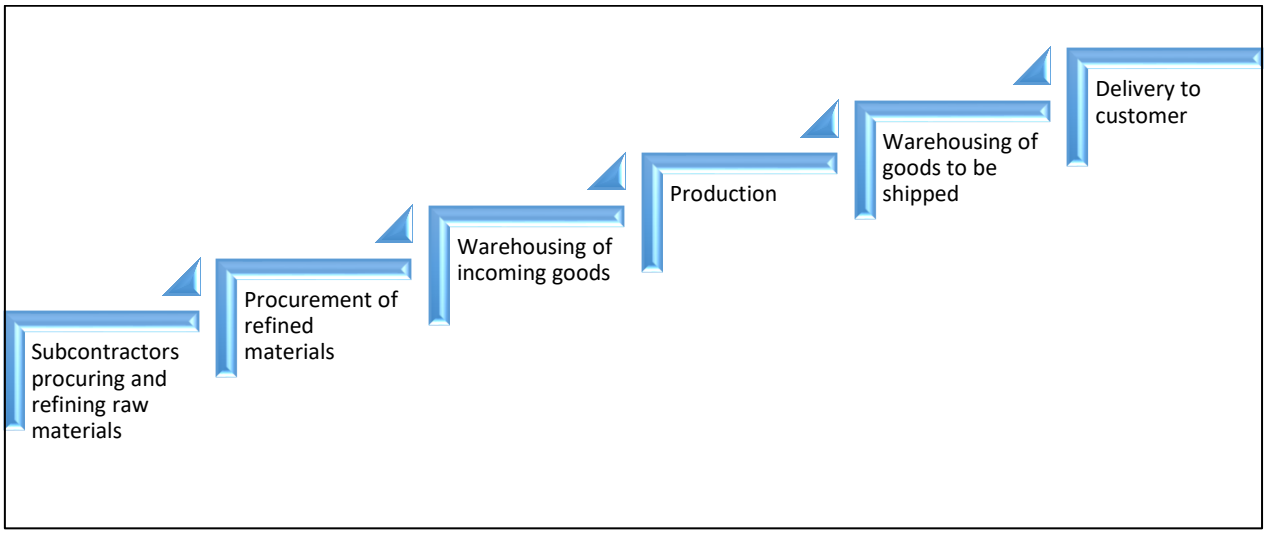

Figure 1. Example of value stream in company X.

When the value is defined and the values stream is mapped, Womack and Jones (1996, p. 21) say that the next step is to focus on flow. Womack and Jones (1996, p. 52) say that flow includes all movement from start to finish required to get the output to customer. It also includes activities between steps of value streams and activities within the steps as well. The aim is to have a constant flow with no waste at any point.

Womack and Jones (1996, p. 24) explain that pull is an important part of lean ideology because it highlights the change in thinking towards the needs of customer rather than doing things the way the producer has used to do. By contrast, Womack and Jones (1996, p. 67) explain pull by saying that an activity should only be completed if there is a demand for it. Figure 2 illustrates pull where the orange arrows illustrate demand which is referred to as pull in the context of lean thinking (Figure 2). Moreover, orange arrows also refer to information flow which indicates that the process in the previous step can begin (Figure 2).

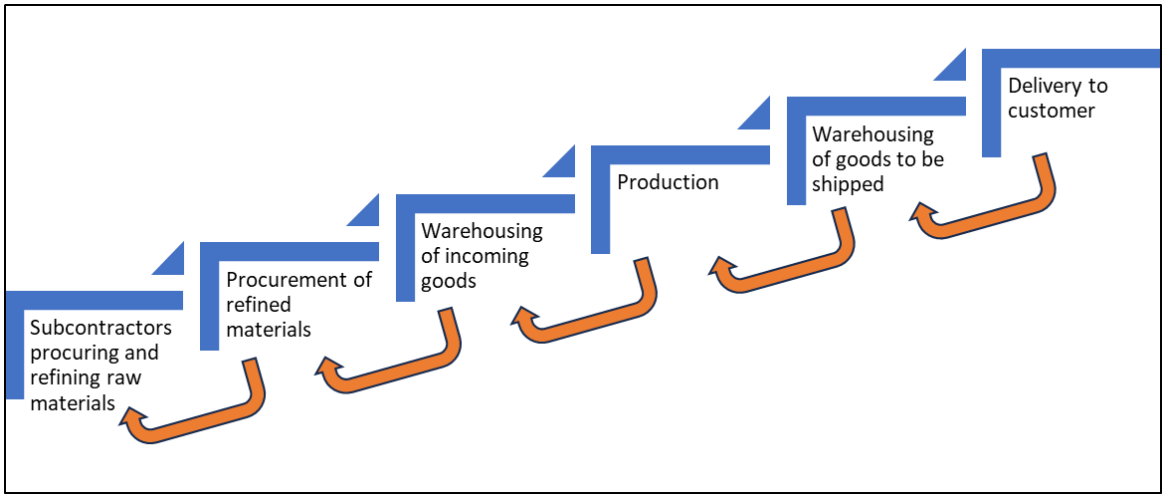

Figure 2. Example of pull in company X.

When the pull is implemented to whole value stream, it means that nothing gets done without a demand. However, Womack and Jones (1996, p. 67) remind that in practice a such establishment is difficult to achieve. Despite this the goal should be that no activity is completed unless there is a demand. The difference of push and pull are one way to explain the two different approaches of managing uncertainty that were presented at the beginning of this chapter 2.1.1. Push results in excessive or out-of-stock situation by nature because the driver for production is either a forecast or a fixed plan. On the other hand, as pull is based on demand there should not be an excessive stock or out-of-stock situation. On the other hand, as said, in practice it is difficult to implement because it would require seamless cooperation and information flow throughout the supply chain. To this end, even though an organization would be able to implement pull internally, the whole supply chain, including vendors, should be part of the implementation to make pull work seamlessly.

As stated, using pull in the value stream should be enough to manage the uncertainty and remove waste in the supply chain. However, there can be a situation where demand is not telling the truth. A such situation is called the bullwhip effect. According to Wang and Disney (2016) the bullwhip effect describes a phenomenon where the variability

increases when moving upstream along the supply chain. This means that the demand seems to be higher than it actually is.

Figure 3 illustrates the bullwhip effect. Demand from customers has only a small fluctuation, but the variability of the demand increases upstream. Therefore, one could argue that even if the pull were fully implemented, it cannot provide coverage against the bullwhip effect. It is possible that pull is not working as intended if the perceived demand is incorrect in case of a bullwhip effect is occurring and in that case the pull is not working as intended.

However, Wang and Disney (2016) point out a good quality information sharing can reduce the negative impact of the bullwhip effect. As said, information flow is an important part of pull. Therefore, if the information flow in pull were updated to take potential bullwhip effect into consideration, pull method could be able to adjust the production to match the actual demand.

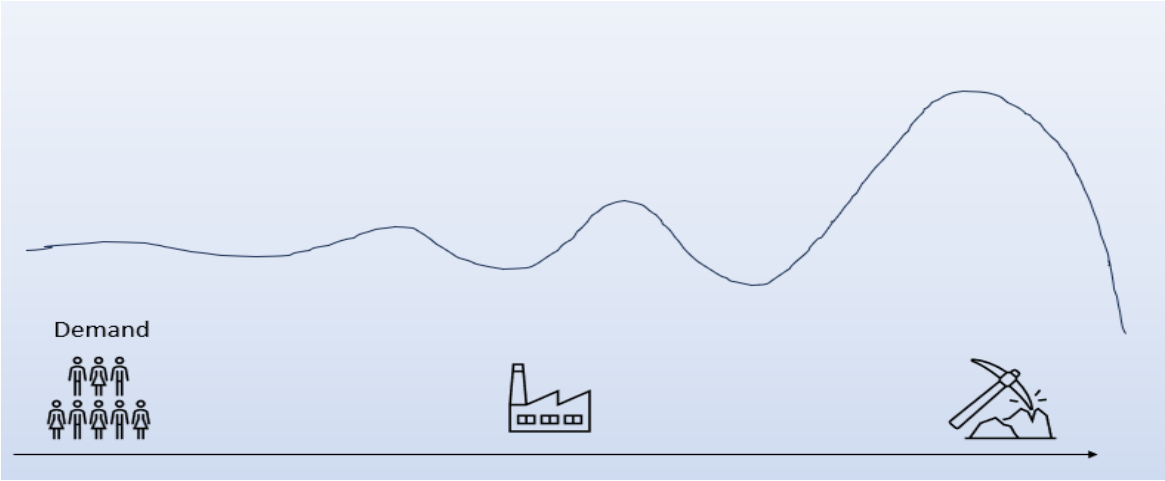

Figure 3. The bullwhip effect.

The fifth principle of lean ideology is perfection. Womack and Jones (1996, p. 25) say that in this context perfection means that the value definition, value stream, flow, and pull can be constantly improved. As stated, to reach zero waste can be difficult. On the contrary, that means that there will always be room for improvement. Womack and

Jones (1996, p. 26) say that there are always new technologies or concepts developed that are better than the previous ones. Therefore, even in the unlikely scenario that an organization would have a perfectly defined value, and value stream with no waste, constant flow, and pull, the perfection would only last for a moment because there would be a new technology or something occurring that could improve the organization.

To this end, perfection in the context of lean is an ideal which the organization should work towards. On the contrary, the state of complete perfection is practically unreachable. Therefore, the pursuit of perfection will create the cycle of continuous improvement which is beneficial.

Womack and Jones (2005, p. 42) say that mapping the value stream can be used to illustrate the whole value stream. To this end, Kumar et al. (2014) say that a value stream mapping tool can be used to identify the parts of the value stream that add value and the parts that do not add value. Moreover, they say that in addition to value stream mapping, lean tools such as 5S can be powerful tools in improving the performance of the SCM. To this end, the theory of lean has been applied into practice by many organizations. For example, a case study where lean thinking was used to improve the performance of a company in a manufacturing industry, resulted in major improvements in quality and productivity (Kumar et al., 2014).

2.1.2 Hoshin Kanri

Akao (1991) says that hoshin kanri is a methodology that can be used to align the daily activities performed by the organization with the strategic objectives of the organization. Moreover, he says that hoshin kanri is a methodology which systematically goes through one step at a time in order to make the change happen. To this end, he highlights that there are many factors to consider when applying hoshin kanri in practice. For example, one must define the core objectives, make sure that there are enough resources to achieve those objectives, and consider ways to measure the system in a bigger picture.

To be able to align the daily activities with the strategy, the strategy must be defined (Akao, 1991). Akao (1991, p. 124) says that strategic consideration can mean things like management philosophy, management vision, long-term management plant, and annual company policy. Moreover, he says that once the strategic considerations are in place, the responsible departments must be defined. The responsible department oversees the daily activities and ensures that those targets are reached.

Furthermore, Akao (1991, p. 5) points out that the plan-do-check-action -cycle is vital for hoshin kanri. It provides a method of control and highlights continuous improvement. In this context, plan refers to the policy defining and planning that was explained in the previous paragraph. “Do” means the concrete actions that are taken based on the plan. After actions, the results are checked and evaluated. In case the plan is not fulfilled, the cycle starts all over again.

In light of the previous paragraph, Akao (1991, p. 5) states that every decision in hoshin kanri should be based on actual data. Moreover, he says that a thorough data analysis is required to provide the facts of the topic which the decisions can be based on. To this end, data can provide bulletproof answers and facts of the topic. However, when conducting a data or statistical analysis, one must truly understand what they are measuring and analyzing. In case data analysis is the background of every decision, data quality must be ensured.

Yang and Su (2007) talk about an extension model that is based on hoshin kanri. The model was tested in a case study by Yang and Su (2007). The model is called EIDPER which is an abbreviation for six stages. The stages are envision stage, identify stage, diagnose stage, execute stage, and review stage. The first stage, envision, is about thinking how the organization would want to transform. Identify stage is about identifying ways to make the transformation happen and then setting key performance indicators, KPIs, to measure the progress. In the diagnosing stage, an analysis is

performed to find waste in the processes and after that concrete solutions proposals are proposed. In the prioritizing stage, the solution proposals are then put in prioritized order and then in review stage the proposals are put in action according to the order list. Lastly, the results are reviewed. The findings of the case study imply that the EIDPER model can be used to align the top management goals throughout the organization in an effective manner. Moreover, the findings of the case study show that it can support managing uncertainty in SCM, managing fluctuating demand, and supporting the growth of the business.

2.1.3 Management by Objectives

Humble et al. (1975, p. 18–19) says that MBO refers to a management system where the objectives of an individual employee are aligned with the objectives of the organization. Moreover, Humble et al. (1975, p. 11) clarifies that MBO considers the organization and the individual simultaneously. Therefore, they say that the requirements of the organization and the needs of the individual are taken into account. Furthermore, they say that MBO should not be considered as a totally different alternative to other management methods but rather as a method that aims to complement the other management methods.

Humble et al. (1975, p. 23–24) list the benefits for organizations when using MBO as a management method. They say that MBO approach assures that the whole organization focuses on tasks that impact profits rather than wasting resources on tasks that have no positive impact on profits. Moreover, MBO can support identifying defects in processes. Furthermore, the continuity in the organization can be improved since MBO impacts positively on succession planning. Lastly, MBO supports creating an organizational structure where the power and the responsibility is in the same place.

In addition to benefits for the organization, an individual can also benefit from MBO. Humble et al. (1975, p. 24–25) say that when the individual and organizational goals are

aligned, things like frustration and unclarity decrease. To this end, an individual has a better understanding of their objectives and what impact does the achievement of those objectives has for the business. Moreover, in organizations that use MBO, an individual has better chances for personal development and advancement in their career.

Antoni (2005) says that his study shows that MBO positively impacts the job satisfaction and the productivity of the team. However, he points out that these findings related to MBO are about the team, not individual level. He clarifies that MBO can be successful in organizations where the teams are able to do self-governing. Furthermore, he adds that more research is needed to prove causality of his findings. On the other contrary, Roth (2009) challenges the claim by saying that MBO can have a negative impact on things like teamwork and creativity. To this end, Humble et al. (1975, p. 83) state that the possible problems and negative impacts of MBO occur if MBO is not implemented as it is supposed to be implemented.

As stated, MBO highlights objectives which then obviously must be measured. To this end, Chamorro-Premuzic and Waber (2022) say that even though there is a large amount of data available nowadays, it can be difficult to provide hard facts that would support the view of the organization regarding the top employees. They claim that often the perceived success is image-driven and based on reputation rather than on hard facts. To that end, they highlight the importance of having organization wide and individual objectives that can be measured.

Therefore, Chamorro-Premuzic and Waber (2022) support the view of Humble et al. (1975, p. 83) that the possible problems related to MBO happen because of poor implementation of MBO. Moreover, Chamorro-Premuzic and Waber (2022) say that individual employees must understand the KPIs that affect them and how they impact the organization. They add that it is important that employees are included in the process of KPI definition so that the process is inclusive. They justify their claims by

saying that the need for organization wide collaboration is constantly increasing and therefore a fair, transparent, and inclusive KPI usage is vital.

2.2 Performance Measurement in Supply Chain

Kaplan and Norton (1996, p. 21) say that measurement of targets is vital for organizations just to survive in the competition. Moreover, they say that if something is not measured, it cannot even be managed. Kaplan and Norton (1996, p. 2) say that BSC supports leaders and employees of the organization to understand the goals and targets that the organization wants them to achieve.

Ramaa et al. (2009) agree with the previous paragraph and say that that in order to have a successful supply chain and be successful in SCM, organizations have to measure the performance of the supply chain. To this end, Morgan (2004) says that supply chain has a lot of untapped potential when it comes to significantly improving the business. Moreover, he also says that performance measurement plays a big role in this. To this end, Elrod et al. (2015) agree with the importance of measurement but in addition they state that choosing the correct KPIs is also vital even though choosing the correct KPIs can be difficult.

2.2.1 Strategy Maps

Kaplan et al. (2004, p. 27) say that the strategy of the organization illustrates and explains how the organization plans to generate value to all stakeholders. Moreover, they point out that in case a vast majority of the value of the organization exists because of intangible assets, strategy creation should focus on those. Therefore, value, yet again, is in the essence of this theory as well.

Kaplan et al. (2004, p. 51–52) say that there are four value related points of view that should be aligned and linked in order to generate value by using intangible assets. The first point of view is that value is generated indirectly. In practice, this means that the training of employees does not directly improve profits, but it can improve processes which then at some point generate more profits as well. The second point of view is that value is related to context. This means that a value adding activity might not necessarily add as much value in other organizations. Third point of view is that intangible assets do not have a market value, but they have a potential value. The last and fourth point of view is that intangible assets are worth nothing alone. Intangible assets require other intangible assets or physical assets to complement them.

Now that the relation of intangible assets is explained, it can be discussed how the intangible assets can be linked to actual processes that generate the value. Kaplan et al. (2004, p. 52–54) say that there are four perspectives that illustrate it. They say that this type of strategy map is called BSC. The four perspectives in it are financial, customer, internal as well as learning and growth.

Kaplan et al. (2004, p. 52–54) says all four perspectives in BSC have a purpose in terms of value generation. Kaplan et al. (2004, p. 52–54) say that financial perspective defines how intangible assets are converted into value. The customer perspective illustrates the factors that customers consider as value. Internal perspective refers to processes where intangible assets are converted into tangible value. Lastly, the perspective of learning and growth defines the different intangible assets that can be integrated into value generating assets.

Figure 4 illustrates the position of BSC and strategy maps within the hierarchy of different ways an organization addresses its' goals and reason for existence. To this end, Kaplan et al. (2004, p. 54) say that everything in the organization starts by defining mission since mission explains why the organization even exists in the first place. Moreover, they say

that strategy maps illustrate the strategy whereas BSC focuses on performance indicators.

Pirnay (2021) claims that strategy maps can have problems related to accuracy which results from bias that occurs because of using soft data. To this end, she says that since strategy maps are used to support decision making such errors should not exist. Therefore, she suggests that instead of soft data, organizations should use hard data and have a data-driven approach when it comes to strategy maps. She says that a data-driven approach would reduce the errors caused by bias and soft data.

Armstrong (2019) says that strategy mapping as a tool has potential that is not always fully achieved. Moreover, he also challenges the original idea of strategy maps but for a different reason than Pirnay (2021). Armstrong (2019) says that strategy mapping should be separated from BSC. Moreover, he says that the theoretical framework of strategy map is not fully aligned with the reality that organizations face. Therefore, he suggests that to grasp the full potential of both tools, strategy maps and BSC, they should be separated. To this end, he adds that his findings suggest that strategy map should not necessarily be associated with a single tool, BSC for example, but instead strategy map should be seen as a tool of its own to grasp the full potential of it. The statement of Armstrong (2019) is contradictory with Kaplan et al. (2004) since BSC has traditionally been linked with Strategy Maps.

Figure 4. Strategy Maps and BSC in the organization (adapted from Kaplan et al. (2004, p. 55).

2.2.2 Balanced Scorecard

As already stated in previous chapter, Kaplan and Norton (1996, p. 2) say that BSC has four perspectives. All four perspectives have an important impact on the performance of the organization. Furthermore, Kaplan and Norton (1996, p. 2) explain that the reason for BSC is to convert the intangible mission of the organization into measurable metrics which support fulfilling the mission. To this end, Kaplan and Norton (1996, p. 147) say that BSC can communicate the strategy of the organization to employees.

Kaplan and Norton (1996, p. 199) say that BSC increases transparency of the strategy of the organization, and it makes it easier for employees to understand the strategy because BSC makes strategy more tangible. Moreover, they say that the transparency that BSC creates makes it easier for employees to suggest actions that improve

performance since employees have a clearer understanding of the strategy. Therefore, a well-designed BSC can be a good way for the top management to communicate strategy.

Bhagwat and Sharma (2007) say that there are certain steps to consider when implementing BSC in practice in an organization. The first two steps are connected. Firstly, data regarding strategy and objectives for all four perspectives needs to be gathered and at the same time the BSC concepts must be made familiar in the organization. After that, objectives can be decided and finalized, which allows the creation of the first version of BSC. Next, one should ask for feedback and improve BSC based on the comments. Finally, BSC needs to be well communicated with all employees within the organization. Moreover, Balfaqih et al. (2016) agree with the steps. To that end, they add even though performance measurement in SCM has been studied for a long time, there is still room for additional research.

In light of the previous paragraph, Bhagwat and Sharma (2007) say that aligning the objectives of the individual employee with the defined objectives of BSC will boost the impact of BSC. This claim supports the discussion on chapter 2.1.3 where the poor implementation of MBO was mentioned as the reason for failure of MBO. Therefore, properly created BSC can support MBO since BSC makes it easier for employees to understand the metrics they are measured on.

Bhagwat and Sharma (2007) say that BSC should measure the daily operations of the organization. Moreover, they say that there is a risk that the created metrics in BSC can be contradictory to one other. Therefore, it is crucial that the metrics and how they are linked to each other are properly understood. For example, if the value of inventory is aggressively decreased, it can impact the delivery reliability because there might be component shortages.

A case study by Balaji et al. (2021) points out that the set targets are not always achieved. They say that the uncertainty of an organization’s capability to reach targets impacts

predictability and forecasting if the performance is not what is expected. Therefore, they say that understanding the reasons why metrics are not reached is important for organizations. The relation of different BSC perspectives is also important to understand. Furthermore, it is important to choose the right metrics and evaluate them from time to time. BSC has four perspectives that are suggested to be measured.

However, in the modern era, sustainability is constantly a more important factor. Therefore, Tseng et al. (2019) say that a sustainable supply chain should also consider measurable perspectives such as financial, environmental, social development related, and also risk related metrics. To that end, they claim that measures regarding social development in the supply chain are the most important one when it comes to sustainability of the supply chain.

Shafiee et al. (2014) argue that even though BSC seems to be a good way to compare different decision-making units, it actually is not. They justify their claim by saying that BSC cannot tell which of the decision-making units are efficient and which are not. There can, for example, be different number of resources and competencies, baselines, and different customers. To this end, the BSC approach might be too simplified. Therefore, this only highlights the importance of understanding the metrics in BSC as well as the differences in sub-organizations. On the other hand, as Shafiee et al. (2014) suggest, BSC might not be suitable to compare different sub-organizations and other tools might be needed in addition to benchmark sub-organizations with each other. To that end, Shafiee et al. (2014) say that if data envelopment analysis is used with BSC, the efficient and inefficient decision-making units can be recognized more effectively. Xin and Li (2011) also say that data envelopment analysis is a proper method to evaluate supply chain. However, they do not discuss the connection with BSC. To this end, Shafiee et al. (2014) say that previous research is insufficient so more research regarding this topic is needed.

2.3 Data and Business Intelligence

This part of the thesis addresses topics that support the successful creation and implementation of the *Power BI* tool. Therefore, topics covered are *Data and Supply Chain Performance*, *Building of a Business Intelligence Tool*, and *Data Culture*. Before sub-chapters, data and business intelligence are being discussed.

Data can be used to support decision making. BI refers to data systems that provide data-driven support for decision making (Power & Sharda, 2015). Moreover, Esposito et al. (2022) define BI as technology that allows to work with data in a way that improves the performance of the organization. Therefore, data can be used to improve the performance of the business or that is the aim at least. This is easier said than done. To this end, Bean (2022) states that only one in four organizations is a data-driven organization. Moreover, DalleMule and Davenport (2017) add that the utilization rate in decision making for data in a structured format in the organization is not even 50 %. They also say that the numbers are even worse for unstructured data where the utilization rate is below 1 %.

Fantini and Narayandas (2023) say that there are three different approaches one can take when conducting analytics that are **descriptive**, **predictive**, and **prescriptive**. **Descriptive** analytics means business intelligence and analysis of what has already happened or what is already known. **Descriptive** analytics aim to support the understanding of what has happened. On the other hand, **predictive** analytics can also be called prediction engines. **Predictive** analytics aims to provide support for decision-making. **Prescriptive** analytics means decision automation. **Prescriptive** analytics aims to provide a solution and tells what should be done. Overall, when deciding what approach to use, one should remember that there needs to be a balance between the use of data and humans to achieve the most successful outcome. Moreover, the approach should be selected case by case and the availability of data is also an important factor.

Furthermore, Fantini and Narayandas (2023) says that descriptive analytics can be a support on a daily basis. They add that it can, for example, be in the form of a dashboard. However, they warn that descriptive analytics performed by employees in the organization can be affected by bias. For example, a person can use descriptive analytics to search for confirmation for their opinions and views that were already made before analytics. Then again, they say that descriptive analytics is able to guide leaders in the right direction and is often a suitable option because descriptive analytics is relatively easy to set up compared to the other two approaches.

Even though predictive analytics is supposed to predict the future, Fantini and Narayandas (2023) say that forecasting and predicting the future is extremely difficult. Moreover, they add that in order to forecast the future, one model is probably not enough which can make predicting more complex. They also point out that the objectives of the people working with data might not be aligned. What they mean by this is that a data scientist is interested in the accuracy of their model whereas a business analyst is interested in the impact of the analysis. They say that predictive analytics can, for example, be used for demand planning.

Fantini and Narayandas (2023) state that prescriptive analytics have the power to provide most value of the three analytic approaches. However, they point out that this approach can be the most expensive and the most difficult one to implement. They say that prescriptive analytics is suitable to use when, for example, one aims to optimize inventory levels.

2.3.1 Data Culture

DalleMule and Davenport (2017) highlight the need for data strategy in the organization. They consider **data offense** and **data defense** as the critical factors when considering data strategy. Data defense is about reducing risk by providing data utilization as support for compliance and regulatory related activities. On the other hand, data offense is about

supporting the business by creating impact on business and increasing the value for customers. DalleMule and Davenport (2017) highlight that the key fact to remember is that both data offense and data defense need to be considered and some kind of balance is required between them.

DalleMule and Davenport (2017) list the differences between data offense and data defense. The main activities of data offense consist of things like data analytics, modeling, and visualization whereas data defense consists of data standardization, methods for data storage, and data access. From the data management point of view, data offense is about flexibility whereas data defense is about flexibility.

However, Sainam et al. (2021) state that it is rare that an organization is capable of fulfilling the created data strategy. They say that by assessing seven data performance and usage related dimensions, an organization can tell if it is performing well in the field of data usage or not. The seven dimensions are culture, leadership commitment, operations and structures, skills and competence, aligning strategy and analytics, proactiveness, and empowering employees. The next paragraphs will discuss how organizations can improve data usage by considering these dimensions.

Bean (2022) states that almost all CEOs say that cultural aspect is the biggest barrier when an organization tries to transform into a data-driven organization. He adds that technology required for useful data usage is there but because of difficulties in data culture, the creation data-driven organization remains to be difficult. Therefore, the creation of data culture plays a big role in the attempt to become a data-driven organization.

Waller (2020) says that there are ten steps that are needed to take when creating data culture. Table 1 shows the ten steps. Lead by example means that top management needs to show the way and make it clear that decisions need to be backed with data (Table 1). Choosing KPIs is important because they are a way to tell employees what

things are the most important once for the organization (Table 1). Data scientists should work in close collaboration with business leaders because data scientists are experts on data, but business leaders have the expertise about business (Table 1). There can often be issues with data access and that should be an easy but an impactful fix (Table 1). Quantifying uncertainty means that it should be standard to determine the confidence level of data because absolute certainty is extremely difficult to achieve (Table 1). Creating a proof of concept is a good way to introduce something concrete that then can be modified and replicated in the organization (Table 1). Sufficient training is vital because that is the only way to ensure that people in the organization have the skills needed to work with data (Table 1). The aim of data analytics does not have to be limited to providing more value to customers, but it can also be used to support all stakeholders (Table 1). Data consistency is key and, in this context, it means that there should be unified sources of data in the organization because otherwise the consolidation of data becomes difficult (Table 1). Lastly, data analysts should provide an explanation why a certain analytical choice was taken so that the one reading the analysis will understand the potential tradeoffs that the choice causes (Table 1).

Table 1. 10 Steps to achieve data culture (adapted from Waller, 2020).

10 Steps to achieve data culture
1. Lead by example
2. Choose KPIs
3. Close collaboration between business leaders and data function
4. Fix data-access related issues
5. Quantify uncertainty
6. Create proof of concept
7. Offer sufficient training
8. Data analytics can be used to support all stakeholders
9. Data consistency in the organization is key
10. Explain the taken analytical choices

AlOwaish and Redman (2023) say that there are two vital things to consider when creating data culture. Firstly, the basics of data must be ensured. This means that data quality is the place to start from since data quality is essential. Secondly, it is important to get everyone involved in the organization. In practice this means that it should become a norm in the organization to understand that everyone is same time creating data and utilizing data on a daily basis. To create data culture, AlOwaish and Redman (2023) mention the same things as in Table 1. For example, they say that training, proof of concepts, leading by example, and fixing data-access issues are important when creating data culture.

Training provides a concrete way for people to get hands-on experience in data usage and as mentioned it is important from a data culture point of view. Bersin and Zao-Sanders (2023) say that organizations should provide training for employees to improve their data skills. They say that for example, the ability to ask right questions, make insights out of data and overall data handling skills can and should be taught to employees.

To this end, Redman (2022) also points out that training of the current people is important. He says that is not enough that there is a centralized function consisting of data scientists. He explains that even the best data analytics tools are not beneficial if employees throughout the organization do not know how to use them. Therefore, he encourages organizations to use and train the employees they already have since it is essential when trying to be data driven.

2.3.2 Data and Supply Chain Performance

As said in chapter 2.1, there are many operational activities related to SCM. To improve SCM, organizations have tried to create tools to achieve better results. That said, Detwal et al. (2022) say that organizations constantly emphasize and aim to lean towards data bases decisions. To this end, Esposito et al. (2022) highlight the importance of having a

BI tool to analyze the whole supply chain with real time data. As a solution they say that a centralized BI tool which has an overview of the whole supply chain is beneficial for the leaders to make decisions.

Wantao et al. (2017) state that data-driven supply chain improves supply chain capabilities and supply chain responsiveness. Moreover, both of these improvements positively impact the financial performance as well. Chavez et al. (2017) add that a data-driven approach for SCM also increases customer satisfaction. However, Wantao et al. (2017) and Chavez et al. (2017) point out that research in this field is still scarce, but their study supports the claim that data-driven approach is beneficial for SCM.

Upadhyaya and Kakkad (2020) say that when measuring supply chain, the focus should be on metrics that are aligned with the manufacturing strategy. Moreover, they say that data can be used to improve supply chain activities related to manufacturing strategy like forecasting, planning, and risk management. They say that because there is a trend in outsourcing, risk management because more important. That requires accurate forecasting in which data usage can be helpful.

As said in chapter 2.1.1, information sharing is vital for pull and thus important for risk management. Likewise, Urcioli and Hintsa (2018) highlight the importance of information sharing in supply chain to mitigate the negative impacts of supply shocks. They say that the use of data can give more time to react to occurring problems as data can reveal possible problems earlier. They add that lack of, or poor information sharing could in fact be a cause for bullwhip effect which was also addressed in chapter 2.1.1.

Similarly, Anitha and Malini (2018) also highlight the importance of data analytics as a support for supply chain. They say that because there can be supply shocks and overall volatility in the markets, advanced use of data analytics can be beneficial for supply chain. To this end, Trkman et al. (2010) state that organizations that use data as support for supply chain tend to outperform the ones that do not. They say that organizations

already have the data, and they just need to use it. They add that the point is that it is beneficial to back decisions with data.

2.3.3 Building of a Business Intelligence Tool

Esposito et al. (2022) say that organizations understand the potential benefits of BI tools and make big investments to acquire such tools. However, they point out that many times, the implementation of BI tools is not easy. They say that to make BI tools work the starting point should be to determine KPIs and data analytics needs for the organization. This supports the 10 steps presented in Table 1 where the close collaboration between data and business functions is highlighted.

Bersin and Zao-Sanders (2023) that there are few things that are especially important when conducting data analysis. They say that characteristics of good analytics include factors like storytelling-like way of explaining results, simple visuals, and ability to show meaningful visuals. These characteristics are not directly related to building of dashboards, but they can be applied to dashboards as well.

Barton and Court (2012) say that data usage can be a game changer for an organization, but it needs to be done correctly. They say that firstly, choosing the right data is vital since there is so much data available, one must be able to utilize the data that provides most value. Secondly, with the right data, organizations can build models to boost and optimize their business. Thirdly, as already said in chapter 2.3.1 training is vital and Barton and Court (2012) agree with that. They add that the purchase or even 38implementation of data analytics tool is not enough if employees do not know how to use it.

Ladley and Redman (2020) point out that it is still a common problem for organizations to embed data usage into the strategy of the organization. They also point out that it is common that organizations are unable to align the data utilization to match the needs

of the business. However, they say that if an organization manages to embed data usage to strategy and as support provider for business, it will improve the competitiveness of the organization. Therefore, data usage must be a factor to consider when creating and adjusting the strategy of the business.

Diplock et al. (2018) say that the way to start improving the data usage an organization should identify the current status of the current ways of data usage, starting by creating something small, continue by building a toolkit, and lastly have employees who preach about data usage inside organizations. Furthermore, they say that there are three basic components of good characteristics of data analytics. Firstly, find people who have the ability to combine data analytics skills with knowledge of the business. Secondly, make it standard that data analytics results in concrete action proposals. Thirdly, create a team of people who are highly skilled in data analytics who then create ways of working and toolkits for the organization.

Likewise, Desai et al. (2022) say that often organizations realize the potential impact of data usage but they simply fail or do not even know how to achieve the potential. Desai et al. (2022) offers product management like thinking as solution to this. They explain that organizations should consider data and potential offerings built from data similar to as products that are sold to customers. In practice this approach simply means that organizations should build data tools that different departments, business leaders, and employees need in order to make the most of their roles. To conclude, they say that a simple solution is to build what customers want but, in this context, customers mean data users.

From the technical point of view, Esposito et al. (2022) say that building a BI tool with real time data is beneficial. Having data available all the time is obviously better and more user-friendly than having to ask for updates or ad hoc reports. There are a variety of BI tools that provide the capability to build a tool like this. Khatuwal and Puri (2022) say that *Power BI* and Tableau are such tools. They say that these BI tools allow

organizations to build dashboards that can, for example, be used to create dashboards for senior leadership, analysis tools, and interactive reports. There are also other similar tools and even Excel could be used as such a tool. However, as this study is delimited of using *Power BI*, there is no need for a detailed comparison of different alternatives.

Khatuwal and Puri (2022) say that the benefit of Tableau is that it is fast in visualizing data and also fast at integrating data. The reports and dashboards can be created in the desktop version of Tableau but there is also a web version, Tableau Online, which makes sharing of the dashboards and reports easier. Tableau is also easy to use. Similarly, *Power BI* is also easy to use and there is a variety of visualizations to choose from. Moreover, it is also fast to set up and it is easy to integrate with current IT systems.

Kalé and Jones (2016, p.183–185) explain that there are some key elements that should be considered when creating a report. First, the report must be easy to understand because if the report cannot be understood, there is no point. It is also important that the report is available and accessible at the time when it is needed, and the data used in the report must obviously be reliable. Lastly, all data needed for decision making should be included in the report but at the same time the creator of the report should only add data that is relevant to the user.

Kalé and Jones (2016, p.183–185) explain that building a report is quite straightforward and there are only three steps that are illustrated in Figure 5. Kalé and Jones (2016, p. 187-189) present the steps as steps for creating a report. However, a similar method can be applied to building a BI tool because the idea is same. Kalé and Jones (2016, p. 187) say that the on creating a report should start with identifying the requirements and needs of the users. There is no point in creating a tool which no one will use so therefore it makes sense to ask what is needed beforehand. Kalé and Jones (2016, p. 187) say that finding the data sources that are needed to provide the required report is also important and the creator of the report should consider a variety of sources since not all information is necessarily at the same time. Moreover, they say that sometimes data

needs to be combined to get the desired data. Kalé and Jones (2016, p. 189) say that the point of the third step is to visualize data. They say that vital things to consider are clarity, simplicity, and that the data is summarized in a reasonable way.

Figure 5. Steps for building a BI tool (adapted from Kalé and Jones (2016, p. 187-189).

3 Methodology

The methodology of the thesis will be presented in this chapter. This thesis is an abductive case study that uses a mixed method methodological approach. The quantitative dimension in this thesis included the survey method where respondents gave numerical answers to a survey. On the other hand, the qualitative dimension in this thesis was reflected by having a close collaboration with the case company throughout the thesis project. For example, there was a workshop, constant discussion between milestones, and discussions based on the answers given by the respondents. These concepts will be explained in this chapter. After that, there will be three subchapters. Firstly, the first subchapter explains the selected method which is information system design method. Moreover, the case assignment is also explained. Secondly, the data collection process and survey related to is presented. Thirdly, the last part of the chapter discusses the reliability and validity of this thesis.

Yin and Campbell (2003, p.13–14) describe case study as an empirical method which aims to conduct the study in the real-life context of the studied phenomena. In this thesis, the objective is to improve the reporting and the performance of the case company with a data-driven approach. Moreover, the aim is to build a BI tool with *Power BI* which achieves the objective. Therefore, a case study is a suitable research method for this thesis.

Schwartz-Shea and Yanow (2011, p.28) say that deductive and inductive reasoning follow a linear step-by-step logic which relies on general principles. On the contrary they say that abductive reasoning in research can be like solving a puzzle or surprise. For example, in orienteering, people navigate from one place to another step-by-step whereas the process of solving Rubik's cube is not straightforward. Similarly, the research in this thesis is not linear because the goal is not only to build a data model that is theoretically a good data model, but the goal is to have a BI tool that achieves the objective of the thesis. Moreover, Schwartz-Shea and Yanow (2011, p.28) point out that abductive reasoning in

a study also aims to provide explanations to understand the puzzle-like characteristic better.

If the goal of this thesis were to build the best possible BI tool from data architecture point of view, the process would be linear. However, this thesis aims to build a BI tool which improves the reporting and performance of the case company so there are multiple factors to consider. Moreover, there is no clear linear way of constructing a BI tool from this kind of starting point so that is why this thesis is abductive study. In this context, the building of the BI tool is like solving a puzzle so abductive study is a suitable approach in order to achieve the objectives of the thesis.

Farquhar (2012, p.6) points out that when conducting a case study, the studied phenomenon can be studied in its actual context. Moreover, he adds that when the case study is done as an assignment for a company, case study method means that the researcher needs to collect evidence of the studied phenomenon. To this end, this thesis aims to collect evidence that data-driven approach is an approach that can and should be used when a company wants to improve its reporting and performance.

Cresswell (2017) says that mixed method study has a qualitative and quantitative dimension. However, Matović and Ovesni (2020) point out that mixed method is not a study where the qualitative and quantitative dimensions are separated from each other. To this end, they add that optimally both of these dimensions are complementary to each other in mixed method research. This thesis aims to use both dimensions as complementary to each other. This will be explained in more detail in the upcoming paragraphs.

Gilham (2010, p.10–11) states that even though case study can have a quantitative dimension as well, the qualitative dimension is the primary. He explains that by having a qualitative dimension, the researcher can see the studied phenomenon from the point of view of those who are concerned by the results. In this thesis, the ones that fill the

survey and are interviewed are the ones who will be using the *Power BI* tool. Therefore, it is vital to have the qualitative dimension in order to build a tool that actually supports the people who are going to be using it.

Gilham (2010, p.80) says that a quantitative dimension of the case study can clarify the study and support the case study. He adds that the reason for this is that numbers tend to have a clarifying effect. That is the very reason why quantitative dimension is also included in this thesis. Moreover, the aim is to be more data-driven within the company, so it also makes sense to have quantitative results as well for the thesis as well.

As the reasoning in the previous paragraphs suggests, the abductive mixed method case study is reasonable methodological approach for this thesis. Having a mixed method approach allows to really dig into the research problem to truly understand the topic and provide answers to research questions, but at the same time the quantitative dimension compliments the qualitative dimension by providing numbers and statistics.

3.1 Information System Design as a research Method

Helo et al. (2019, p.27) explain that information system design is a method where either a new design or the full implementation of an information system is being conducted. They add that it is important that the design or the full implementation matches with the desired user requirements and that it is aligned with the objectives of the organization. Moreover, they add that this method can have similar characteristics as a process improvement method would have.

Al Kilani and Kobziev (2016) conducted a study where they researched the different methods that can be used when researching information systems. They discussed the pros and cons of qualitative and quantitative approaches. Moreover, they also addressed case studies. Qualitative and quantitative dimensions can both be used and as they both have weaknesses and strengths, this thesis is a mixed method study where it aims to

utilize the strengths of both. Moreover, Al Kilani and Kobziev (2016) state that case study is a suitable method to use in information systems related research and therefore it is justified to use it in this thesis as well.

Article by Peffers et al. (2007) explains how to perform information systems related research by using design science. They created a methodology and tested it in four case studies. The methodology they created provides a six-step approach for information systems related research. This thesis follows these steps as there is an identified problem. Objectives are also set. The built tool will be fully implemented so there will be a demonstration. The success is evaluated by using surveys and the results are being communicated in the case company and in this thesis.

Hasan (2003) states that information systems related research can provide insights and support the completion of different processes in the organization. For example, information systems related to research can support social processes and thus improve interaction within the organization. This again confirms that the information systems design method indeed is a suitable research method in this thesis.

The concrete output from the point of view of the case company is to build a *Power BI* tool. Therefore, information system design was selected as a method for this thesis. To this end, the output will not be a design, it will be a full implementation. Helo et al. (2019, p.28) say that in the information system design method the data can, for example, be collected by conducting interviews to find out the requirements of the users or surveys to measure the results.

To conclude, information system design is suitable when considering the purpose and objectives of this thesis. Moreover, information system design method is backed by previous literature. Therefore, it is viable to use this method in research and especially in this kind of research where a BI tool is being built.

3.1.1 Case

Simons (2009, p.28) highlights the need for thorough planning when conducting a case study. To this end, she says that the design of the case study as well as the actual conduction of the study require a lot of thinking. Moreover, she explains that the researcher is required to deepen their understanding of the topic already before the research has even begun. Therefore, before the research plan, a lot of preparations were already made for this thesis.

Firstly, there was a kick-off workshop which included many people in multiple functions. The goal of this workshop was to gather information about current data usage and identify processes or ways of working where a data-driven approach could improve the reporting and performance. Moreover, there were also a lot of one-on-one conversations conducted between the researcher and various employees in order to gain a deeper understanding of the topic. Based on the workshop and discussions after that, the research plan was created, and the objectives, and the desired output were clarified.

In conclusion, to complete the assignment and fulfill the requirements of the assignor, a *Power BI* tool is built. Moreover, the research questions and answers to them are going to be used in the building of the tool. Moreover, the theoretical framework is also used as a support so that the *Power BI* tool supports the concepts and management styles that the case company uses. Lastly, the research was funded by the case company.

3.2 Process of Data Collection and Data Analysis

The data for this thesis was collected via surveys, interviews, and from the data systems of the case company. There are two surveys. The purpose of the first one was to understand the status quo and the purpose of the other survey was to evaluate the success of the case study. To this end, the idea of the first survey was to evaluate factors

like how often data is used, does it play a significant role in decision making, do users find current data usage sufficient, and what could be improved. The second survey measured whether the new *Power BI* improved the reporting and performance of the case company.

Brace (2018, p.50) says that the longer the survey takes to complete, the less the respondents are paying attention to their answers. Moreover, he says that when designing a survey, one should pay attention to that are the questions really needed. By only having questions that are actually needed to achieve the objectives, the length of the survey can be kept as short as possible so that the respondents are more likely to focus on the survey. To this end, Brace (2018, p.3) adds that the one who will use the survey has to rely on that the people answer as truthfully and to their best capabilities as possible. Therefore, to avoid the problems of a too long survey with meaningless questions, both surveys in this thesis only have ten questions.

Interviews are also used to gather information in this thesis. Interviews were already conducted before the research plan to gain deeper understanding of the topic so that the research plan and the research would have the best possible outcome in relation to the assignment. The interviews conducted were semi-structured because the aim is to build a tool for the people that are also going to be interviewed so it was not optimal to limit the potential ideas by having a too structured approach. The interviews were conducted as part of a workshop where people from multiple functions were gathered to discuss potential data usage. In practice this meant that the workshop had a clear structure which was guided by using a Power Point presentation. The purpose, objectives, and research questions of the thesis were presented so that the participants understood the context. To this end, the presentation guided participants to discuss and point out current problems related to data usage. Therefore, the workshop was linked to the first and second objective because the aim was to identify potential improvement ideas in relation to user experience and performance and reporting. The participants in the workshop are the same people as respondents in the survey.

Brinkmann (2018) says that an interviewer should use semi-structured interview when they try to understand the phenomenon from the point of view of the one being interviewed. He continues by saying that while a semi-structured interview has some structures which in practice mean certain themes or questions, there should also be plenty of room for open discussion. A semi-structured interview was chosen as an interview method in this thesis so that there would be more spontaneous discussions.

The tool used for data analysis for the collected data via surveys was Excel. Excel was used to consolidate the answers of the respondents. Excel was also used to create descriptive charts which are presented in chapter 4. Moreover, the verbal assessment of the results was also part of the data analysis which can also be found in chapter 4.

As said, the arranged workshop was a semi-structured interview. The data collected from there was organized into different groups and themes in Excel. Similar problems and ideas were gathered into the same group. The consolidated data was analyzed together with the participants of the workshop. The analysis heavily influenced the structure of the built *Power BI* tool which is presented in chapter 4.

Data from the company database was collected from the ERP system of the case company. The collected was used to build the *Power BI* tool. Table 4 in chapter 4 contains KPIs of the case company. The collected data from the database was used to gather the information and data needed in relation to KPIs so that the *Power BI* tool could be built.

3.3 Reliability and Validity

Fàbregues and Molina-Azorín (2017) say that mixed method studies tend to have difficulties with evaluating quality. They claim that there are difficulties with this because the standardized core for the quality criteria is not determined. Therefore, there is no common way of evaluating reliability and validity because this thesis is a mixed method

study. However, that does not mean that reliability and validity could not be evaluated. The different methods used to evaluate and ensure reliability and validity are discussed in the upcoming paragraphs. Moreover, the selected methods used in this thesis are also discussed.

Carmines and Zeller (1979, p.9) explain that reliability is referred to when determining the consistency of a measurement in research. Furthermore, the point of evaluating the reliability of the research is to find out that the results stay the same even though the same survey were to be conducted multiple times. Therefore, if the consistency of a survey is high, then the reliability is also high.

Carmines and Zeller (1979, p.37) say that there are four standard ways to evaluate the reliability of the selected measurement method which are, the split-halves, retest, alternative-form, and internal consistency method. Split-halves method is a way where the selected measurement method is divided into two halves and after that the two halves are statistically compared to each other (Carmines and Zeller, 1979, p.41). Retest method is a way where the respondents or test takers perform the same survey or test again and after that the results of these two occurrences can be tested (Carmines and Zeller, 1979, p.37). Alternative-form method is somewhat similar to retest because a second test is also conducted after the first test. The difference is that in alternative-form method, the second test is different than the first test, but it has the same measurement purpose (Carmines and Zeller, 1979, p.41). Lastly, the internal consistency method is a method to measure and evaluate the consistency within the same test by having questions that can be compared to one other (Carmines and Zeller, 1979, p.44).

In this thesis, respondents themselves create a strong basis and foundation for reliability. Respondents are highly experienced employees who work for the case company in leadership and managerial positions. Moreover, the assignment for this thesis was given by them. The assignment was to build a *Power BI* tool to be used by the respondents. Therefore, they are also best at evaluating the outcome and the impact of the *Power BI*

tool as they are the ones who requested and set the expectations for the output of the thesis.

On the other hand, the delimitations and limitations can also affect the reliability of this thesis. For example, the number of respondents is only ten. However, the respondents are part of the leadership team of the case company, so they have a good understanding of the bigger picture compared to specialists and thus it can be argued that they are better at evaluating the impact of the *Power BI* tool on the reporting and performance of the case company. Therefore, a smaller number of respondents is justified but the potential impact on reliability is considered.

To conclude, the strong basis and foundation for the reliability explained in the previous paragraphs is the backbone of the reliability for this thesis and case study when considering that RQ1 is directly about the case company. To this end, when evaluating the impact of a single tool on the entire case company, the ones leading the case company are the best ones to evaluate it especially when they have set the expectations for the tool. RQ2 attempts to find an answer to a more general level. To support the reliability in the context of RQ2, a thorough literature review was conducted to find supporting evidence as a single company case study cannot be generalized. However, even a single case company study can give indications in relation to RQ2.

In addition, internal consistency is used to calculate and determine reliability of survey 2, but as the number of respondents is only ten, it is important to note that a single answer can heavily impact on the result of reliability measuring. Internal consistency was used in survey 2 as that was the survey that was used to evaluate the results.

Internal consistency was applied to this study by calculating Cronbach's alpha which is a statistical measure to evaluate internal consistency (Carmines and Zeller, 1979, p.44). Cronbach's alpha is a mathematical formula for it was created by Cronbach (1951). In this thesis *Datatab* is used to perform the calculation.

The purpose of the thesis was to improve performance and reporting of the supply chain in the company in a data-driven way. The questions in survey 2 were created to evaluate that. Questions 1, 3, 4, 5, 6, and 8 in survey 2 have ordinal values, have the same scale and all of them measure the output of the thesis in relation to the purpose. Therefore, it is expected that answers to these questions would be somewhat aligned. For example, question 3 asks if respondents are satisfied with the tool and question 4 asks to evaluate the impact on the reporting of the case company. If a respondent said that they are very satisfied and that the impact on reporting is negative, it would be quite contradictory. Therefore, Cronbach's alpha is calculated as a support for backbone of the reliability for this thesis.

However, it is important to note three things. Firstly, the backbone of reliability is still the one explained earlier in this chapter. Secondly, the respondents base their answers on the built *Power BI* tool which is presented in chapter 4. Thirdly, the number of respondents is only ten so individual answers can influence the result of the reliability test a lot.

Cronbach's Alpha for the six items, questions in this case, was calculated and the result was 0,61. Table 2 shows the result of the calculation question by question. If question 1 were to be excluded, Cronbach's Alpha would have been 0,78. According to George and Mallery (2003) if Cronbach's Alpha is above 0,6, interpretation would be questionable. If above 0,7, interpretation would be acceptable. Below 0,5 is unacceptable and above 0,9 would be excellent. Table 3 shows the results when question 1 is excluded, and as said, the in that case is 0,78 which would mean that interpretation is acceptable. It could be that question 1 does not measure the purpose as well as other questions especially when viewing the corrected item total calculation in table 2 and table 3.

Table 2. Calculated Cronbach's Alpha.

Question	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	-0.21	0.78
Q4	0.4	0.54
Q3	0.45	0.56
Q5	0.37	0.55
Q6	0.75	0.33
Q8	0.61	0.42

Table 3. Calculated Cronbach's Alpha if Q1 is excluded.

Questions	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q8	0.67	0.7
Q6	0.78	0.65
Q5	0.54	0.75
Q4	0.52	0.75
Q3	0.33	0.8

In addition to internal consistency, survey 2 asked whether there has been enough training in question 8 and whether all pages are used by at least one of the respondents, question 2. 100% answered that there has been enough training which indicates that at least insufficient training has not affected in answers. Question 2 indicates that all pages are used which means that the bad quality pages have not affected the study as the built solution was aimed to be tailored according to requirements of the respondents.

Carmines and Zeller (1979, p.10) explain that validity is referred to when evaluating the relation of indicator and concept. Furthermore, validity refers to how well the selected

indicators measure what they are supposed to measure. In other words, validity is considered when conducting a test, a survey, or a similar method as part of the research.

Criterion-Related validity is referred to when determining how well a measurement method is able to predict performance in other matters (Carmines and Zeller, 1979, p.17). For example, how well a test for driver's license measures the actual driving capability in traffic. Content validity evaluates that are all relevant contents taken into account with the selected measurement method (Carmines and Zeller, 1979, p.20). For example, does a driver's test include all reasonable aspects needed to successfully drive in traffic. Construct validity is used when validity in relation to a theoretical concept is measured (Carmines and Zeller, 1979, p.22). Face validity is a subject test where a respondent or an expert is asked to view the test and evaluate whether the test fulfills the purpose and covers topics that it is supposed to cover (Holden, 2010, p.637–638).

In this thesis, face validity and content validity were used to evaluate validity. Similarly, as in reliability, the respondents themselves are the backbone of the validity for the same reasons as for reliability. Therefore, the supervisor from the case company was used to perform face validity test for the contents of the survey. In addition, the university supervisor was asked to perform a face validity test. Both agreed that the surveys measure what they intend to measure. Content validity was evaluated in a similar way as both supervisors are experts.

In addition, a weak market test was performed. The idea of the weak market was to ask that were results similar to what the respondents were expecting. In this study, the supervisor from the case company represented respondents in the weak market test and was asked this question. He said that the results are expected. Implementation is often difficult, and this thesis identifies the logical key success factors in relation to implementation.

4 Results

This part of the thesis will present the results. There are five chapters about building the BI tool and then there will be a chapter about the conducted surveys. The BI tool presented in the five chapters is a *Power BI* tool. The case company wanted the BI tool to be built with *Power BI* since *Power BI* is an application that is already used within the company. Therefore, it will be easier for employees to learn to use it since many already have some experience with the tool. Moreover, since *Power BI* is already used at the case company, it will be easier to maintain the tool since there is an existing knowledge regarding the *Power BI*.

The chapters about building a BI tool do not cover every single step of building a dashboard with *Power BI*. There already are many tutorials and courses from the technical point of view. Moreover, as said in the introduction, the focus is not too much on the technical point of view. Therefore, the point of view of these chapters is to present how a BI tool can be built in a way that improves performance and reporting of the case company. On the other hand, the chapters also include technical aspects regarding the building of a *Power BI* tool. However, the point of this thesis is not to be a step-by-step guide of how to build a dashboard with *Power BI* but rather a study that aims to achieve its' objectives and find answers to research questions. To conclude, a person without *Power BI* experience will not be able to build a *Power BI* tool based on this thesis but a person who has sufficient technical skills might learn new things and more importantly this thesis aims to provide answers how to build *Power BI* in a way that is aligned with principles of the company.

Marek et al. (2020) conducted a study where 180 research papers were studied with the goal of identifying KPIs that are often used in manufacturing companies. They say that companies use KPIs to measure performance and use KPIs that they find to be the best one for them. However, even though many manufacturing businesses use different KPIs, they can be mapped within the performance dimension which consists of time, flexibility, cost-efficiency, and quality (Marek et al, 2020). To this end, the case company is no

exception as they have many KPIs which are used to measure the success of the supply chain. Moreover, the KPIs are mostly related to the categories of performance dimension. The exception is the measure regarding safety as one could argue that safety could be a dimension of its own.

Table 4 shows a selection of different KPIs that are used in the case company and the explanation for them. However, it is important to note that there are other KPIs used as well but table 4 shows the relevant KPIs in the context of this study. The KPIs in table 4 present the KPIs that require calculation. KPIs that do not require calculation are self-explanatory and thus they are not mentioned in table 4. For example, sales and order intake are such metrics. The KPIs mentioned in table 4 are to be referred to in upcoming paragraphs and to make it more understandable, they are gathered in one table.

Table 4. Some KPIs of the case company.

KPI	Explanation
LTI	Safety first. LTI is a safety related KPI which is an abbreviation for lost-time-injury, and it calculates the number of LTIs. LTI refers to work related injuries that result in sick leave.
Book-to-Bill	Ratio of OIT and Sales. Formula: OIT / Sales. If Book-to-Bill > 1, then there are more new orders coming in than sales. If Book-to-Bill is < 1, then there are fewer new orders coming in than there are sales. This KPI can be used to predict upcoming sales as well as to analyze the reasons that cause a change in Book-to-Bill
Reliability	Reliability is a KPI that calculates the percentages of on time deliveries of total deliveries.
Availability	Availability is a KPI that calculates the percentages of confirmed delivery dates that are within the range of requested delivery date by customer. This KPI indicates the availability of capacity in relation to customer requirements.
RTY	All units are tested in the case company before delivery. Rolled throughput yield is a KPI which indicates the percentages of successful tests in all tests.
Inventory	There are few inventory related metrics used. There are days of inventory, and then the value of inventory. Important thing is to track different valuation classes of inventory such as raw materials and finished goods.
Productivity	Productivity of the production of the case company is measured by comparing the actual output of the production with the set baseline. The goal is to increase productivity every year.

As table 4 shows, effective KPIs do not need to be complex and highly mathematical. To this end, one could argue that simpler KPI is easier to communicate to employees and thus is more aligned with the findings of the literature review. As stated in chapter 2.2.2,

KPIs are merely the illustration and a way to communicate the strategy and objectives of the company as well as the success in those areas. The important thing is to understand the KPIs, what effects them and most importantly, how an employee can positively influence KPIs. This also highlights the importance of simplicity. The point is that there is no need to overcomplicate the KPIs. The *Power BI* tool that is presented in the upcoming chapters is a tool which not only communicates and visualizes the KPIs but is also a tool that can be used to analyze the KPIs which supports better decision-making in relation to set KPIs and thus impact the performance of the organization as well.

4.1 Data Model

This chapter will present the data model and how the data model is built. Data modeling is a method that uses graphical diagrams to communicate a solution for a problem (Blaha, 2010, p.1). In this case study, data modeling is used to illustrate the solution for data flow and storing of data. This chapter also addresses topics regarding analytics for Excel, Power Query, date table, and automatic updating and refreshing of underlying data. This chapter aims to provide an example of how the data model can be built with *Power BI* in a way that is easy to maintain and modify.

There are multiple data sources from which data can be loaded to *Power BI*. In this case study, data is loaded from Excel. Microsoft Excel is a spreadsheet tool where data can be organized, calculated, and visualized, (Microsoft, 2023a). Analysis for Excel is an add-in for Excel which allows the creation of structured queries based on data in ERP. Because the direct link between *Power BI* and ERP is prevented in the case company, the data is loaded from Excel.

Figure 6 illustrates the data flow in the data model and is also the simplified version of the data model. Regarding the data flow, a structured query is loaded from ERP by using the Analysis for Excel add-in (Figure 6). After that data is loaded into *Power BI* Desktop and transformed by using Power Query (Figure 6). Tables, visuals, and measures are also

built in *Power BI* Desktop (Figure 6). Lastly, the *Power BI* tool is published to *Power BI* Service which is the online version of *Power BI* where the created tool can be shared to users (Figure 6). *Power BI* Service also includes the *Power BI* workspace where things user access can be managed.

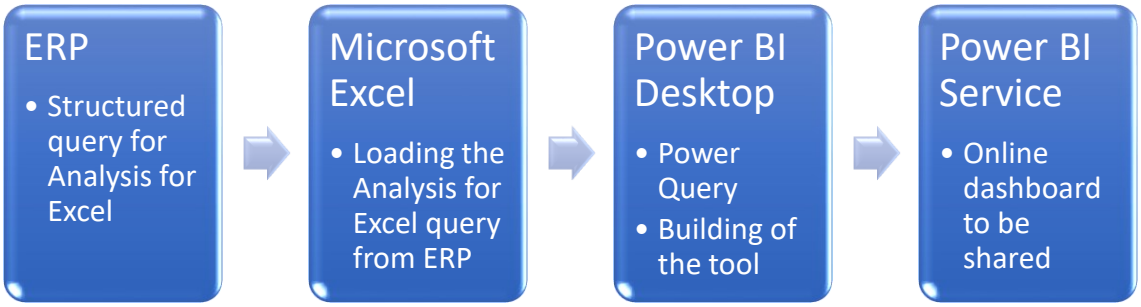

Figure 6. Data flow in data model of the case study.

Figure 7 illustrates the more detailed data model of the *Power BI* tool. One could argue why data is not directly loaded to *Power BI* from ERP but in this case study that was not possible because it is not allowed in the case company. However, as the queries are already structured because they are obtained via Analysis for Excel, less organizing of data is needed in *Power BI*. All steps have their own purpose which is explained in the upcoming paragraphs. More importantly, the automatic data flow between steps will also be explained.

In this data model, Power Query is the most important tool for organizing and handling the data. Power Query is a tool that can be used to transform, modify, and combine data, (Microsoft, 2023b). By paying attention to data handling with Power Query, the building of *Power BI* visuals and measures gets easier. When creating measures and charts, it is important to have enough filtering options so that the ever-changing requirements and points of views from the business can be matched.

For example, the case company has two different order intake (OIT) flows which are sales orders (SO), and stock transport orders (STO). SOs and STOs originate from different queries in the ERP, but by using the features of Power Query, the two queries could be combined. This means that all new orders can be viewed in one place in the *Power BI* tool and there is no longer a need to combine the two queries manually or view them separately.

Similarly, sales and OIT originate from different queries but having the ability to review them in the same visual is beneficial when analyzing the upcoming changes in sales and OIT. These queries could also be combined by using the relationship feature in *Power BI*, but this could also be done by using the append query feature. Append query combines two different queries into one. It is important to note that the column headers should be the same for the queries to be combined or otherwise there will be blank cells.

Sales and OIT data are similar by nature because there is information about the customer, product, value, and quantities and therefore appending query is a good way for combining such data. By creating an additional column with value of “Sales” or “OIT” for sales and OIT queries respectively with Power Query, there will be a way of sorting and filtering sales and OIT data for visuals and measures even though sales and OIT data are mixed in one query. To make this work, the SO and STO flows for both, sales and OIT, were first combined in Power Query and only after that the already appended queries were combined as one query which includes all sales and OIT related data. This highlights the benefits of Power Query because performing such work manually every time would take a lot of time. Moreover, the Power Query removes the risk of errors compared to performing steps manually every time.

The biggest benefit of this approach is related to filtering options because now there is no need for complicated relationship creation between tables as there is only one table but also a way to separate sales and OIT data. By building the *Power BI* tool in this way gives more control for the user as there are multiple filtering options. Moreover, by

giving more control to the user, the tool can support more users as there is no need for separate solutions to match the different needs of different employees. The key thing to make this work is to create the columns which indicate that is the data on rows sales or OIT related. A similar approach for combining different queries can be used for other use cases as well.

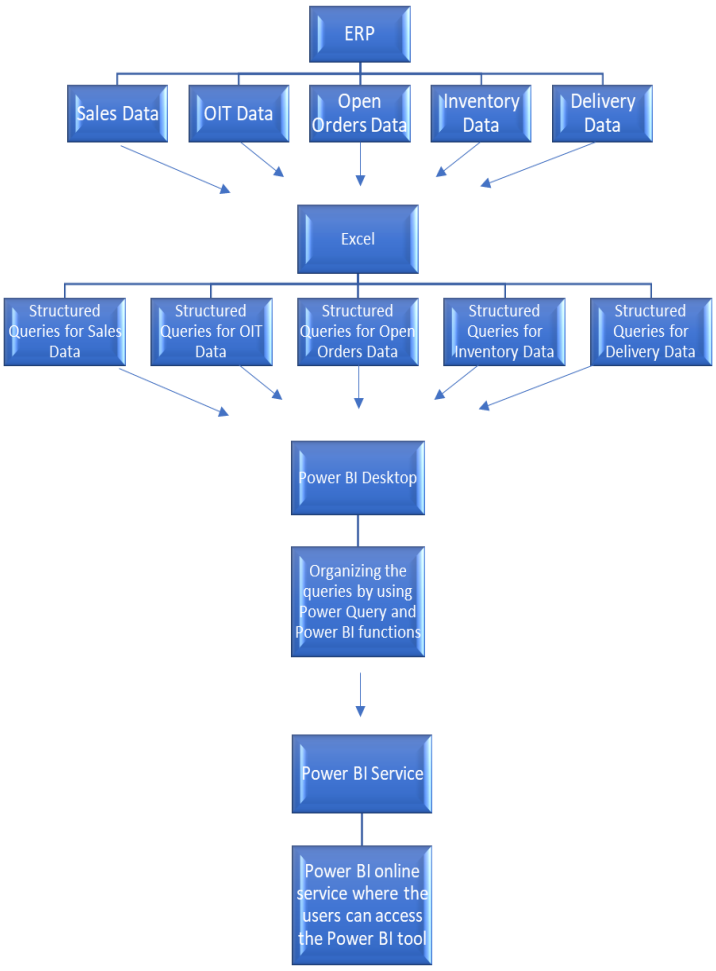

Figure 7. Data model for the Power BI tool of the case study.

Updating data can take a long time and therefore an automatic solution for updating and refreshing data is recommended. There are many options for automatic updates and the best way should be evaluated case by case. For example, automatic update could be set with Microsoft Power Automate or with programming languages but in this case study, automatic update is handled by using an Excel VBA macro that is launched by using the

Windows task scheduler. For the automatic update, a spare laptop or virtual computer can be used.

Next paragraphs explain the automatic update used in this case study in more detail. There is a designated laptop where a Windows task scheduler is set to launch an Excel VBA macro at a certain time. The VBA macro updates all structured ERP queries required for the *Power BI* in Excel and for some there are dynamic parameters regarding the date so that no manual intervention is needed. *Power BI* Service has a possibility to set automatic data refresh and that is used to refresh the *Power BI* tool to match the updated data queries. In this case, the process of updating takes about an hour so that is why the automatic update is crucial because otherwise it would take a big portion of someone's workday but now the time can be used for more value adding tasks. Therefore, it is important to consider how the updating of data is handled because otherwise the updating itself can have a negative impact on productivity.

To this end, also the use of Power Query improves the data flow because when refreshing and updating the data, the steps done with Power Query are done automatically. For example, if two columns are combined with Power Query, the combination of columns happens automatically even though data is refreshed, updated, and possibly has the number of rows is changed. Therefore, in case there are routine steps taken with data handling, Power Query can be used. Moreover, one can also use if-clauses and write code with advanced editor in Power Query so even though the data handling would be complex, Power Query could handle that. Therefore, it is a valuable tool to use for updating and processing data.

4.2 Structure of the Power BI tool

This chapter explains the structure of the *Power BI* tool. The different pages and the overall setup of the pages will be explained. The *Power BI* includes information regarding KPIs presented in table 4. There is a variety of information regarding the whole supply

chain. The structure is based on the input of the respondents, and it is tailored to match their requirements.

The structure of the *Power BI* tool is based on the data sources shown in figure 7. Moreover, there are also support queries used like mapping tables for products and regions but the important data from the user's point of view is based on sales, OIT, open orders, inventory, and delivery data. The different pages on the *Power BI* tool consist of these data sources. The pages and the data for them were selected based on survey 1 and interviews. Close collaboration between the builder of the *Power BI* tool and the users of the *Power BI* tool resulted in a tool that matches the requirements of users and business. The findings regarding lean methodology in chapter 2.1.1 also support this approach because one should work closely with the customer even so that in this case the customers were internal. Moreover, table 1 in chapter 2.3.1 highlights the importance of close collaboration between business and data functions when creating a data culture within the organization.

Date table has a significant importance when building a *Power BI* tool. For example, one user might be interested in viewing the open orders on a daily level for the current week whereas another user might be interested in viewing the open orders for different years on a quarterly level. Therefore, it is important that the user has total control of the period and of the date hierarchy level for visuals of the *Power BI* tool. Date table can be directly built into the *Power BI*, or it can be, for example, built with Excel or SQL and then it can be extracted to *Power BI*. Within the created date table, a date hierarchy can be constructed which includes yearly, quarterly, monthly, weekly, and daily level. By building a such hierarchy, the user has the control and therefore one *Power BI* tool can serve the needs of the many rather than having to build separate solutions for everyone. Moreover, it is easier to build the pages when all data tables are linked to a single date table. Even though a page would have multiple data tables one date filter will be enough as all data tables are linked to that same date table. This also improves the user experience as there is less complexity and therefore less risk of errors.

4.3 Advanced Features

This chapter is more from the technical point of view since it presents some advanced features of *Power BI*. These features are essential when considering objectives of the thesis, so it is important to discuss them as well. The features discussed are Data Analysis Expression (DAX) formulas, tooltips, bookmarks, and dynamic measures. DAX formulas allow the creator of the *Power BI* tool to use functions, operators, and values to create advanced calculations that are known as measures in *Power BI* (Microsoft, 2023c). Using DAX formulas gives more control over measure creation as *Power BI* offers standard measures as well but there can be a need for more advanced measures and that is why DAX formulas are needed. The next chapters address measures created with DAX formulas in practice.

With DAX formula, a dynamic measure that shows the growth within certain period can be compared. For example, users are often interested in the change or growth of KPI and that is why a dynamic measure is needed. The illustrated KPI provides more value to users if it also shows the growth in addition to the metric itself. It is also important that it is dynamic so that the measure takes changes in date and other filter changes into account.

Let’s use the appended sales and OIT data query as an example. Firstly, two measures must be created. One that sums sales and one that sums OIT. This is why it is important to create columns that enable the filtering of sales and OIT data because now filtered sum measures can be created. After that, a year-over-year growth percentage calculator can be created with a DAX formula. The period could also be any other but in this case a year-over-year was used.

The DAX code for measure, *Sales LY*, shows how one can calculate a dynamic measure which shows the same period for sales that is filtered but just one year prior to the selected period. After the dynamic measure for the previous period is created, one can

create a measure which shows the year-over-year growth as variance or as percentage. That DAX code for expressing percentual change, *Year-over-Year%,* is also below.

```
Sales LY = CALCULATE (
     [Sales],
          DATEADD ('Date Table'[Date],-1, YEAR)
               )

Year-over-Year% = CALCULATE (
          ([Sales] - [Sales LY]) / [Sales LY]
               )
```

DAX formulas can also be used in custom labels where the creator gets full control of the format of the figures. In *Power BI*, there can be a visual issue that a value label is not seen on the chart because there is not enough space. In these kinds of cases, a custom format created with DAX formula can be useful so that no information is left out from the chart. Custom labels also allow to insert information to a visual that is not necessarily directly linked with the data used in visual and thus custom labels created with DAX formula can be used to provide more insight into the metrics on the visual. A custom label could include information or a measure from a completely different data source than used in the visual.

This again highlights the importance of a proper date table to which all data tables are linked because then the custom label would also be filtered to match the selected period. However, it is important to notice that in custom labels, the *Power BI* default way of formatting or scaling measures does not work. Therefore, one can use custom format strings to scale or format the measure in the desired format. The custom format string can be created with DAX formula by using *FORMAT* -function.

Tooltips are useful to use when one is trying to fit a lot of information in a compact way. By default, tooltips provide information of the visual in a written way. For example, if the value of a bar in bar chart is 10mEur, the tooltip shows the exact value to the last decimal.

However, the default tooltip does not really provide additional value and therefore a custom tooltip can be very useful.

The overview page of the created *Power BI* tool presents the most important KPIs in a compact way. By using a custom tooltip, more information of the metric can be visualized. For example, the KPI regarding sales shows the sales figure, target, and year-over-year growth percentage. The enabled custom tooltip shows the same information but in a way that is divided into different product classes.

Therefore, custom tooltips are a great way of improving user experience and adding value because custom tooltips make it easier to perform quick analysis of the KPI and provide a way to communicate more information in a compact way. Custom tooltips can be enabled in settings of the visual and they are activated when hovering on a visual. Custom tooltips can, for example, include text or visual. In practice, custom tooltips are regular pages on *Power BI* that can only be seen when hovering on visual that is linked with it.

Bookmarks are also a way to create compact pages. Bookmarks can be used to save views in *Power BI*. Moreover, the saved views can be linked with buttons. By linking the bookmark with a button, a saved view can be activated by pressing a button. This allows to have multiple visuals in one page that are related to same category rather than having to create multiple pages for different visuals. Furthermore, this again supports the idea of having one *Power BI* tool for many because the user has more control over the visuals because it can differ what visuals users require.

To this end, a user can create their own bookmarks in *Power BI* Service. If there is a certain filtering that a user uses, the user can save it by creating a personal bookmark that is only visible for them. A personal bookmark saves time because personal bookmarks save the selected filtering and the way how the visual is illustrated. The personal bookmark can be activated by selecting the saved personal bookmark.

4.4 Data Visualization

Data visualization may sound like a topic that is not a top priority when building a tool. However, data visualization can make a difference in one way or another. Therefore, this chapter will address data visualization and the impact different choices of visuals can have.

Selecting the correct and most effective chart and visual style can be subjective. Some may prefer darker colors whereas others may prefer lighter colors. *Power BI* offers various charts and abundant ways of changing the visuals however the creator wants. There are also default themes provided by *Power BI* and one can also find created themes online. However, when creating a *Power BI* tool, one can also create a theme of their own. The creator can customize the default colors which are then used by default when inserting a new chart. This can save time when the colors do not have to be manually changed every time a chart is created. Colors can be customized by using hex codes in *Power BI*. Hex codes for colors can, for example, be found from various online resources.

In this case study, a lighter theme was used because that was preferred by the respondents. A darker theme was also presented as an option, but a lighter theme was selected. In this case, the respondents thought that the lighter theme visuals were easier to embed into their presentation in case they directly take screenshots from the *Power BI* tool. This highlights that even the colors and contrast of the theme should be considered as this also impacts the satisfaction of the users.

4.5 Training and Security Considerations

The *Power BI* tool has a lot of sensitive data about the case company. Therefore, security consideration is vital. Security considerations will address access and row-level security (RLS). Lastly, there will be a training consideration. It does not matter how good the tool

is if no one knows how to use it properly. Therefore, training is also an important topic to consider.

Security-wise controlling of access is vital. In *Power BI* service, access can be given to whole organization or only to selected people. For the *Power BI* tool of the case study, access is given to selected people in the company according to company guidelines. In case there is an access request, it is also handled according to company guidelines.

Because there is a lot of data about the business, restricted access might be a solution for some users. RLS is a feature of *Power BI* which can be used to give restricted access (Microsoft, 2023d). For example, if a user should only have access to data of certain region or product, RLS can be used to determine that kind of restricted access. Therefore, the use of RLS increases the flexibility and the number of potential users because the owner of the *Power BI* tool does not have to select from approving or declining an access request and instead restricted access can also be given.

As mentioned in chapter 2.3.1, training is also an important part of creating data culture. Moreover, as mentioned in chapter 2.3.3, training is important because if no one knows how to use the *Power BI* tool, the *Power BI* tool is useless. Therefore, training sessions which have time for questions can be beneficial. Moreover, training sessions can be recorded so that people who are not able to attend during certain times or join the company later can also learn to use the tool. In addition, a slide deck with instructions is also beneficial because then users can check things from it afterwards. Similar information can also be added to the *Power BI* tool in the form of a page or information can be embedded into pages as well. The content of the training session can vary depending on how advanced the created *Power BI* is and depending on the skill level of the users.

Berinato (2016, p.10) presents a matrix for good charts and states that a good chart has two characteristics that make it good: design execution and contextual awareness. In

other words, the chart should be good technically and it should deliver the intended message. Berinato (2016, p.57) says that when people view visuals, people see the things that stand out. These things can, for example, be unique colors or outliers.

When creating visuals, the creator has a lot of power. The creator selects the chart or visual type, they select the axis range, and colors. Berinato (2016, p.258) says that the essence of visualizations and charts serve as a way to present ideas and as a way to tell stories. To this end, he adds that when done properly, one can show things that were not seen before and therefore good visualization can influence people and their decision making. It is important to keep in mind what is the message of the visual and how to technically produce a visual that serves the purpose of creating that particular visual in the first place.

4.6 Survey Results

This part of the thesis analyses the results of the surveys. The process of data collection and data analysis methods are explained in chapter 3.2, so this part focuses on analyzing the results. The purpose of these surveys was to find answers to the research questions and to determine the success of the created *Power BI* tool in relation to the objectives and to the assignment of the case company. The reliability and validity of the survey is assessed in chapter 3.3.

The purpose of the first survey was to understand the status quo. The first survey aimed to gather information of ideas regarding the new *Power BI* tool. Moreover, the first survey aimed to find out how satisfied the respondents were with the current tools and what are their needs regarding the new tool. The second survey was conducted after the *Power BI* tool was created and used for some time. The purpose of the second survey was to find out that were the objectives of the thesis achieved and what respondents thought about the new tool. The first survey can be found on appendix 1 and the second survey can be found on appendix 2.

Figures 8 and 9 indicate the importance of data among the respondents. 90 % of respondents said either often or always when asked how frequently you rely on data for your daily tasks (figure 8). Moreover, 80% of respondents said that data plays either a moderate or significant role when they make decisions (figure 9).

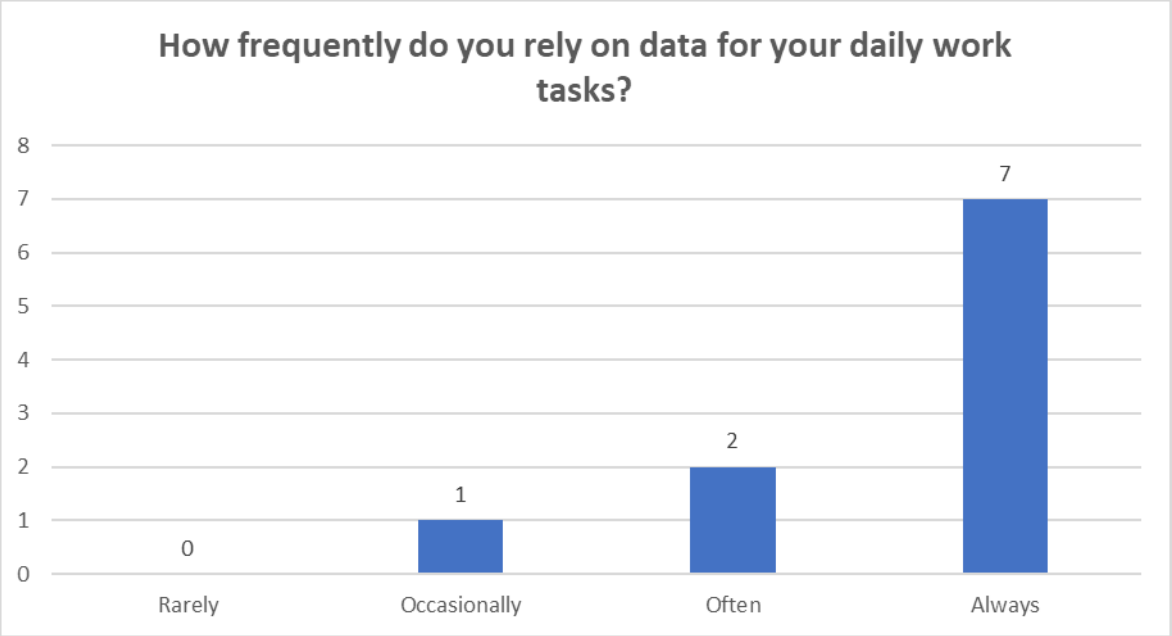

Figure 8. How frequently do you rely on data for your daily work tasks? Survey 1

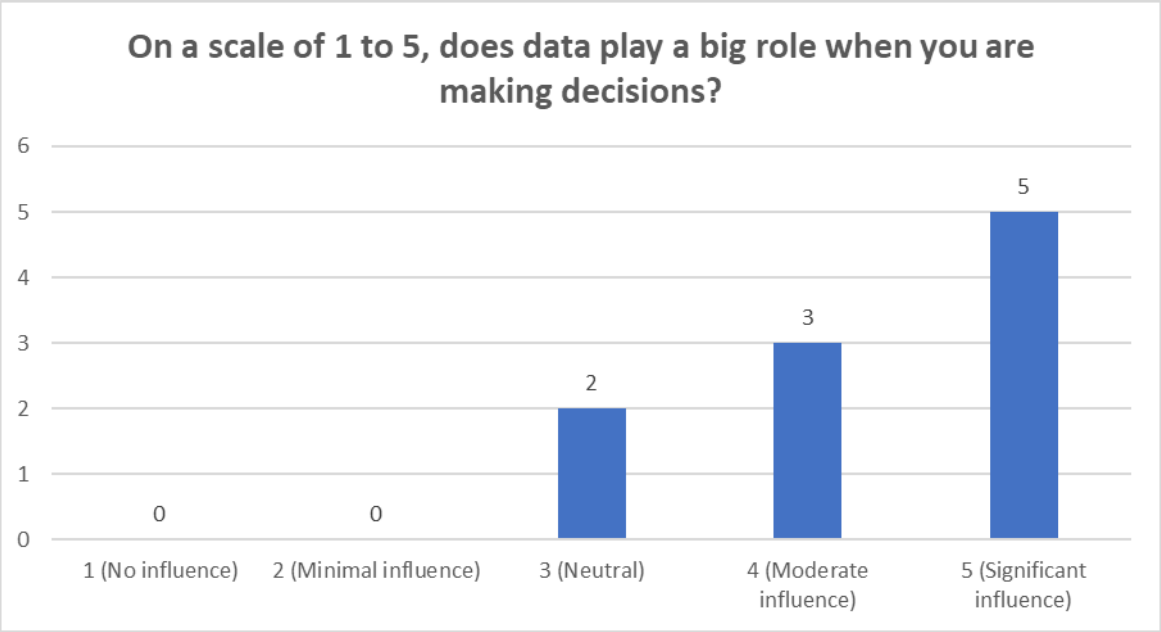

Figure 9. On a scale of 1 to 5, does data play a big role when you are making decisions? Survey 1

Figure 10 illustrates the answers when asked about the dashboard that was used before the new one was created. Rather many were already satisfied with the previous tool. Considering the assignment, it is rather surprising, but it can indicate a few things. Firstly, continuous improvement is at the root of the case company and therefore improvement is aimed at even though things were okay. Secondly, it can be that as mentioned in introduction, it is hard to even imagine potential data related improvements if you do not even know what to ask for. However, since 40% were either dissatisfied or neutral and no one was very satisfied, it means that there is room for improvement.

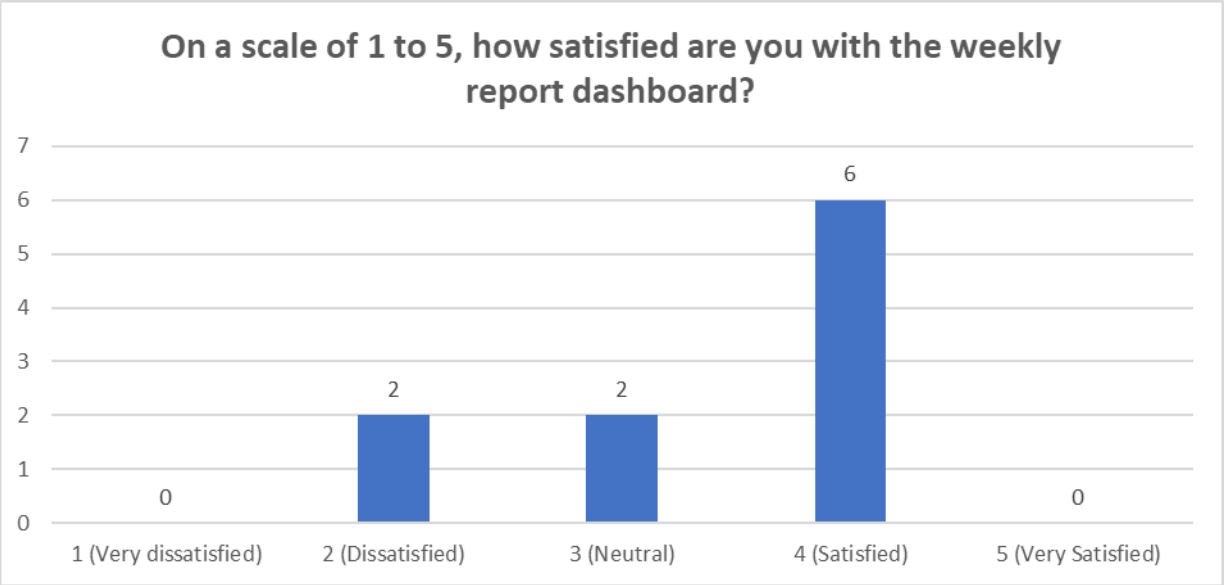

Figure 10. On a scale of 1 to 5, how satisfied are you with the weekly report dashboard? Survey 1

Figure 11 shows that for 70 % of the respondents, data collection takes either a moderate or noticeable portion of their workday. Considering that the respondents are working in leadership and managerial roles, it is actually rather alarming since one could argue that in such positions, one would optimally spend more time in decision making, for example. Then again, figures 8 and 9 showed that data is needed for decision making and overall, for their tasks. Therefore, the problem seems to be that data is in a format that requires a lot of work to process. Therefore, this is one of the key improvement points identified.

Questions 9 and 10 in survey 1 were open questions where respondents were given an opportunity to make requests for the new dashboard as well as give overall comments about data usage. There were many requests but there were few things that many requested. Respondents requested visual, simple, and easy to reach KPIs. To this end, it was also requested that actual performance could be compared against the target and the change percentage over time could be seen. The other much requested feature was the ability to drill down on visuals and on data. To this end, enough filters were requested and also different visuals and tables for the same topic but just from different points of view. To conclude the requests, readymade visuals and KPIs were requested but if

needed, the user would have control in the dashboard to perform deep analysis if needed.

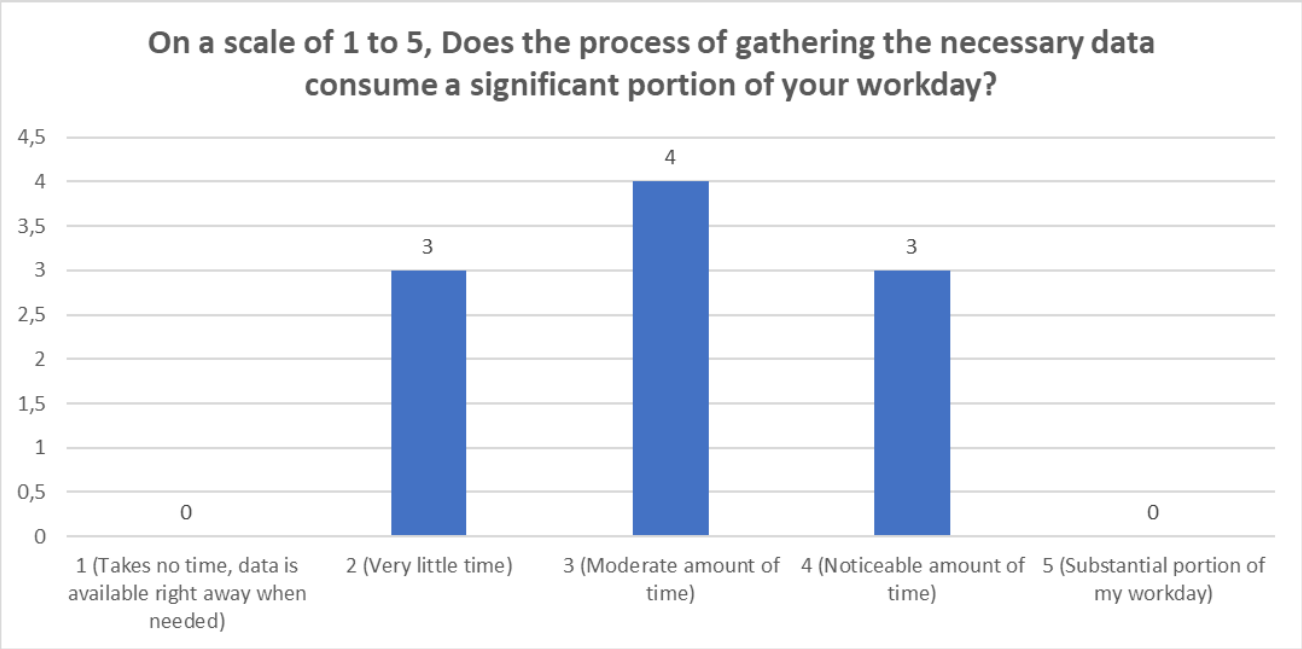

Figure 11. On a scale of 1 to 5, Does the process of gathering the necessary data consume a significant portion of your workday? Survey 1

Figure 12 shows the results for question 3 in survey 2. 100 % of respondents were satisfied or very satisfied with the new *Power BI* tool and 90 % of them were very satisfied. Moreover, 90 % of respondents gave higher scores than in survey 1, question 4, where the old *Power BI* tool was evaluated. This indicates that the purpose of the thesis was achieved, and the three objectives were successfully completed.

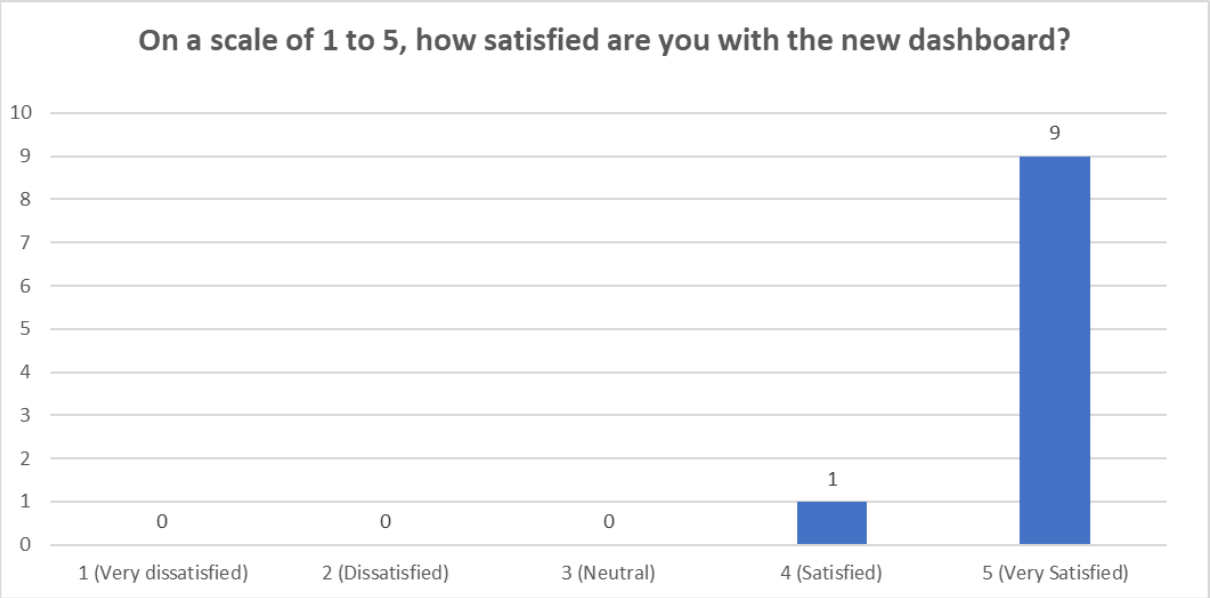

Figure 12. On a scale of 1 to 5, how satisfied are you with the new dashboard? Survey 2

Figures 13 and 14 illustrate answers to questions 4 and 5 respectively. It is safety to say that respondents think the impact of the new *Power BI* tool was positive on both, reporting and performance, but it seems that the perceived impact seems to be more positive on reporting than in performance. When considering that it is a data tool which focuses on KPIs, it is logical that the impact is greater on reporting. Moreover, it is a single tool so a major impact on performance would not even be expected. However, it indicates that it has positive impact on performance as well and therefore it indicates that data-driven approach in other areas would not only improve reporting but also the performance.

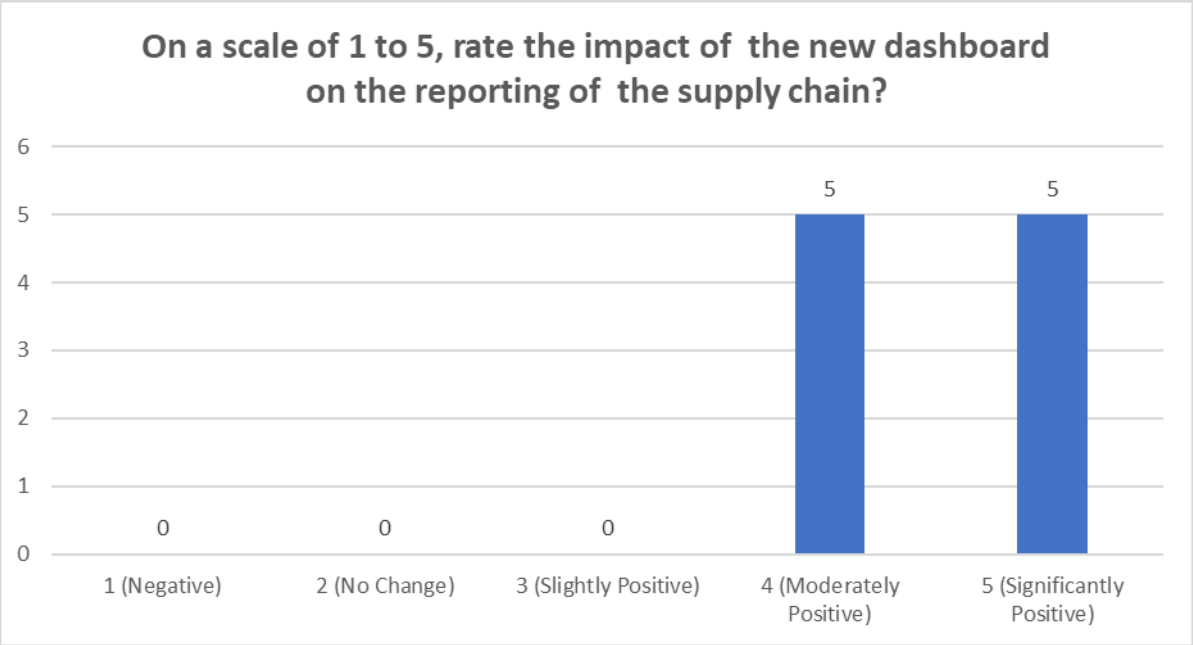

Figure 13. On a scale of 1 to 5, rate the impact of the new dashboard on the reporting of the supply chain? Survey 2

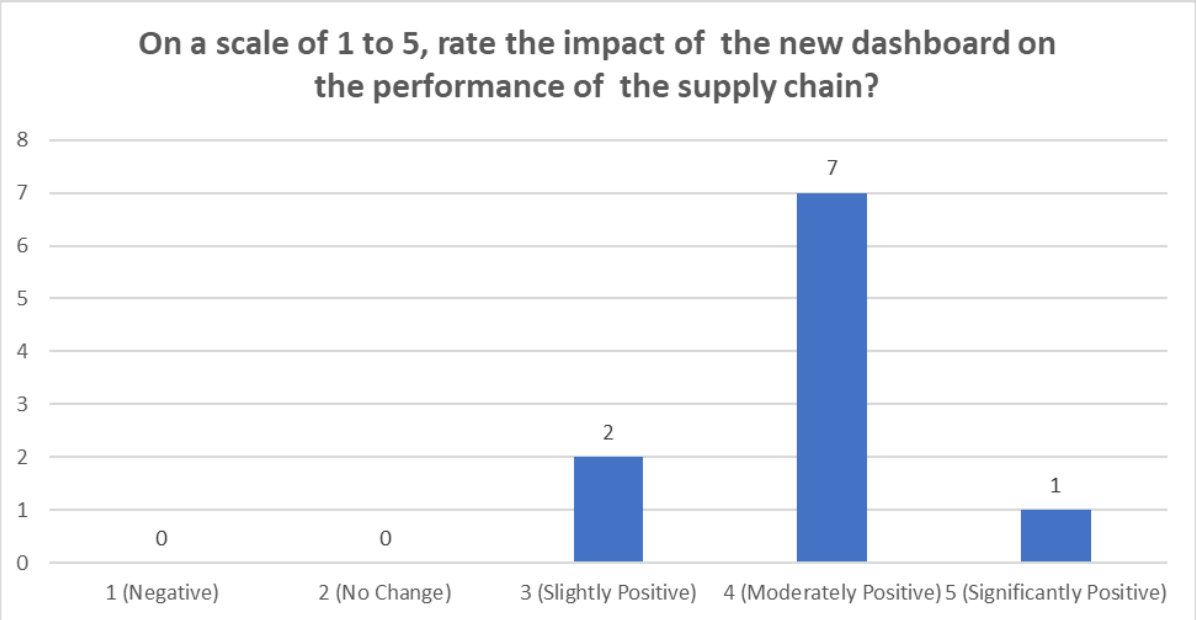

Figure 14. On a scale of 1 to 5, rate the impact of the new dashboard on the performance of the supply chain? Survey 2

One key improvement area found in survey 1 was that gathering data takes a lot of time. Therefore, there was a question in survey 2 where potential time savings of the new tool

were evaluated. Figure 15 illustrates the results and 100 % of respondents said that it the new *Power BI* tool has saved time in data gathering. Moreover, 70 % respondents said that time savings were either moderate or significant. Considering that this was one of key improvement areas, the answers shown figure 15 confirm that the selected approach and the way *Power BI* tool was built, was the right way in relation to creating time savings for respondents in data gathering.

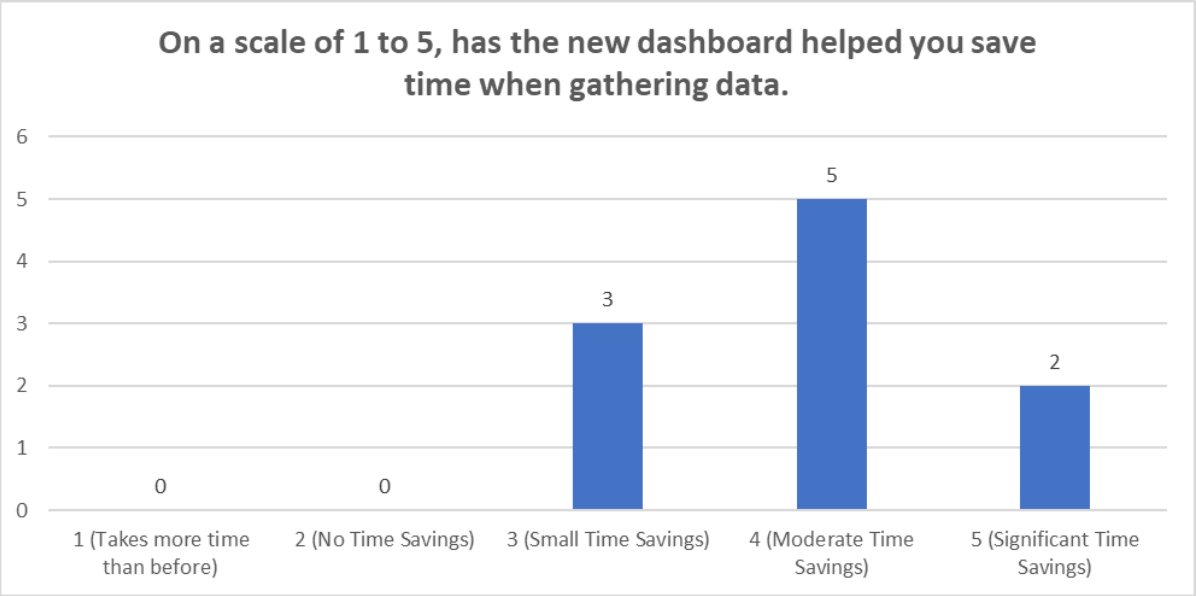

Figure 15. On a scale of 1 to 5, has the new dashboard helped you save time when gathering data. Survey 2

Survey 2 also had two open questions which gave an opportunity for the respondents to evaluate the results in a freer manner. Moreover, the results have also been discussed with the respondents so that their answers are fully understood. Question 9 asked about possible challenges or obstacles regarding the use of the new *Power BI* tool. As the tool is rather complex and has a significantly larger amount of data than the previous one, it made sense to ask about this since the answers could then be taken into account when answering research questions. Respondents mentioned difficulties in understanding how each page works, how to use the filters, and that simply the large amount of data made it complex to use at first. However, it was also mentioned that these were obstacles that respondents were able to overcome by simply learning to use the new

Power BI tool. Moreover, as said, 100 % said that there was enough training which most likely supported learning of the rather complex features.

Question 10 provided an opportunity for respondents to evaluate the strengths and weaknesses of the new *Power BI* tool as well as a possibility to give further improvement ideas. Respondents were pleased with the ability to perform quick analysis by drilling down on pages and visuals. Respondents were also pleased that the tool is very comprehensive in terms of data. Positive feedback was also given on the fact that now all KPIs are in one place and that there is one set of numbers which makes it easier to communicate between different functions. Respondents also said that it is a good thing that the tool is automatically updated.

There were also some improvement ideas given as answers to question 10. It was said that user experience could be still improved so that the pages were less full. On the other hand, respondents were pleased with the amount of data and with the control provided by having many filters, bookmarks, and tooltips. Therefore, the takeaway from here is that there seems to be a tradeoff between the amount of data and user experience, at least to some extent. Then again, if there would not be enough filters or bookmarks, it could also impact negatively on user experience as there would not be that much control.

There were also a few requests for new features. One respondent said that the *Power BI* tool has potential to create even more value, and, for example, safety stock calculations could be integrated on the *Power BI* tool. In addition, an even more detailed view on OIT was requested in relation to confirmed dates. Overall, all comments regarding improvement ideas highlight the statement said already in the introduction that it is difficult to ask for new ways of data usage if one cannot even imagine the potential use cases or features. Therefore, the new *Power BI* tool seems to have also worked as an inspiration for new ideas since there are many features that illustrate potential use cases which people may not have seen as possible features beforehand.

Lastly, there was a question regarding the effectiveness of the new *Power BI* tool in relation to communicating the targets of the case company to the teams of the respondents. Considering the learnings regarding strategy maps, MBO, and BSC in literature review, it is important to find out that does data-driven approach support those methods and principles. Figure 16 shows that the new *Power BI* tool succeeds in communicating targets since 90 % say that it is moderately or very effective in communicating targets. Moreover, 70 % consider it to be very effective (figure 16).

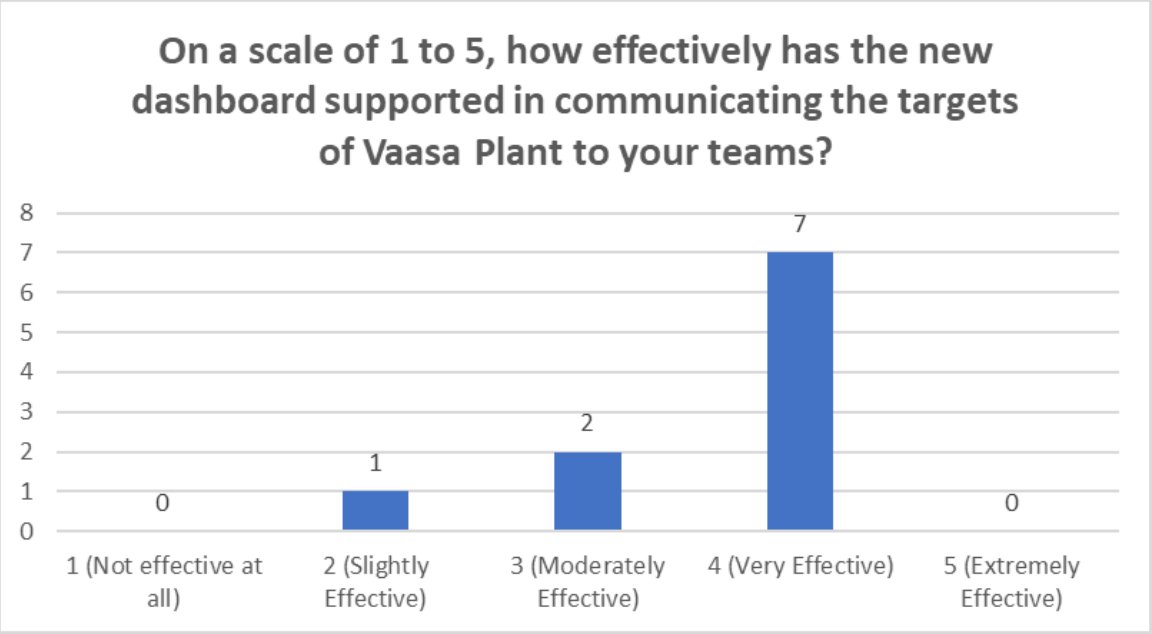

Figure 16. On a scale of 1 to 5, how effectively has the new dashboard supported in communicating the targets of Vaasa Plant to your teams? Survey 2.

5 Conclusion

The purpose of this thesis was to improve the performance and reporting of the case company with a data-driven approach. It was determined that the purpose would be achieved by completing three objectives as explained in the introduction. This thesis was a mixed method study where both qualitative and quantitative dimensions were used. Moreover, the information system design method was used as it was suitable for a study where a BI tool was built. Data collection was conducted via surveys and there also were semi-structured interviews. Data analysis was conducted by using Excel and creating descriptive charts and verbally assessing the results.

Nowadays corporations can be massive. For example, the total number of employees in the case organization of this study is over 42 000 employees. Therefore, management methods and tools presented in this part of the study can be effective ways to improve the performance of the organization. However, as often stated, one must be careful that the methods and tools are implemented as intended and that the methods and tools used are thoroughly understood throughout the organization. Moreover, the implementation of these methods and tools can be time consuming and extremely difficult. On the other hand, these methods and tools can be powerful and with proper implementation, they can provide benefits for the organization.

The remaining chapters of this thesis will present the main findings and results. Purpose, objectives and if they were achieved is also discussed. There will also be a chapter regarding managerial implications and recommendations for future research. After that, the limitations of the thesis will be explained. Lastly, there is a short chapter for acknowledgments.

5.1 Findings and Result

The concepts, SCM, lean, Hoshin Kanri, MBO, Strategy Maps, and BSC, presented in chapters 2.1-2.2 seem to have lot of overlapping characteristics and they can even be complementary to one other. Lean ideology can be an effective way of managing an organization or SCM. The concept of Hoshin Kanri can support lean ideology. Strategy maps can support clarifying of the strategy and BSC can make it easier to communicate strategy within the organization. Moreover, MBO can support the impact of strategy maps and BSC.

Singh et al. (2017) highlights collaboration in supply chain as a vital factor in the success of supply chain. However, they admit that more research on this topic would be needed. To this end, this thesis agrees with the claim because the building of the *Power BI* tool was done with close collaboration between various functions within supply chain. The results indicate that this approach was an aspect that resulted in improving reporting and performance of the supply chain in the case company and that it is also a key success factor when implementing a data-driven approach.

Forecasting and predicting can be extremely difficult because always in the motion future is and therefore the ability to react to sudden changes is important. Data can support seeing the change quicker so data can also play its part in an agile supply chain even though data would only be descriptive. To this end, almost 20 years ago, Morgan (2004) already pointed out that it will be vital to have constant access to data so that managers and people in leadership positions are able to make correct decisions swiftly and efficiently. The results in this thesis are quite clear and state that firstly, there is a demand for that and that the *Power BI* tool is an answer to this demand.

As said in chapter 2.1.3, MBO can have problems in case implementation of it is not done properly and therefore the communication of objectives is vital. To this end, in chapter 2.2.1, it was mentioned that one should use hard data when it comes to strategy maps. Moreover, as said in chapter 2.2.2, BSC is a way to visualize the strategy to employees.

The created *Power BI* tool and results that were presented in chapter 4 support these methods. The created *Power BI* includes the KPIs that management has set and then it also communicates and visualizes them in an understandable way. Moreover, the *Power BI* tool is based on hard data. Therefore, one key factor for a successful implementation of data-driven approach is to align data usage with the management methods of the organization.

As found in chapter 2.2.2 the communication of BSC is vital and everyone in the organization should be made familiar with it. The created *Power BI* tool supports this principle as the most important KPIs are now gathered in one place where leadership and managers have a more effective way of communicating the targets. To this end, the survey results in chapter 4.6 also support this as 90 % of respondents said that the *Power BI* tool has been moderately of very effectively supported in communicating targets to their teams.

Moreover, as found in chapter 2.2.2 it is important that metrics are understood and why a target is reached or why it is not reached. The *Power BI* tool supports that as well because users can drill-down in visuals or the set tooltips. In addition, the overview page of the *Power BI* tool was inspired by BSC. Therefore, this further indicates that when implementing a data-driven approach, it should be in alignment with the management concepts of the business.

In chapter 2.3.1 data culture was discussed and as said, a successful creation of data-driven organization requires a proper data culture. To this end, when creating a *Power BI* tool, one should make sure that there is a data culture in order to get the full benefits of *Power BI*. In chapter 2.3.1 many ways and steps for improving data culture were discussed. To conclude, creating a data strategy that considers data offense and data defense summarizes the creation of data culture. DalleMule and Davenport (2017) conclude that the aim of data offense is to improve the performance and

competitiveness of the organization whereas the aim of data defense is to ensure compliance and proper data governance.

In this case study, there was no need to focus on creating data-driven culture as the results in survey 1 showed that respondents use and rely on data and that the organization already had a strong emphasis on data-driven decision making. However, this only highlights that when implementing a data-driven approach, creating data culture is vital because if there is no emphasis on data-driven decision making, even good BI tools are not useful as people would not use them. The ten steps presented in table 1 in chapter 2.3.1 provide guidance on creating data culture. Similarly, Wantao et al. (2017) say that there is plenty of data in organizations that is never used. Therefore, the implementation of BI tools requires the creation of data culture as well.

Chapter 2.3.3 discussed building a BI tool. Findings indicate that simplicity, meaningful visuals, and right data are crucial factors from the user's point of view. The need to align strategy and data was also highlighted here. Moreover, the importance of working with the users when creating a BI tool was mentioned and it is aligned with the results as well as with other parts of literature review. In addition, the ability to provide real-time data to users adds value. When considering these things, user experience consists of many things and as results indicate, it can vary depending on the user. Therefore, close collaboration with users is beneficial when creating a BI tool. Moreover, as results indicate, a dynamic and interactive BI tool which gives control to the user improves user experience.

This thesis had two research questions. Let's address RQ1 first. The results indicate that a *Power BI* tool that is built in close collaboration with the users and that is aligned with the management methods of case company resulted in an improved performance and reporting in the case company. Moreover, the results indicate that the use of advanced features of Power BI unleashed the potential of it which then resulted in an improved performance and reporting in the case company. In other words, results indicate that

when having the technical capability to build a *Power BI* tool that matches the requirements of the users, improved performance and reporting is achieved in the case company.

As said, RQ2 was created so that this thesis could provide more generalized results. However, it is important to remember delimitations and limitations when reviewing the answer to RQ2. However, close collaboration was mentioned in many parts of the literature review by many different sources and the results of the case study also strongly support that. Therefore, a key success factor for implementing a data-driven approach to supply chain is a close collaboration between users and the creator of the BI tool. Moreover, having the technical capabilities to implement a data-driven approach is also a key success factor. It can be tricky to find out what users want as users might not understand the possibilities that can be built and that is exactly why finding out what users want is also a key success factor.

Similarly, an alignment between the data-driven approach and management concepts as well as the strategy of the company are key success factors according to results of this thesis. Moreover, this was also supported in the literature review. Moreover, the findings on literature review indicate that creation of data culture is significant when implementing a data-driven approach in the supply chain. As mentioned, the case company already had a strong emphasis on data-driven decision making so creation of data culture was not tested in the case study. However, the results indicate that a strong emphasis on data-driven decision making was strongly supported in implementing the *Power BI* tool as there was no resistance against change among users.

In conclusion, the explained ways how data can be used to improve the performance and reporting in the supply chain can also include things that were not found in this thesis because of the delimitations and limitations but overall results suggest that the found ways truly improve performance and reporting. In a more general level, they key success factors are, but not limited to, identifying the requirements of the users, close

collaboration, data culture in the organization, and aligning data usage with strategy and management methods. To conclude, find out what users want and build what users want.

5.2 Limitations

This thesis was a single company and single industry case study and therefore it is a limitation when considering the generalization of the results. There is also a potential data collection limitation because there might have been a response bias. This is because the respondents are co-workers of the thesis writer and therefore there is a possibility that socially expected answers were given in the evaluation even though it was highlighted that answers should be as objective as possible. The study also has geographical and cultural limitations as the study was located in one country and all respondents share the same nationality. Lastly, there was a limitation caused by time constraint as there was a contract between the thesis writer and the case company which stated that there was a deadline for completion.

5.3 Managerial Implications

The new *Power BI* tool is built, and it is in use. It is also determined that it fulfills the requirements of the assignment and that the purpose and the objectives of this thesis are achieved. Next step would be to consider the lifecycle management and continuous improvement of the new *Power BI* tool as especially continuous improvement is a vital principle in the case company. Moreover, lifecycle management is also important so that the tool stays up to date in future as well.

In a more practical level, the case company could identify potential use cases for automating the updating of reports. Moreover, the case company could identify potential use cases for Power Query in data management and in semi-automated

updates for reports. These use cases could provide quick wins as they are not difficult to implement.

By using a custom tooltip, more information of the metric can be visualized. Security-wise controlling of access is vital. In Power BI service, access can be given to whole organization or only to selected people. For the Power BI tool of the case study, access is given to selected people in the company according to company guidelines. In case there is an access request, it is also handled according to company guidelines training is also an important part of creating data culture.

The building of the Power BI tool was done with close collaboration between various functions within the supply chain. The results indicate that this approach was an aspect that resulted in improving reporting and performance of the supply chain in the case company and that it is also a key success factor when implementing a data-driven approach.

It will be vital to have constant access to data so that managers and people in leadership positions are able to make correct decisions swiftly and efficiently. One key factor for a successful implementation of data-driven approach is to align data usage with the management methods of the organization. One should make sure that there is a data culture in order to get the full benefits of *Power BI*. *Power BI* tool has been moderately of very effectively supported in communicating targets to their teams. Therefore, it could be connected to BSC.

5.4 Recommendation for Future Research

Razmak et al. (2021) and Majiwala et al. (2019) did studies on using lean ideology as a way of managing data. The findings on chapter 2.1.1 say that the five principles of lean ideology are value, value stream, flow, pull, and perfection. When considering how the *Power BI* tool was built, the use of lean ideology in data management makes sense.

The tool was built with close collaboration with the customers which in this case were internal employees and by working this way, the value was identified. Moreover, as the tool was tailored as per requirements, it means that pull was guiding on what pages to add to the *Power BI* tool. The considerations regarding data model and data flow and automatic updates are related to value stream and flow. Lastly, continuous improvement was seen in surveys as improvement ideas were also requested and given for the ready tool.

Therefore, it would make sense to conduct a study on managing data with lean ideology. There have already been studies about that topic as said but developing or improving the framework of lean ideology in relation to data management would be an interesting research topic. Moreover, the findings of that study could generally provide better ways for data management in the whole case company and potentially outside of the case company as well.

For future research the emerging technologies to data that could benefit supply chains and organizations should be studied. Govindan (2022) talks about the impact of industry 4.0. Industry 4.0 has already provided and will most likely continue to provide new innovations for data utilization. Therefore, research in this area would also be a logical next step when looking for ways to gain competitive advantage. To this end, the built *Power BI* tool is mainly descriptive. Using artificial intelligence or other industry 4.0 related technology, the tool could include more predictive and even prescriptive features.

As said in chapter 2.3.1, creation of data culture is important. Similarly, Spisak (2022) highlights the importance of making data usage as a standard way to operate when making decisions. Furthermore, he also says that missing data culture is the barrier for creation of data-driven organization. To this end, he says that computational leadership science, CLS, is potentially the next big thing in data analytics and that it could provide huge value for organizations. Basically, it provides a capability to do complex analysis by

utilizing tools and methods like simulation and AI. Therefore, CLS could be one way of making **predictive** and **prescriptive** analytics a reality for the case company as well and thus it would potentially be a good idea for future research.

Lastly, ESG which stands for environmental, social, and governance is a rising topic. To this end, Kaplan and McMillan (2021) state that BSC should be somewhat reinvented and modernized to match the requirements of ESG. Moreover, they say companies might have limited finance and controlling systems which only focus on financials. To this end, they say that BSC could be modified to match the needs created by the triple bottom line. Triple bottom line refers to people, planet, and profits. This would also be an interesting area to perform further studies as the triple bottom line could potentially be integrated into the *Power BI* tool.

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Appendix

Appendix 1. Survey 1

	Survey for thesis of Waltteri Yliranta (Data-Driven Performance Optimization and Reporting in the Supply Chain Management of the case company: Unleashing the Power of Power BI)
	Respondent's Name:
	Respondent's position (title):
	Introdcution:
	The scope of the thesis is limited to Vaasa Supply Chain so please try to answer to the questions based on this scope
	Answers will be utilized in the thesis as well as in the development of the new Power BI tool (replacement for D800 weekly)
	There are a total of **10** questions. Questions 1-8 can be answered by marking "X" in the designated boxes
X	

	Questions
	1. How frequently do you rely on data for your daily work tasks? Please select only one of the options
	Rarely
	Occasionally
	Often
	Always

	2. Which types of data do you most commonly work with? Selecting multiple options is allowed.
	Sales Data (Including Order intake & Open Orders)
	Financial Data (Fixed Expense, Cost Center budget)
	Inventory Data
	Lead Times Data
	Material Data (Reservation requirement, POs, Material master etc.)
	Production Planning Data
	Production Productivity Data (Efficiency, Used Hours etc.)
	Other (Please specify below)

_____

_____

	3. On a scale of 1 to 5, how satisfied are you with the current reporting methods and tools available to you? Please select only one of the options
	1 (Very dissatisfied)
	2 (Dissatisfied)
	3 (Neutral)
	4 (Satisfied)
	5 (Very Satisfied)

	4. On a scale of 1 to 5, how satisfied are you with the D800 weekly report dashboard? Please select only one of the options
	1 (Very dissatisfied)
	2 (Dissatisfied)
	3 (Neutral)
	4 (Satisfied)
	5 (Very Satisfied)

	5. On a scale of 1 to 5, does data play a big role when you are making decisions? Please select only one of the options
	1 (No influence)
	2 (Minimal influence)
	3 (Neutral)
	4 (Moderate influence)
	5 (Significant influence)

	6. On a scale of 1 to 5, Does the process of gathering the necessary data consume a significant portion of your workday. Please select only one of the options
	1 (Takes no time, data is available right away when needed)
	2 (Very little time)
	3 (Moderate amount of time)
	4 (Noticeable amount of time)
	5 (Substantial portion of my workday)

	7. On a scale of 1 to 5, is the current organizational culture characterized by a strong emphasis on data-driven decision-making and practices? Please select only one of the options
	1 (Not at all)
	2 (Limited emphasis
	3 (Moderate emphasis)
	4 (Substantial emphasis)
	5 (Strongly emphasized)

	8. On a scale of 1-5, how optimistic are you about the potential impact of the improved Power BI report on enhancing reporting and performance within the company? Please select only one of the options
	1 (Not Optimistic)

	2 (Somewhat Optimistic)
	3 (Neutral)
	4 (Optimistic)
	5 (Very Optimistic)

9. What specific features or functionalities would you like to see in the Power BI solution to address your reporting and performance needs? Please answer below

10. Any other comments regarding data usage? Please answer below

Appendix 2. Survey 2

Survey 2 for thesis of Waltteri Yliranta (Data-Driven Performance Optimization and Reporting in the Supply Chain Management of the case company: Unleashing the Power of PowerBI)
Respondent's Name:
Respondent's position (title):
Introduction: **Review of the PowerBI tool (D800 Dashboard)** There are a total of **10** questions. Questions 1-8 can be answered by marking "X" in the designated boxes. 9-10 are open questions.

Questions

1. How frequently do you use the new dashboard? Please select only one of the options
Never
Rarely
Once in a week
Few times a week
Daily

2. Which pages do you most commonly work with in the dashboard? Selecting multiple options is allowed.
YTD KPI Performance
Sales and OIT
Book-to-Bill
Open Orders / Analysis of Open Orders
Sales & Open
Reliability
Availability
Inventory (Weekly and Monthly)
Delivery Report
Finished Goods Analysis

3. On a scale of 1 to 5, how satisfied are you with the new dashboard? Please select only one of the options
1 (Very dissatisfied)
2 (Dissatisfied)

3 (Neutral) 4 (Satisfied) 5 (Very Satisfied)

4. On a scale of 1 to 5, rate the impact of the new dashboard on the REPORTING of the supply chain? Please select only one of the options.
1 (Negative) 2 (No Change) 3 (Slightly Positive) 4 (Moderately Positive) 5 (Significantly Positive)

5. On a scale of 1 to 5, rate the impact of the new dashboard on the PERFORMANCE of the supply chain? Please select only one of the options.
1 (Negative) 2 (No Change) 3 (Slightly Positive) 4 (Moderately Positive) 5 (Significantly Positive)

6. On a scale of 1 to 5, has the new dashboard helped you save time when gathering data. Please select only one of the options
1 (Takes more time than before) 2 (No Time Savings) 3 (Small Time Savings) 4 (Moderate Time Savings) 5 (Significant Time Savings)

7. Do you feel that there has been enough training for using the new dashboard? Please select only one of the options
1 (No) 2 (There has been training but more would have been needed) 3 (Yes)
Any comments regarding training? Please answer below (Optional)

8. On a scale of 1 to 5, how effectively has the new dashboard supported in communicating the targets of Vaasa Plant to your teams?
1 (Not effective at all) 2 (Slightly Effective) 3 (Moderately Effective) 4 (Very Effective)

5 (Extremely Effective)

9. What challenges or obstacles have you encountered in using the new dashboard?

10. Any comments? Please share your thoughts and experiences with the new dashboard. What do you believe are its strengths, weaknesses, and areas where it could be improved to better serve your and your team's needs?