UNIVERSITY OF TURKU
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FEASIBILITY OF THE CHOSEN INVENTORY MANAGEMENT MODEL IN A MANUFACTURING COMPANY

A case study

Operations and Supply Chain Management
Master's thesis

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Globalization has led to increased business uncertainties and disruptions. For example, COVID-19 challenged most supply chains by affecting stocking and inventory flow management. As a result, the importance of inventory management has increased, as inventories act as a protection against uncertainties. On the other hand, they also tie a lot of capital. Consequently, many organizations have implemented an information system to ensure efficient inventory management. However, many companies have difficulties synchronizing their visions and strategy as part of their inventory management decisions.

This research focuses on the feasibility of the chosen inventory management model in a manufacturing company. The aim of this research is to interpret the chosen inventory management model and determine to what extent it fits the case organization´s inventory management strategy and reflects the operating environment´s needs. In addition, the study aims to identify how the SCM system X´s inventory management model affects the case company´s operations.

To meet this twofold research aim, a literature review of relevant literature was carried out and practical research was implemented. The latter was conducted using a qualitative case study as a method. The research data was collected with semi-structured interviews by interviewing a total of five interviewees from the case company and the SCM system X´s reseller organization. The data was analyzed with theory-guided content analysis, and finally, the results were structured using the feasibility framework created on the basis of the literature review. The framework outlined the relationship between the three strategic levels of the company´s inventory management and the SCM system´s decision support system, but also described the impact of the information technology use on organizational processes.

The findings underline that the SCM system X and its inventory management model are in line with the strategic and tactical levels of the case company, as their main target is to increase availability and reduce inventories. However, from the availability point of view, the minimum service level must be separately set for the most strategically important customers so that the optimization of the inventory management model supports the case company´s strategy. At the operational level, the case company´s ERP was relatively compatible with the SCM system, whereas the optimization logic of the inventory management model raised the need for the case company to identify its strategically important products and set a minimum service level for them. In addition, based on the results, the ABC classification used by the case organization was advised to abandon. However, if the classification is needed, it was suggested to follow a multi-criteria approach instead of a single criterion in order to better identify strategically important products.

The main conclusion drawn from this study is that the chosen inventory management model mainly fits the case company´s inventory management strategy but requires some changes to the case company´s processes to achieve more benefits of the SCM system X. In addition, the implementation of the system has had both direct and indirect impacts on the organization's business, most of which are positive.

Key words: feasibility, inventory management, inventory management model, manufacturing company, decision support system

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Oppiaine: Toimitusketjujen johtaminen
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Globalisaatio on johtanut liiketoiminnan epävarmuuksien ja häiriöiden lisääntymiseen. Esimerkiksi COVID-19 haastoi useimmat toimitusketjut vaikuttaen varastoinnin ja varastojen virtojen hallintaan. Tämän seurauksena varastonhallinnan merkitys on kasvanut, sillä varastot toimivat suojana epävarmuuksia vastaan. Toisaalta koska varastot sitovat myös paljon pääomaa, monet organisaatiot ovat ottaneet käyttöönsä tietojärjestelmän varmistaakseen tehokkaan varastonhallinnan. Monilla organisaatioilla on kuitenkin ollut vaikeuksia yhdistää visionsa ja strategiansa osaksi varastonhallinnan päätöksiään.

Tämä tutkimus keskittyy valitun varastonhallintamallin toteutettavuuteen valmistavassa yrityksessä. Tutkimuksen tarkoituksena on tulkita valittua varastonhallintamallia ja määritellä miltä osin se sopii case-yrityksen varastonhallintastrategiaan ja heijastaa sen toimintaympäristön tarpeita. Lisäksi tutkimus pyrkii tunnistamaan, miten toimitusketjujärjestelmä X:n varastonhallintamalli vaikuttaa case-yrityksen operaatioihin.

Tutkimustavoitteiden saavuttamiseksi tehtiin kirjallisuuskatsaus sekä toteutettiin tutkimuksen empiirinen osuus. Tutkimusmetodina käytettiin laadullista case-tutkimusta. Tutkimusaineisto kerättiin puolistrukturoiduilla haastatteluilla haastattelemalla yhteensä viittä haastateltavaa case-yrityksestä ja toimitusketjujärjestelmä X:n jälleenmyyjäorganisaatiosta. Aineisto analysoitiin teoriaohjaavaa sisällönanalyysiä käyttämällä, ja lopulta tulokset jäsenneltiin toteutettavuusviitekehyksen avulla, joka luotiin kirjallisuuskatsaukseen pohjalta. Viitekehyksessä hahmoteltiin organisaation varastonhallinnan kolmen strategisen tason suhdetta toimitusketjujärjestelmän päätöksenteon tukijärjestelmään sekä kuvailtiin tietotekniikan käytön vaikutuksia organisatorisiin prosesseihin.

Tutkimustulokset osoittavat, että toimitusketjujärjestelmä X ja sen varastonhallintamalli ovat linjassa case-organisaation strategisen ja taktisen tason tavoitteiden kanssa, sillä molempien päätavoitteina on lisätä saatavuutta sekä vähentää varastoja. Saatavuuden näkökulmasta minimipalvelutaso tulisi kuitenkin asettaa erikseen strategisesti tärkeimmille asiakkuuksille, jotta varastonhallintamallin optimointi toimii case-yrityksen strategiaa tukien. Vastaavasti operatiivisella tasolla case-yrityksen ERP-järjestelmä nähtiin jokseenkin yhteensopivana toimitusketjujärjestelmän kanssa, kun taas varastonhallintamallin optimointilogiikan myötä esiin nousi tarve tunnistaa strategisesti tärkeät tuotteet ja minimipalvelutasojen asettaminen niille. Lisäksi tulosten pohjalta case-yrityksen ABC-luokittelusta ehdotettiin luovuttavan. Mikäli luokittelusta ei kuitenkaan haluta luopua kokonaan, ehdotettiin ottamaan käyttöön monikriteerinen menetelmä yksikriteerisen menetelmän sijaan, jotta strategisesti tärkeät tuotteet saataisiin paremmin tunnistettua.

Tutkimuksen johtopäätöksinä voidaan todeta, että valittu varastonhallintamalli on linjassa pääosin case-yrityksen strategian kanssa, mutta vaatii kuitenkin joitakin muutoksia case-yrityksen prosesseihin. Lisäksi toimitusketjujärjestelmän käyttöönotolla on ollut sekä suoria että epäsuoria vaikutuksia case-yrityksen liiketoimintaprosesseihin, joista suurin osa on ollut positiivisia.

Avainsanat: toteutettavuus, varastonhallinta, varastonhallintamalli, valmistava yritys, päätöksenteon tukijärjestelmä

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LIST OF ABBREVIATIONS

API	Application programming interface
ATO	Assemble-to-order
AX	Microsoft Dynamics AX
CODP	Customer order decoupling point
D365	Microsoft Dynamics 365
DSS	Decision support system
EOQ	Economic order quantity
ERP	Enterprise resource planning
ETO	Engineer-to-order
FGI	Finished goods inventory
IA	Inventory-to-assets ratio
ID	Inventory days
IS	Inventory-to-sales
IT	Information technology
ITO	Inventory turnover ratio
KPIs	Key performance indicators
KS	Knowledge system
LS	Language system
MTO	Make-to-order
MTS	Make-to-stock
OPEX	Operational excellence team
OPP	Order penetration point
PPS	Problem-processing system
PS	Presentation system
SBU heads	Sales business unit heads
SKUs	Stock-keeping units
TIC	Total annual inventory costs
UTL	“Up to level”
WIP	Work-in-process

1 INTRODUCTION

The acceleration of globalization has led to an increase in business uncertainties and disruptions. These factors have had a negative impact on supply chain performance. (Teerasoponpong & Sopadang 2022, 1.) For example, COVID-19 challenged most supply chains and production systems as it had effects on organizations´ stocking and inventory flow management (Priyamvada & Kumar 2022, 1). However, even before the pandemic, it has long been known that inventory acts as a significant buffer against uncertainty. The disadvantages of holding stocks have been noticed as well. (Baker 2007, 65.) Rushton et al. (2022, 224) argue that inventory costs are the most significant logistic costs in manufacturing companies. Inventories are also one of the biggest assets that companies have in the manufacturing industry as they include raw materials, components, work-in-process, and finished goods (Singh & Verma 2018, 3868). Although inventory costs vary between companies and industries, it has been asserted that the inventory carrying cost is most cases over 25 percent of its annual value (Stock & Lambert 2001). Thus, Akindipe (2014, 93–94) states that an inventory, in terms of efficient management and planning, is one of the key components which affects the total performance and the final operating result of the organization. Therefore, giving attention to inventory management in manufacturing organizations and conducting critical research on the subject is justified.

From a supply chain management point of view, monitoring and measuring information from the main operational and performance parameters of the organization, such as inventory, is essential (Gunasekaran & Ngai 2004, 270, 291). Many organizations use information systems to follow up on these parameters and their inventory management processes automatically run relying on information technology. This will enable companies to achieve competitive advantages (Shah et al. 2002, 282). However, Relph and Milner (2015, 6) point out that many companies are unable to effectively synchronize their business vision and strategy into inventory management decisions. Automation processes are often focused on the technical feasibility of the solution and thereby ignoring the overall vision of the company’s success factors (Nitsche et al. 2021, 234). Consequently, if the information is incorrect, the system’s ability to guarantee, for example, adequate availability may be at risk. (Kang & Gershwin 2005, 843.) It is therefore important to align supply chains´ objectives with the existing information systems (Shah et al. 2002, 284).

The investment in information technology and its impacts on inventory performance have been broadly studied in different academic disciplines (Shah & Shin 2007, 769). However, it has been noticed that there is a lack of research on how specific supply chain strategies can be aligned with supply chain information system strategies (Qrunfleh & Tarafdar 2014, 341). For organizations to achieve their business objectives, IT investments should be well-targeted (Dehning et al. 2007, 806). Hence, it is justified to conduct more research on this topic. Furthermore, studying the topic will also promote an understanding of how supply chain strategies and information system strategies can together improve supply chain performance. (Qrunfleh & Tarafdar 2014, 341.)

1.1 Background

This thesis is conducted as an assignment to the case company which manufactures industrial consumable parts for the business-to-business market in four different locations. The case company has customers in more than 100 countries as well as warehouse locations on several continents. The case organization has grown steadily in the 2020s and its revenue was 100 million euros last year.

The company´s growth over the last few years, extensive geographic footprint, and the management of a wide range of products has created a need to develop processes. Therefore, the implementation of the supply chain planning software, offered by the external service provider, has been started in the year 2021. It is intended to help manage a complex supply chain network and to improve the efficiency of inventory management. The software, however, requires adaptation to the needs of the company, which in turn requires the end-users to understand how the system works. Thus, this study focuses on the feasibility of the software´s inventory management model, as the logic of the inventory management model is not yet well known within the case company.

To assess the feasibility of the inventory management model, it is also important to gain a broader understanding of the case company´s inventory management practices. As the case company´s supply chain is quite complex, this study is restricted to the inventory management of one factory location and make-to-order and make-to-stock finished goods. Furthermore, the study focuses on one product group which offers the highest return compared to the other two product groups. Within this product group, the focus will be on three core items referred as D, E, and F.

1.2 Research objective and structure

This study aims to identify the feasibility of the chosen inventory management model in a manufacturing company. The focus is to interpret the chosen inventory management model and determine to what extent it is compatible with the case organization's inventory management strategy and reflects the operating environment´s needs. On the other hand, the purpose is also to outline what to consider so that the inventory management model would support the organization’s inventory strategy better. In other words, this research examines the current state of inventory management and the feasibility of a new inventory management model in the case company. In addition, the study aims to determine the impacts of the chosen inventory management model on the operations of the case company. To meet these objectives two research questions were set:

1. *To what extent does the chosen inventory management model fit the organization’s inventory management strategy?*

2. *How does the chosen inventory management model affect the operations of the case company?*

The thesis is set out as follows. The first chapter introduces the topic by leading to the themes of research. Moreover, it determines practical motivation and limitations as well as research objectives and questions. The second and third chapters dive into the theoretical framework. Chapter 2 focuses on inventory management and gives the reader an overview of the role of inventories, inventory costs, and typical inventory practices and models. In Chapter 3, the feasibility of the new inventory management model is approached from a strategic perspective, and the theory of the decision support system is presented. Furthermore, the role of information technology is presented, and at the end of the chapter, a feasibility framework for the manufacturing company´s new inventory management model is created. Chapter 4 introduces research methods and the justification for their selection. Research findings are then presented in Chapter 5, according to the main themes of the framework created in Chapter 3. Finally, Chapter 6 aims to build an overall picture of the topic by combining and interpreting the results, as well as comparing them with previous research results.

2 INVENTORY MANAGEMENT

Inventory management is a part of supply chain management, and it can be defined as a combination of procurement, transportation, stocking, and utilization of inputs. It includes forecasting, planning, inventory management, scrap management, and disposal. In other words, inventory management means managing material flows and the capital committed to the stock. (Akindipe 2014, 94; Singh & Verma 2018, 3868.) The primary objective of inventory management is twofold: firstly, to find the inventory levels that will meet customer demand, and secondly, to avoid overstock situations by minimizing investments in inventory (Singh & Verma 2018, 3868). This raises the question: how to find the balance between these two sides of the coin?

2.1 Role of inventories

The importance of holding inventories in the global supply chain has increased as the impact of globalization on lead times has been recognized (Baker 2007, 64–65). Moreover, Baker (2007, 64) states that supplier lead times are significantly higher than those of customers, except for new product lines, and therefore holding inventories is necessary in order to fulfill customers´ needs. According to Chikán (2009, 132), the main task of inventories is to streamline business operations and maintain a link between different units of an organization through the buffer provided by inventories. Williams and Tokar (2008, 222) further specify in their definition that the purpose of inventories is to maintain a balance between supply and demand processes. The need for inventories is also justified by occasional fluctuations in demand and possible transport delays. Therefore, the role of stock against uncertainty as a risk management tool is emphasized. (Baker 2007, 64.) Cannon (2008, 581–582) also asserts that according to broad research literature keeping stocks is necessary at times. On the other hand, Jammernegg and Reiner (2007, 183) highlight that inventories may occasionally signal inefficient management of the supply chain.

Inventories also have cost implications for companies (Agami et al. 2012, 469). Therefore, Agami et al. (2012,469) state that companies are under pressure to reduce stock levels to ensure profitability. Firstly, inventories tie up capital, which means the tied capital cannot be used for other investments. Secondly, storing, moving, and handling inventories generates costs. Thirdly, inventories also hide some process problems which have cost impacts.

2.2 Inventory costs

Elrod et al. (2013, 40–42) argue that one option for efficient measurement of a supply chain is cost. They describe different cost measures in their study and four of them can be directly associated with inventories: *inventory costs*, *inventory obsolescence*, *finished goods inventory* (*FGI) costs*, and *warehouse costs*. Inventory cost can be defined as cost related to inventory on hand which covers raw materials, work-in-process (*WIP*), such as components, and finished products in storage. Callioni et al. (2005, 136) state that the most significant cost of these stored materials and items is the holding cost. It consists of capital cost which is tied up to inventories, and the physical cost of having items in stock. Even though inventory cost varies from one company to another, inventory costs are usually unavoidable as companies need inventories to face market uncertainty. These types of inventories are called *safety stock*. (Elrod et al. 2013, 42.)

The inventory obsolescence cost means the costs linked to obsolete inventories or products whose value has fallen over time. (Elrod et al. 2013, 42.) To minimize these costs Elrod et al. (2013, 42.) suggest information sharing between different entities in supply chains. Furthermore, Callioni et al. (2005, 136–137) add that a well-anticipated demand will also help to reduce these costs.

FGI costs refer to the costs of finished goods in inventory, warehouse, or transit (Elrod et al. 2013, 42). The study of Capcun et al. (2009, 789–790) implicates that although WIP is an inventory type that has the highest correlation with all financial performance measures in manufacturing companies, FGI performance has a more significant impact on operating financial performance. Their results also show that the level of FGI should be low which means better inventory performance. In other words, companies should reduce their FGIs in relation to the sales ratio.

Warehouse costs may sometimes be mistakenly confused with inventory costs, although they are not the same (Chan 2003, 536). As mentioned earlier in this chapter, inventory costs refer to the products themselves, whereas warehouse costs can be defined as a cost arising from the maintenance of the storage facilities. Examples of this include rent, utilities, personnel, and maintenance costs. (Elrod et al. 2013, 43.)

In addition to these costs listed above, Gunasekaran et al. (2004, 339) mention also shortage costs and risk costs. The shortage cost is associated with a loss of sales. In a manufacturing context, the cost of damage, such as a breakdown of machinery or a scrap cost and rework related to it, can be mentioned as examples of risk costs.

2.3 Customer order decoupling point

When companies manage their supply chains, they need to decide what production strategy they are pursuing. The decision is made by setting the customer order decoupling point (*CODP*), also called the order penetration point (*OPP*), which indicates when the item is associated with a specific customer order. (Jammernegg & Reiner 2007, 184; Demeter & Golini 2014, 64). Olhager (2003, 320) defines four different production strategies: engineer-to-order (*ETO*), make-to-order (*MTO*), assemble-to-order (*ATO*), and make-to-stock (*MTS*) (Figure 1), which are also widely accepted in the literature (Demeter & Golini 2014, 64). All strategies position the OPP differently. In the case of ETO, planning and production are carried out after the customer order is received (Olhager 2003, 320). In the MTO production the OPP is located in the raw material inventory, while in MTS it is in the finished goods inventory. Instead, in the ATO production some of the parts are ready in stock, but the product is finished after the customer order has arrived. (Jammernegg & Reiner 2007, 184.)

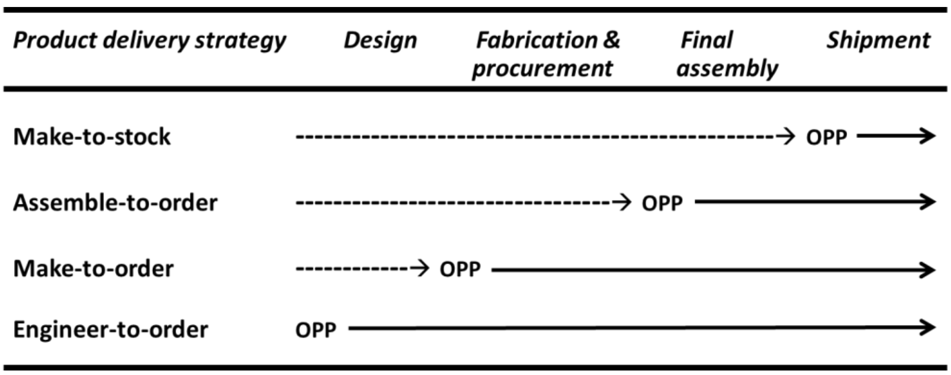

Figure 1 Strategic positioning of the order penetration point (Olhager 2003, 320)

Different manufacturing strategies are linked to the ability to manage and handle a wide range of products and customize them (Olhager 2003, 320). In terms of inventory management, the chosen strategy also defines inventory-related issues. The MTO strategy requires companies to maintain a very large stock of raw materials in order to meet customer orders as soon as possible. Instead in the MTS environment, the high level of finished goods inventories is necessary so that orders can be fulfilled from stock. In the ATO policy, on the other hand, customization of products is carried out in the last stages of production, resulting in a lower level of component inventory compared to the stocks of products produced from the outset. The ETO strategy has also lower inventories compared to the MTO strategy, as lead times from company to customers are usually long, and companies can purchase raw materials while development processes are ongoing. (Demeter & Matyusz 2011, 161.)

2.4 Stock keeping unit classification

Stock-keeping units (*SKUs*) refer to items in stock that have been treated differently depending on their product-specific characteristics. For example, differences in the predictability of demand, annual sales volume, product value, and storage requirements may lead to different production and inventory practices. Therefore, companies selling different types of SKUs benefit from the categorizing of SKUs for a limited number of classes based on item characteristics. This enables organizations to make decisions and manage the classes determined instead of a single product which would be a slow and laborious process. (Van Kampen et al. 2012, 851.)

When creating a SKU classification companies have to decide how many classes are used and how to set limits between these categories. However, the primary objective is to identify and utilize the similarity of products regarding different characteristics so that the categorization can be done. (Van Kampen et al. 2012, 851–852.) According to Bacchetti et al. (2013, 263–264), this is an important step as the classification of SKUs helps to determine service levels, forecasting methods, and inventory control practices for each class. Boylan et al. (2008, 473) also state that SKU classification has a marked impact on inventory and customer service levels. Therefore, organizations should keep in mind their inventory management targets when making classifications (Santos et al. 2015, 413).

There are different approaches and methods to categorize SKUs (Van Kampen et al. 2012, 851). However, Van Kampen et al. (2012, 866–867, 870) identify five interrelated factors which are central when operationalized SKU classes (Figure 2). Firstly, the aim of the SKU classification has to outline. It can be focused on inventory management, forecasting, or production strategy and hence gives guidance to choose characteristics that appropriate the certain strategy. If the chosen strategy leans on inventory management, the objective usually is reducing the money or space tied up in inventories. Consequently, product and volume related characteristics, such as unit costs or space needs, are used. On the other hand, if the aim is forecasting, characteristics are more often considering timing and therefore, for example, the average demand interval is used as a characteristic. In terms of production strategy characteristics related to volume, such as total demand, are useful.

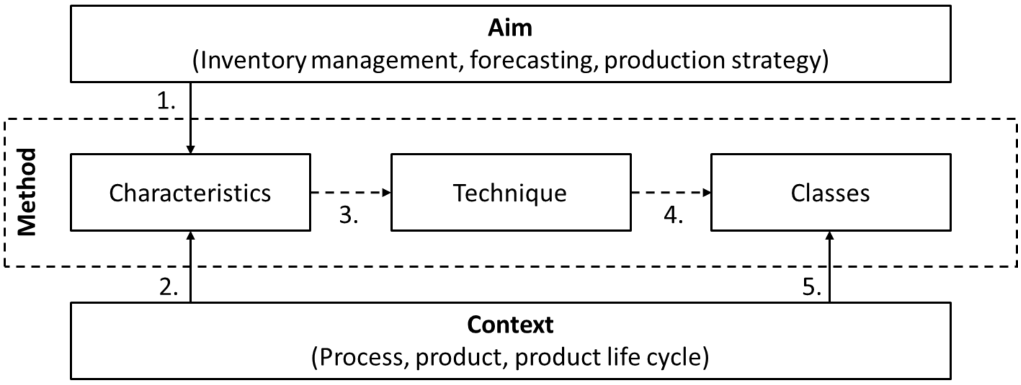

Figure 2 Conceptual framework for SKU classification (Van Kampen et al. 2012, 866)

Secondly, the context also influences the validation of characteristics and the choices of SKU classes. These contextual factors refer to the production processes, the product itself, and the life cycle of the product. For example, the criticality and perishability of the item or its lead time can contribute to the controlling of characteristics. (Van Kampen et al. 2012, 857, 865–866.)

When characteristics are chosen based on the aim and context, the next step is to validate the classification technique between two options: judgemental, and statistical. The first mentioned techniques are based on expert opinions and communicate the views of managers, whereas statistical techniques are based on data on SKU characteristics. In other words, judgemental techniques are qualitative and statistical ones follow quantitative methods. A VED technique that determines the criticality of the product is one approach of judgemental techniques and it aims to extract tacit knowledge of managers, while ABC analysis, which will be further examined in the following sub-chapter 2.4.1, acts as an example of a statistical technique. Eventually, either technique type is used, the result will be SKU classes that are still influenced by the context, for example, different batch sizes may affect borders of different SKU classes. (Van Kampen et al. 2012, 863–864, 870.)

2.4.1 ABC analysis

ABC analysis is a widely used method to manage different SKUs (Torabi et al. 2012, 530). In the traditional view, the analysis is based typically on one classification criterion. The annual demand volume or demand value is usually used as a categorization factor (Van Kampen et al. 2012, 851; Hatefi 2013 et al. 2014, 776). On the other hand, classification can also be done based on the unit level, with the criterion of the usage rate of the product or its unit value. However, when conducting the ABC analysis, the most important is to identify factors that make a level of control for a certain item valuable. Moreover, it should also be considered that analysis is performed separately for different inventories, such as raw materials and finished goods. (Onwubolu & Dube 2006, 69.)

The idea of analysis builds on Pareto´s principle which points out that 20% of the causes lead to 80% of the consequences (Kubasakova et al. 2015, 35). Following this insight, the ABC analysis divides SKUs into essential and less vital ones. Consequently, the company´s inventory is classified into three different classes: A, B, and C (Figure 3). (Onwubolu & Dube 2006, 69.) If the chosen classification criterion is, for example, annual demand, the A products represent a small number of SKUs that account for most of the sales volume (Van Kampen 2012, 852). In percentage terms, A class covers about 20% of items in inventory and makes 80% of the company´s sales volume. B class includes about 30% of items in the inventory and represents 15% of sales volume. The rest of the items will be placed in class C, with about 50% of items making 5% of sales volume. (Onwubolu & Dube 2006, 69; Ng 2007, 344.)

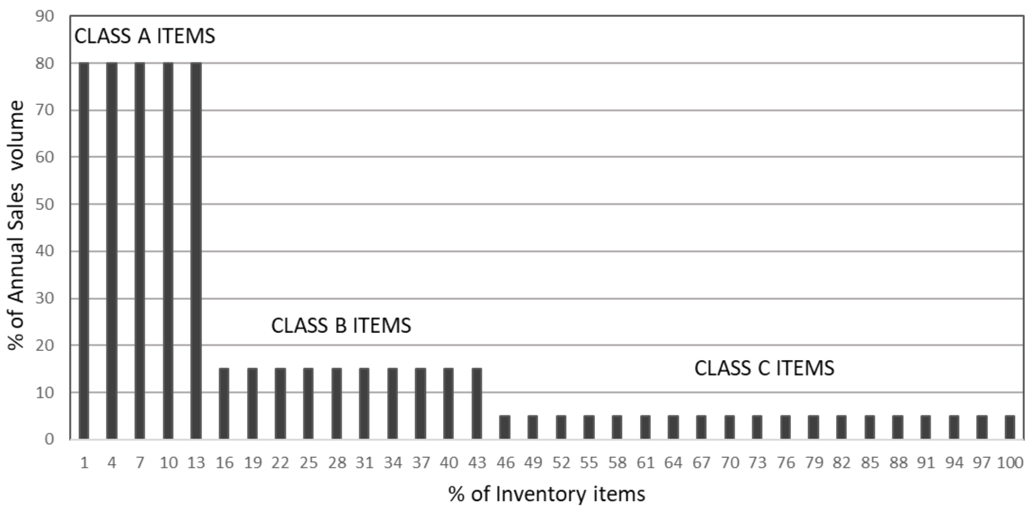

Figure 3 Typical representation of ABC analysis (Onwubolu & Dube 2006, 69)

The ABC analysis has been designed to identify products that have the most significant impact on the overall inventory cost performance of the company (Onwubolu & Dube 2006, 69). As can be seen from Figure 3, A class represents the most important products, B medium priority products, and C low importance products (Hatefi et al. 2014, 776). The percentages given in the classes are not, however, set in stone, since values may vary from one company to another (Onwubolu & Dube 2006, 69). Therefore, the percentages determined also vary in the literature (Onwubolu & Dube 2006, 69; Santos 2015, 415). Furthermore, Kubasakova et al. (2015, 34) state that the borders of the classes are not fixed and may need to be modified over time.

Different views on the importance of the ABC analysis have been presented. Cavalieri et al. (2008, 382) propose that from a financial point of view, the analysis provides an opportunity for the company to assess which products are durable items and which are more consumables. They also point out, that logistically the analysis helps to determine whether the company keeps the goods in storage or controls them on a demand-based basis. Furthermore, Teunter et al. (2010, 343) say that by applying the ABC classification companies can set their service levels which means that the same service level is assigned in its specific class for each SKU.

Teunter et al. (2010, 348) state that there is no specific guidance on setting the service level for different product groups in the literature. As A items represent the most important products, many sources of logistics and distribution management literature assert that the A items should have the highest service level and the C items the lowest one (Viswanathan and Bhatnagar 2005, 259). However, Viswanathan and Bhatnagar (2005, 259) suggest exactly the opposite of setting service levels. They point out that regards to the literature on operation management A group´s items cause high inventory carrying costs and therefore need closer attention and control. Hence, it has been suggested to set a lower service level for the A group compared to the C group to keep inventory costs low. This, on the other hand, means that a review and a replenishment are done more frequently for the A-class items. As regards category B items, service levels are similar to the A items, but the control happens less frequently (Onwubolu & Dube 2006, 69). Instead, the highest service level is set for group C items and the review and replenishment take place less frequently (2005, 259). However, Teunter et al.´s (2010, 348) study implies that the literature is correct in terms of logistics and distribution management and that the highest service level should be provided to the A items.

As can be concluded from the above text, the ABC analysis consists of several stages. Millstein et al. (2014, 71) state that there is usually a three-step approach used among practitioners to control stocks. First, SKUs are categorized as A, B, and C groups according to the criterion, for example, sales volume, chosen at the beginning. Second, the desired values are defined for different categories, such as the target service level, which communicates the organization´s inventory policies. Third, inventory and sales managers asses together with finance whether the inventory control policy is feasible in terms of inventory and management budget.

2.4.2 ABC-XYZ analysis

According to Yu´s (2011, 3420) study, to manage inventory more effectively, the traditional ABC model should be abandoned and replaced by a multi-criteria model. This can be justified by the fact that the ABC analysis accounts for only one criterion and thus ignores other relevant criteria. These criteria include, for example, lead time, obsolescence, and cost information. (Ng 2007, 345; Yu 2011, 3420.) Whybark and Flores (1987, 79) point out that some of these criteria may be even more valuable than the original single criterion chosen in the ABC analysis.

ABC-XYZ analysis can be mentioned as one example of a multi-criteria inventory model. It is an extension of the ABC analysis and applies two criteria. (Stoll et al. 2015, 226.) In other words, the ABC-XYZ analysis uses not only the traditional ABC analysis criterion but also demand or consumption variability as a time-based measure that covers the XYZ analysis part (Kubasakova et al. 2015, 34; Stoll et al. 2015, 226). According to Kubasakova et al. (2015, 34), the XYZ analysis improves the efficiency of sorting related to the importance of products. In their categorization, X represents items that have only small fluctuations in consumption and high predictability. Y group includes items with moderate prediction accuracy and irregular consumption. Instead, the products of group Z have low predictability and irregular demand.

Scholz-Reiter et al. (2012, 446–447) point out in their study that the first step in applying the XYZ analysis is to set the considered period. The second step is to set critical values of the variation coefficient which defines the product's consumption as a standard deviation over a certain period. This, in other words, describes the average consumption. The considered period is usually 12 months which has often been highlighted in technical literature. Moreover, the consumption of products is added up monthly. The variation coefficients are set according to the following logic:

- X-products: variation coefficient *less than 0.5*
- Y-products: variation coefficient *between 0.5 and 1*
- Z-products: variation coefficient *greater than 1*

Based on ABC and XYZ classifications, the ABC-XYZ analysis is created by combining both classes (Figure 4). As can be seen from the figure below, for example, the products of the AX class have the highest sales volume or value and have a good predictability of consumption. Instead, the products included in group CZ have the lowest sales volume or value and the weakest predictability. (Stoll et al. 2015, 228.)

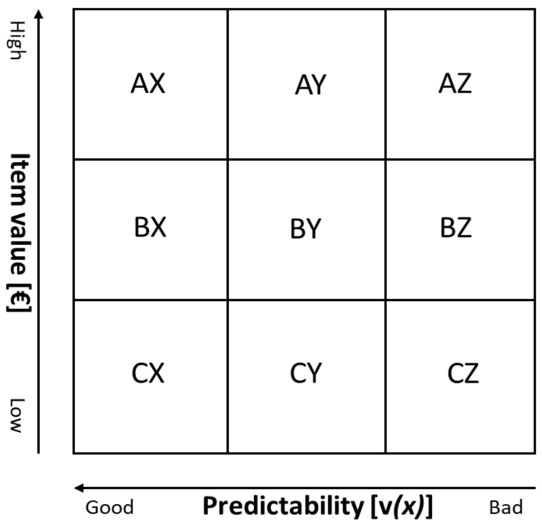

Figure 4 Integrated classification approach: ABC-XYZ analysis (Adapted from Stoll et al. 2015, 228)

In particular, the disadvantage of XYZ-analysis can be the overestimation of the coefficient of variation due to seasonality or other irregularity in purchases (Evdokimova 2021, 2). Thus, this may also have an effect on the ABC-XYZ analysis.

2.5 Inventory models

As companies' performance depends on several factors related to supply chains and there is also uncertainty in the market, attention has been focused on improving the efficiency of organizational activities. With these activities, Ramírez et al. (2012, 320–321) refer to sufficient production to keep production and transport costs as low as possible, while meeting the needs of customers. However, they also point out that companies should not produce items in too big quantities, as the aim is to minimize inventory costs. Based on this, many companies have centered their resources on a good forecast. However, this alone is not enough; an effective stock model to manage inventories is also needed. (Ramírez et al. 2012, 321; Nakhaeinejad et al 2023, 105.)

Inventory models are based on mathematical models and simulation, and they assess, for example, optimal order quantity, reorder point, and safety stock while considering the limitations of materials and resources, and the target service level, by minimizing inventory costs (Boulaksil 2016, 27–28; Nakhaeinejad et al 2023, 105.) Therefore, the importance of inventory models, especially for industrial operations, is acknowledged. An extensive number of studies have also been carried out on this subject since the necessity of mathematical models and simulation to support the right inventory decisions has been recognized. (Nakhaeinejad et al. 2023, 105.) According to Boulaksil (2016, 27), the role of uncertain demand is highlighted in most studies carried out on supply chains and inventory management. However, Nakhaeinejad et al. (2023, 106, 109) state that most studies have also simplified inventory control models by setting the model parameters to static and ignoring the complexity of the real world. The economic order quantity model is presented in the following sub-chapter 2.5.1, as an example of the simplified model. Furthermore, two different approaches to inventory control systems are also introduced in the sub-chapter 2.5.2.

2.5.1 Economic order quantity

The economic order quantity (*EOQ*), which is a well-known simple inventory model, was originally developed by Harris in 1913. It considers as an assumption that demand occurs continuously at a certain constant rate. The basic idea of the model is to place the standard order quantity each time the stock level falls to the threshold. Both the economic order quantity and the threshold are obtained as a result of optimization. (Perera et al. 2017, 216.) To derive the square-root formula of the EOQ, Shenoy and Rosas (2018, 36–38) state that two steps are needed. The first step is to create a formula for the total annual inventory costs (TIC). It consists of the sum of ordering costs, holding costs, and purchasing costs (Figure 5):

TIC= Annual ordering costs + Annual holding costs + Annual purchasing costs

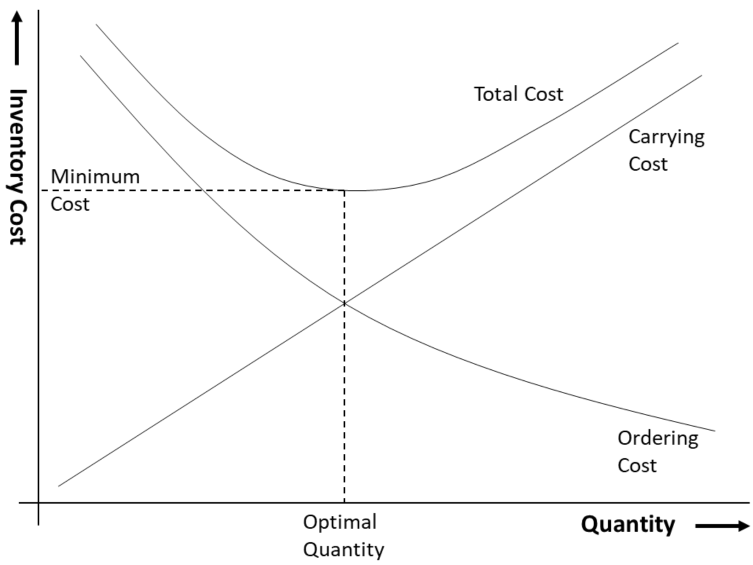

Figure 5 Total inventory cost function (Shenoy & Rosas 2018, 37)

The annual ordering cost can be shown by the following mathematical formula where D is the annual demand of an item, Q is economic order quantity, and C_0 is ordering cost per order:

$$Annual\ ordering\ cost = \frac{\mathrm{D}}{\mathrm{Q}} C_0$$

The annual holding cost consists of the average inventory over the entire duration of the planning horizon of one year which is Q/2, inventory holding rate is i, and C represents the unit cost of item:

$$Annual\ holding\ cost\ = \frac{\mathrm{Q}}{2} iC$$

The annual purchasing cost can be illustrated as follows, where D is the annual demand for an item, and C is unit cost, as mentioned earlier:

$$Annual\ purchasing\ cost\ = DC$$

Hence, the total inventory cost has been derived and is shown below as a mathematical formula:

$$TIC = \frac{\mathrm{D}}{\mathrm{Q}} C_0 + \left(\frac{Q}{2}\right) \mathrm{iC} + \mathrm{DC}$$

The second step is to differentiate the TIC formula with respect to Q, delete the annual purchasing cost from the formula as it is an independent term of Q, and finally equate the remaining clause to 0:

$$\frac{\mathrm{d(TIC)}}{\mathrm{dQ}} = -\frac{\mathrm{D}}{Q^2} C_0 + \frac{\mathrm{iC}}{2} = 0$$

This formula may be reduced to the form below revealing the economic order quantity:

$$EOQ\ = \sqrt{\frac{2\mathrm{D}C_0}{\mathrm{iC}}}$$

2.5.2 Inventory control systems

As stated by Onwubolu and Dube (2006, 70) inventory models´ control systems can be divided into two commonly used types based on a logic of replenishment of inventory:

continuous review system, and periodic review system. The service level, which means the percentage of orders that are received from the existing stock before a stock-out situation, is an important parameter when applying both types of inventory control systems. Furthermore, historic data is also needed so that optimization can be done. In a continuous review system expected demand follows the normal distribution pattern:

$$Z = \frac{\mathrm{X} - \mu}{\sigma}$$

Where *Z* is the number of standard deviations for a specified cycle service level, *X* means reorder point, μ refers to mean of expected demand, σ is standard deviation of demand (Onwubolu and Dube 2006, 70; Shenoy & Rosas 2018, 155). When the reorder point is solved, it is possible to determine the formula of safety stock:

$$SS = Z\sigma$$

Consequently, the order point as well as the safety stock of the continuous review system have finally been defined. However, according to Onwubolu and Dube (2006, 70–71), the use of continuous review is very expensive, so the periodic review system is recommended use instead. The periodic review system differs from the mathematical formula of the continuous one. Firstly, the review interval *R* is calculated based on the EOQ and the annual demand *D*:

$$R = \frac{\mathrm{EOQ}}{\mathrm{D}}$$

Secondly, the order "up to level" (*UTL*) is calculated. The order UTL refers to achieving or undershooting the reorder point which means that the inventory needs to be replenished. The following formula may be applied to the UTL:

$$UTL = \begin{cases} D(R + L_t) & option\ 1 \\ \{D(R + L_t) + s\} & option\ 2 \end{cases}$$

Where L_t refers to lead time, and safety stock *SS* is calculated as follows:

$$SS = Z\sigma\sqrt{\frac{\mathrm{R} + L_t}{L_t}}$$

3 FEASIBILITY OF A NEW INVENTORY MANAGEMENT MODEL

The decision of business systems and their implementation strategy play an important role in inventory management, as these characteristics will eventually determine the strategic impact of new technology (Goodman & Griffith 1991, 261; Relph & Milner 2015, 32.) Hence, it is important that organizations apply information systems that are compatible with their supply chains. In other words, the system supports certain supply chain processes, such as inventory management, and enables information on central parameters. (Qrunfleh & Tarafdar 2014, 340.) This requires that the underlying organization´s supply chain objectives are in line with the system (Relph & Milner 2015, 32).

3.1 Strategic approach

Dehning et al. (2007, 806) argue that IT investments, such as supply chain management systems, are particularly important to target well. In other words, they are implemented to achieve certain business objectives. Thus, to assess the business value of the system, the performance indicators must be considered.

As highlighted by Naseem et al. (2017, 171), strategic management is needed for this process. They describe in their study that the top management must first stipulate the key targets. Second, policies and the development of plans will be drawn up to achieve the objectives. Third, the resources will be allocated to implement the plans. Instead, Rushton and Oxley (see Gunasekaran et al. 2004, 335) define at an even more precise level that there are three levels of the hierarchies in function through which performance can be reviewed: strategic, tactical, and operational level. The strategic level deals with measures that influence the decisions of the top management. It reflects on a large scale, organizational policies, such as financing plans, competitiveness, and adherence to key objectives. The tactical level represents an allocation of resources and measures performance against targets. These targets should be met so that results of strategic level can be achieved. All in all, the tactical level provides information on the decisions of middle management. The operational level, on the other hand, reflects the results of lower-level managers´ decisions. Hence, the achievement of the operational objectives set by managers and employees will determine whether the targets of the tactical level will be achieved.

Gunasekaran et al. (2004, 335) highlight that many companies have failed to maximize the potential of their supply chain as they have not succeeded in developing appropriate measures to follow up effectively supply chains´ performance. Organizations often have quite a multiplicity of performance metrics, although it would be preferable to focus on a few essentials. Lee and Billington (1992, 65) also point out that different departments may have objectives that conflict with each other. Consequently, if operational targets are not aligned inside the company, it results in inefficiencies in the supply chain´s overall performance. Hence, Gunasekaran et al. (2004, 335) state that performance measures should be developed to measure the objectives of the organization and the achievement of those objectives.

3.1.1 Key performance indicators

Key performance indicators (*KPIs*) can be defined as financial and non-financial measures that monitor the performance of a company and help to understand decision making (Velimirović et al. 2011, 63; Bishop 2018, 13). In essence, KPIs aim to achieve firms´ long-term targets. Hence, they motivate managers and all stakeholders to fulfill those objectives. On the other hand, KPIs also reveal information about poor performance and communicate improvement areas. (Velimirović et al. 2011, 63, 65.) Therefore, KPIs are usually made up of a combination of various reports, charts, or spreadsheets, and thus provide realistic and visual information on company health at a glance to the end user (Onwubolu & Dube 2006, 71).

KPIs vary depending on the industry and company. Sometimes they can be based on only standards defined by the industry. However, this is not recommended as failure may result if the organization´s specific needs are not considered. When company create KPIs it should take into account the factors set out in Table 1. (Bishop 2018, 13.)

Table 1 Factors to consider when creating KPIs (Bishop 2018, 13)

• Number of KPIs	• Manageability and controllability of KPIs
• Frequency of measuring KPIs	• Differentiating enterprise wide KPIs from departmental ones
• Consider all organizational levels when formulating KPIs	• Infrastructure to support formulated KPIs
• Targets to be set for different KPIs	• Identifying the purpose of establishing each KPI

Bishop (2018, 13) argues that the number of KPIs should be limited and set only for the most critical activities. Chae (2009, 423) also agrees and adds that organizations should concentrate on necessary KPIs which monitor their meta-level processes such as plan, source, make, and delivery.

In terms of inventory management, the plan but also delivery processes play key roles. There are several different inventory ratios considered in operation management studies included in the two above-mentioned meta-processes. Their use varies from one case to another as the purpose determines the appropriate measure. (Chen et al. 2005, 1018; Shah & Shin 2007, 775; Chae 2009, 424.) With correctly selected indicators, organizations are able to compare the performance from the preceding period with the current performance (Kwak 2019, 760). Furthermore, Hançerlioğulları et al. (2016, 682) point out that companies can also assess their performance against other companies operating in the same field.

Chen et al. (2005, 1018) stress that from the operations management point of view, it is important to know how long stocks are held. The calculation of inventory days (*ID*) provides an answer for this as it tells the average days in which the inventory turns over. In the formula below, I denote the company´s average inventory value in year *t*, and $COGS$ represents the cost of goods sold in year *t*.

$$\mathrm{ID} = \frac{\mathrm{I}_t * 365\ \mathrm{days}}{\mathrm{COGS}_t}$$

Another important measure is the inventory turnover ratio (*ITO*), as it is, according to Vastag and Whybark (2005, 134), the most usually used performance indicator. Hançerlioğulları et al. (2016, 682) also confirm that most empirical papers on inventory management apply inventory turnover ratio to measure inventory performance. They define inventory turnover as the cost of goods sold to the average inventory value in a certain period. The formula below uses the same symbols, *I*, *t,* and *COGS*, as for the previous ID ratio.

$$\mathrm{ITO} = \frac{\mathrm{COGS}_t}{\mathrm{I}_t}$$

The inventory turnover ratio can be approached from several different perspectives (Vastag & Whybark 2005, 134). For example, in Demeter´s (2003, 205) study inventory turnover is used as an indicator of company level competitiveness. Instead, Vastag and Whybark (2005, 134) use that measure to determine the effectiveness of management. However, Demeter (2003, 205) emphasizes that since inventory turnover is influenced by many internal and external factors, the indicator is more suitable for controlling changes within a company than the comparison of business performance. With internal and external factors, she refers, for instance, to the firm size, the type of industry, and the characteristics of the market.

In addition to ID and ITO ratios, Chen et al. (2005, 1018) also mention inventory-to-sales (*IS*) and inventory-to-assets (*IA*) ratios as popular measurements. The inventory-to-sales ratio measure uses the same formula as the ID ratio, but COGS is replaced by sales.

$$\mathrm{IS} = \frac{\mathrm{I}_t * 365\ \mathrm{days}}{\mathrm{sales}_t}$$

The inventory-to-assets ratio compares the average inventory of the company in year *t* to the total assets of the firm in the year *t*. In the formula below, *TA* denotes total assets and the symbol *I* is used as above.

$$\mathrm{IA} = \frac{\mathrm{I}_t}{\mathrm{TA}_t}$$

One more measure, availability, can be added as a follow-up to the above performance indicators. According to Peinkofer et al. (2016, 231), inventory availability can be defined as a combination of the following processes: inventory replenishment, allocation, distribution, and visibility. These characteristics signal the effectiveness of supply chain management practices. However, Zinn et al. (2002, 21–23) point out that availability is an ambiguous concept that is normally defined as a measure of a single product or order level in the literature. Furthermore, there are several indicators at both levels to illustrate the availability from slightly different perspectives. At an item level, can be mentioned, for example *the Probability of No Stockout Within a Lead Time* which refers to the probability that an item will be available in a promised lead time, and *the Unit Fill Rate* which means the quantity of units supplied from stock on hand compared to the total quantity of the ordered units. According to Akçay et al. (2020, 8), the unit fill rate is also referred to as the service level. An example of the order level indicator is *the Order Fill Rat*e. It compares the number of completely filled orders to the total number of orders.

3.1.2 Performance pyramid system

The performance pyramid system is the structural framework created to illustrate a company's performance. It combines elements of activity accounting, industrial engineering, and total quality management. The pyramid consists of four levels defined by *a corporate vision* that forms the triangle tip (Figure 6). The main idea of the pyramid is to institute the strategic vision through different levels by providing a two-way communication system. Objectives are flowing down and measures in the opposite direction. Hence, the performance pyramid enables external effectiveness and internal efficiency to be achieved. (McNair et al. 1990, 30.)

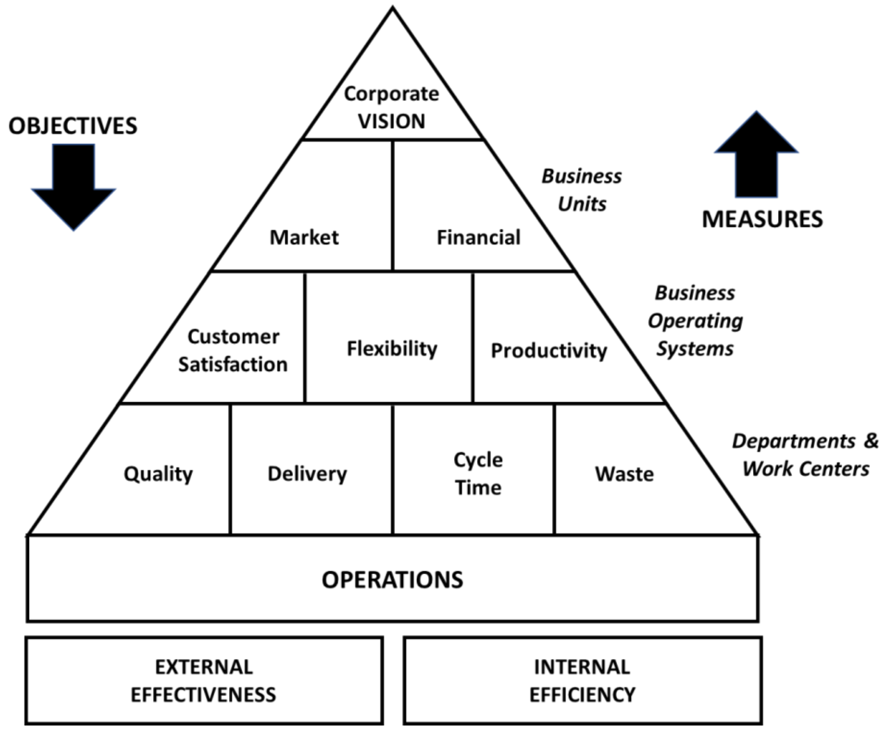

Figure 6 The Performance Pyramid (McNair et al. 1990, 30)

When moving from the tip of the pyramid towards the bottom, the second level is *the business unit level*. It illustrates market and financial targets, such as revenue, market share, and profit goals at the business unit level. In order to meet those specific objectives, strategies, financial forecasts, and budgets are set. (McNair et al. 1990, 30.)

At *the business operating system level*, which is the third level, the purpose is to transform the business unit strategy into tangible operating goals. This is a critical phase, as daily activities should be applied to support strategic and financial objectives as they determine whether these goals have been achieved. The business operating system level is built on three different factors: customer satisfaction, flexibility, and productivity. Customer satisfaction means taking customers` expectations into account. Flexibility can be defined as the overall responsiveness of the business operating system. Productivity refers to the management of activities and resources in such a way that objectives of customer satisfaction are met. (McNair et al. 1990, 30.)

At the fourth level, which is called *the department and work center level*, the role of day-to-day activities is to obtain signals of the capability of this level. As a result, improvements can be made continuously when this capability information flows upward in the pyramid. The department and work center level consists of four different characters:

quality, delivery, cycle time, and waste. Quality and delivery are both tied up to the customer´s expectations. Quality means that the compliance of customers is met, while delivery refers that the right amount is delivered on time. Cycle time and waste can be seen as internal levers which have the strategic importance. Cycle time is defined as the time between the order release and the shipment of the finished goods. Waste means decreasing nonvalue-added resources or activities. (McNair et al. 1990, 30.)

3.2 Inventory control through a decision support system

In today´s competitive market environment, using effective inventory control and order management methods is necessary to ensure good service quality and maximization of profit (Nakhaeinejad et al. 2023, 104). According to San-José et al. (2019, 200), the focus of inventory control is on management decisions aimed at minimizing storage costs and meeting customer needs. The inventory control and other supply chain relation decisions can be made by the decision support system (DSS). It usually is a computer-based information system that controls the flow of goods and services in the supply chain by strengthening the supply and demand indicators (Naseem et al. 2017, 171; Attadjei et al. 2018, 157). Thus, in a bigger picture, the DSS helps supply chain stakeholders to convert information, received from the entire supply chain pipeline or part of it, into decisions. Furthermore, as the system automates processes, the number of human errors also decreases. (Attadjei et al. 2018, 157.)

According to Attadjei et al. (2018, 158), the DSS consists of the following specific parts: the language system (LS), the presentation system (PS), the problem-processing system (PPS), and the knowledge system (KS). The LS represents a part that processes instructions. In other words, the LS received input information from a user. The PS focuses on displaying the information of the DSS. The PPS steers the system to find a solution to the problem at hand, whereas the KS stores data or information that the system contains for analysis. Figure 7 illustrates all these components mentioned above and their relation to each other and the user of the DSS.

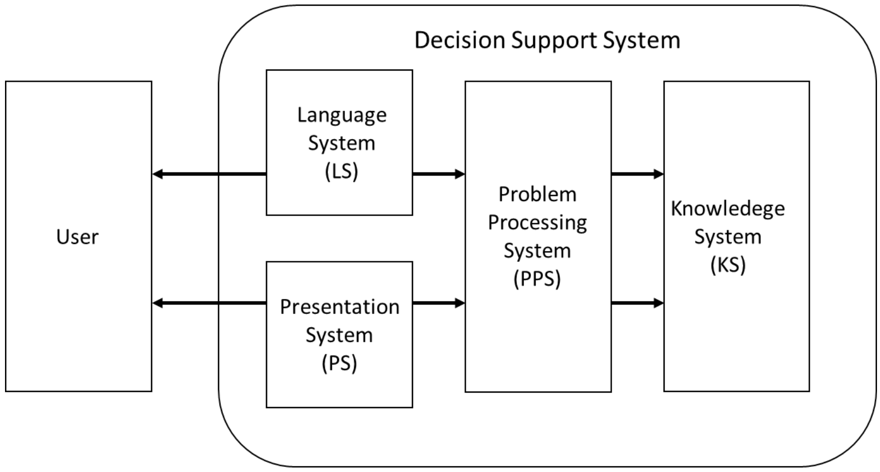

Figure 7 Generic Decision Support System (Attadjei et al. 2018, 158)

The study by Teerasoponpong and Sopadang (2022, 1, 5, 8), where the decision support system is proposed for sourcing and inventory management, can also identify most of the factors shown in Figure 7. According to the study, firstly, decision makers update an input data in application programming interface (*API*). Secondly, the problem processing system starts to set the support solutions by optimizing input information based on internal control parameters. In terms of inventory control, with internal control parameters refer to, service level of inventory, order interval, current on-hand items, and usage rate. Thirdly, the DSS shows following optimized inventory parameters: optimal order quantities, safety stock and reorder points. The figure 8 below combines the perspective of Teerasoponpong and Sopandang study to Attadjei et al. DSS context.

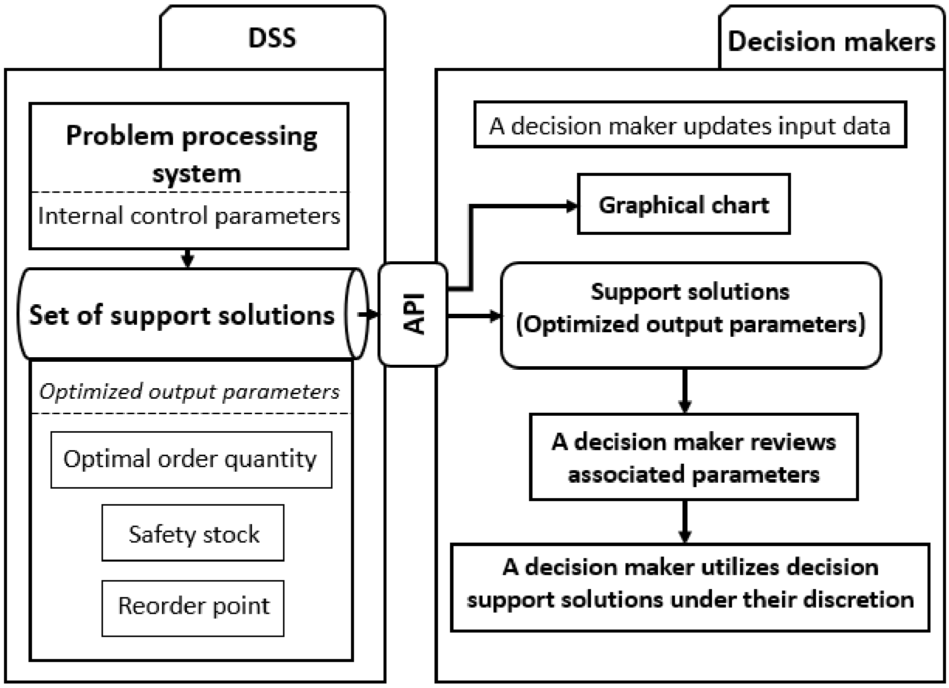

Figure 8 Process of implementing the decision support solutions (Adapted from Teerasoponpong and Sopadang 2022, 10)

Based on inventory parameters that the DSS gives as an output, the system asses and graphically shows predefined performance indicators. Consequently, the decision maker decides whether to accept the proposal on hand (support solutions) or create another scenario with different values of decision variables. (Molinaro et al. 2019, 1440; Teerasoponpong and Sopadang 2022, 8.)

An example of the DSS use and the progress of the process can be considered in the study of Boulaksil (2016, 28), in which he illustrates the process of setting up the safety stock at a common level. A schematic overview of this process is shown in Figure 9.

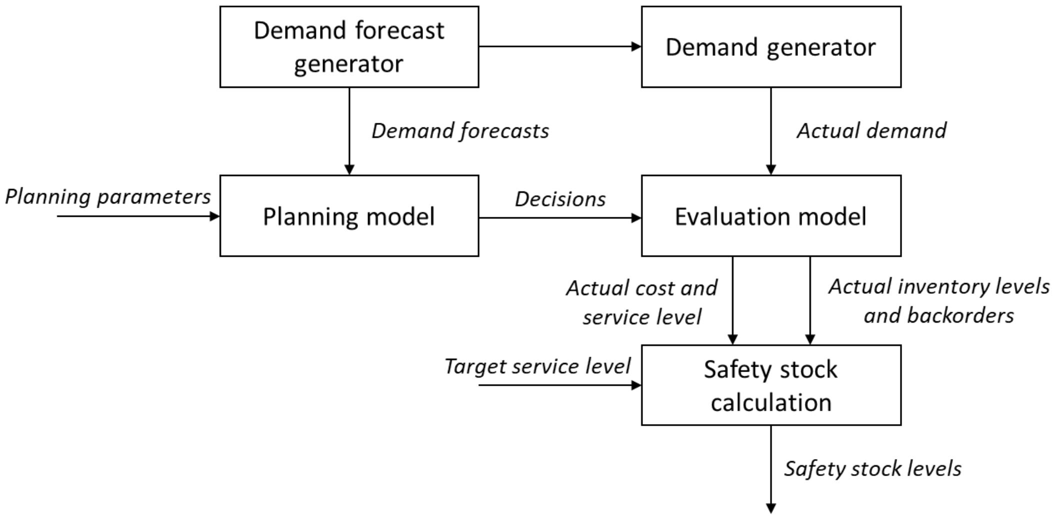

Figure 9 A schematic overview of the safety stock placement approach (Boulaksil 2016, 28)

The centralized planning system is forming the core which controls the supply chain and supports the decision-making process in it. The determination of the safety stock begins from the planning problem defined by mathematical modelling, and it also presumes a setting of a certain time horizon. To solve the planning problem, input parameters, demand forecast, and information about inventory levels and backorders are needed. As a result, the planning model gives a decision, which is implemented inside the company. This implemented planning model serves as a production and inventory decision of the current period. However, the actual demand for that period is revealed afterward and creates a basis for new decision variables which have an effect on the next planning period. Hence, an iterative process repeats itself when the planning horizon is moved one period forward at a time and a new planning problem is faced. Finally, at the end of each period, the organization is able to derive optimal safety stock and achieve the target service level. (Boulaksil 2016, 28.)

3.3 Role of information technology

Information technology (*IT*) enables integration through the value chain by capturing, organizing, and sharing business processes related information within the company but also outside its boundaries (Dehning et al. 2007, 808). Thus, many studies have found that supply chain management software provides value in several different forms (Blankley et al. 2008, 201). However, studies on the link between IT and organizational performance differ in the way they conceptualize key structures and relationships between them (Melville et al. 2004, 283).

One way to examine the value creation of IT is a process-oriented perspective. Dehning and Richardson (2002, 9) simplify in their study this value creation process and its effects on an organization (Figure 10). They stress that information technology has both direct and indirect effects on business processes. Similarly, the development of business processes has an impact on the overall performance of the organization.

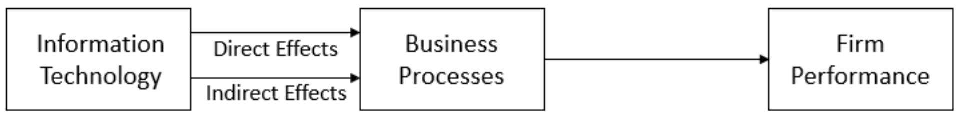

Figure 10 Simplified impact of IT on the firms (Dehning & Richardson 2002, 10)

In terms of the direct effects of IT, an example can be mentioned the improvement of inventory management, whereas indirect effects refer to, for example, the enhancement of decision-making and forecast processes. In practice, improvement of inventory management means that proper use of IT decreases inventory levels, inventory holding costs as well as waste. The improvement of decision-making and forecast processes refers to the availability of new information which was previously unattainable. (Dehning & Richardson 2002, 10.) The combined effects will increase profitability and may also indirectly affect the company's performance by reducing the costs of coordination, sales, administration, and overheads (Dehning et al. 2007, 808). However, Blankley et al. (2008, 201) argue that it is likely that the direct effects will ultimately be the main sources of economic benefits.

Melville et al. (2004, 293) complement the model of Dehning and Richardson by adding factors outside IT to the value generation process. The complementary model considers the characteristics of the focal firm, competitive environment, as well as macro environment (Figure 11).

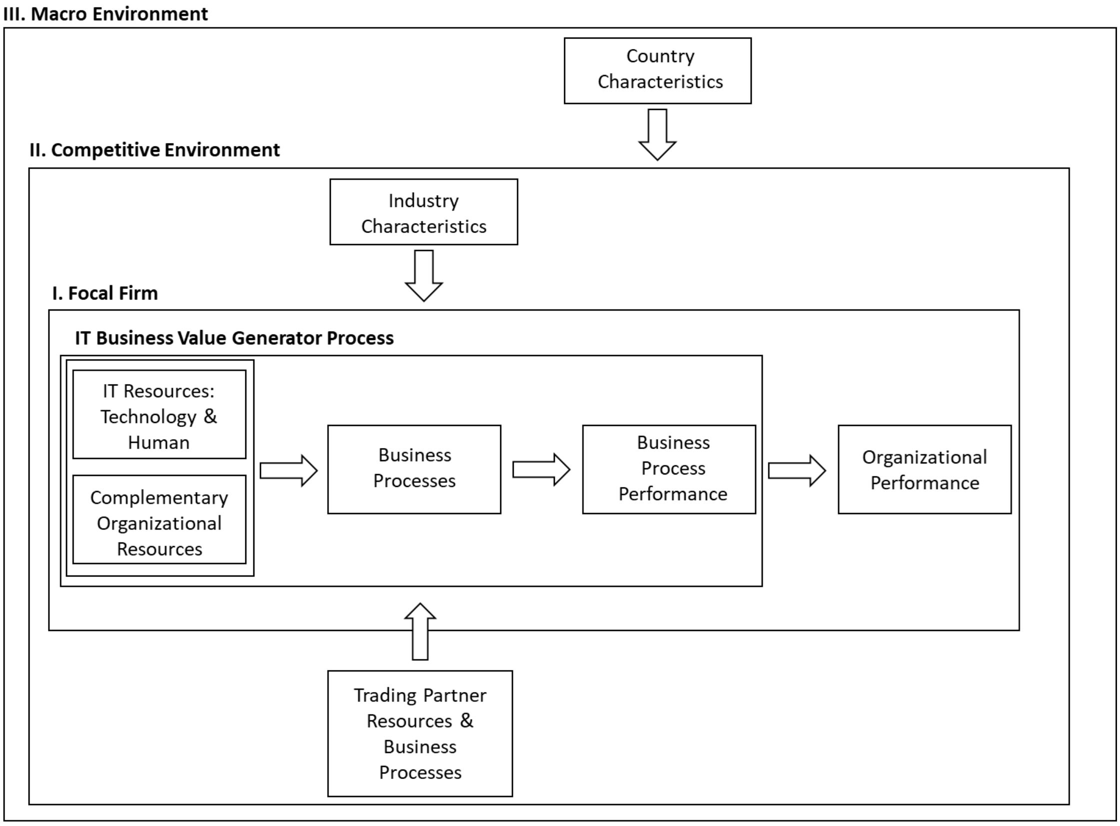

Figure 11 IT Business Value Model (Melville et al. 2004, 293)

The first layer inside the model is the focal firm that acquires and implements IT systems. The value creation for the company is gained, not only through the use of IT but also through the introduction of complementary organizational resources, such as organizational structures or policies. Correspondingly, these together can improve business processes or develop new ones and thus have an impact on the performance of business processes and the overall performance of the organization. (Melville et al. 2004, 293.)

The second layer is the competitive environment which consists of industry characteristics and trading partners. The first mentioned domain includes for instance competitiveness, technological change, and other factors affecting the application of business activities in the target company. The trading partners, which is the second mentioned domain, refer to business processes of focal firm suppliers and buyers. (Melville et al. 2004, 295–296.)

The third and outermost layer is the macro environment. It includes country- and meta-country specific attributes, such as regulation of technology development, research and development investments, IT talent, and culture, which also contribute to the successful application of information technology. (Melville et al. 2004, 297.)

In light of the considerations outlined above, the size and extent of the value that IT creates depends on several factors. To sum up, these are the type of IT and its direct and indirect effects, management procedures, organizational structure, and competitive and macro environment. The impacts are reflected in both business processes and the organization's overall performance. (Dehning & Richardson 2002, 9; Melville et al. 2004, 284.)

3.4 Feasibility framework for the manufacturing company´s new inventory management model

The subject matter of the study has been extensively addressed in research literature from a quantitative point of view by describing various inventory optimization models, and a qualitative aspect of the subject has received less attention. However, as stated by Goodman and Griffith (1991, 261), it is important to have a good understanding of the implementation process since the strategic impact of new technology depends on it. Therefore, the purpose of this study was to highlight a less researched perspective by combining the theory of inventory management, strategic perspective, and information technology.

Based on these three concepts and the literature review of them, a research framework of the feasibility of a new inventory management model was created (Figure 12). It describes a process by which the feasibility of a new inventory management model can be assessed. The framework also helps to understand the impact of the new inventory management model on business.

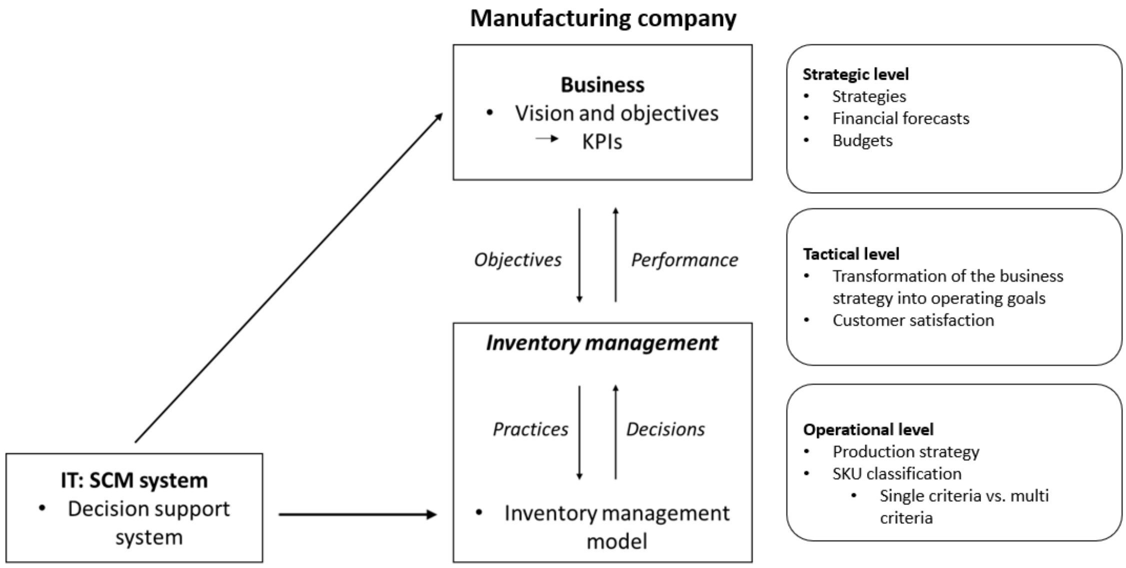

Figure 12 Feasibility framework for the manufacturing company´s new inventory management model

Overall, the figure is formed by keeping in mind the structure of McNair´s et al. (1990, 30) performance pyramid system introduced in sub-chapter 3.1.2. However, as the aim is to examine the feasibility of the chosen inventory management model, the figure highlights in particular inventory management process. In addition, the role of information technology has also been considered in the form of an SCM system and decision support system, as they finally place the possibilities and constraints on the inventory management model. The different levels of action have also been considered from a strategic perspective to ensure a holistic assessment of feasibility.

When analyzing the figure from top to bottom, the process starts by looking at the organization's vision and objectives, which together give the frame to the top-level KPIs. As Velimirović et al. (2011, 63) highlighted in their study, the key purpose of KPIs is to achieve a company´s targets in the long run. To achieve them, strategies, financial forecasts, and budgets are set. As seen from the figure this part of the process is defined as actions at the strategic level and it reflects the top management decisions.

When moving downwards in the figure the second part of the process consists of tactical level actions and reflects the middle management decisions. The main purpose of this level is to transform the business unit strategy into tangible operating goals by allocating resources and measuring performance against objectives. Therefore, objectives flow down in the figure and performance in the opposite direction. In addition, customer satisfaction is also considered at this level, in particular, by integrating it into tangible operating goals.

The third part of the process and at the same time last level is the operational level which reflects the results of decisions taken by the lower-level managers. This level concentrates on inventory management practices and signals the capability of the level through day-to-day inventory activities. Finally, this level determines can the tactical level objectives be achieved. On the other hand, it also enables continuous development of activities when signals of operational capabilities flow to the tactical level.

On a more detailed level inventory management practices means the decision of production strategy and SKU classification. First of all, the production strategy determines the starting point for inventory management, as the positioning of the order penetration point partly defines the capital committed to inventories. Instead, SKU classification classifies SKUs into different groups according to the company´s strategy and helps to define service classes, forecasting methods, and inventory control practices for the groups. SKU classification can be focused on inventory management, forecasting or production strategy, and finally, this approach determines which factor (single criterion classification) or factors (multicriteria classification) the classification is based on.

The inventory management model of the SCM system combines the company´s strategy through inventory management practices with information technology. The DSS that SCM system includes set limitations and helps the company to convert information into decisions. On a more detailed basis, first, the language system of the DSS receives and processes the input data, second, the problem-processing system optimizes input data by leaning on the knowledge system which contains stored data for the analysis, and third, the presentation system offers an output data for the user by displaying the information of the DSS. Based on the DSS system´s suggestion and the company´s strategy, the user validates the output data and makes a decision. Then, the decision and its effects flow upward in the figure, and it enables the measurement of inventory management performance. Finally, these measures are compared to KPIs and the company´s overall targets.

Since the use of information technology has also an impact on business, an arrow has been drawn between the SCM system and the organization´s vision in the Figure 12. The arrow goes through each strategic level and ends up in a vision of the business, reflecting the impact of information technology on both: business processes and the organization´s overall performance. Furthermore, it considers both the direct and indirect effects of information technology but also the effects of the contextual environment including management procedures, organizational structure, and competitive and macro environment.

4 RESEARCH METHODS

This chapter deals with methodology and method choices by justifying decisions and limitations made in this research. The structure of this chapter is as follows: research approach, data collection and analysis, and aspects of trustworthiness and ethical considerations. First, the choice of qualitative research, action-analytic approach, and intensive case study is presented and justified. Second, the semi-structured interview as a data collection method is explored, which follows a description of the theory-guided content analysis method. Finally, Trustworthiness is approached from perspectives suitable for qualitative research, and ethical considerations are addressed based on the protection of human participants.

The main objectives of this study have been borne in mind when making methodological choices. As outlined in the introduction chapter, the main objectives of this research are to, first, identify the feasibility of the chosen inventory management model in a manufacturing company; second, determine the impacts of the inventory management model on the case company´s operations.

4.1 Research approach

The study was conducted as qualitative research and the research approach was classified as an action-analytic. At its simplest level, qualitative research can be determined as a non-numeral description of the form of the data and analysis. The nature of the qualitative study has often also been defined through what it is not by comparing it to quantitative research. This may, however, sometimes be misleading when discussing, for example, the goodness or badness of research. (Eskola & Suoranta 2005,13–14.) On the other hand, when it comes to highlighting differences in research practices (*pragmatic emphasis*) and principles (*epistemology*), comparison can be useful. For example, from an epistemological point of view, when considering how to approach a research problem, quantitative research is based on methods and qualitative on phenomena. (Eskola & Suoranta 2005,14; Hirsijärvi et al. 2009, 136.) In other words, qualitative research is not based on the theory testing or hypothesis, but on a complex and detailed examination and interpretation of the empirical data (Hirsijärvi et al. 2009, 164). Hence, the epistemological approach can be described as interpretivist – the focal point is on understanding the social world of its participants. This also justifies the ontological aspect of qualitative research which is described as constructionist. It means that social properties are the result of interaction between individuals, rather than separate phenomena outside the construction. (Bryman & Bell 2011, 386.)

Since the purpose of this study was to approach the feasibility from the strategic point of view and the logic of chosen inventory management model was largely unknown, the qualitative approach was justified, as the understanding of the phenomena required the examination and interpretation of empirical data. In addition, it was important to understand the company´s inventory management strategy comprehensively, which was achieved by including representatives of different strategic levels in the study and interpreting their views and experiences. The nature of research also justifies the selection of an action-analytic research approach that seeks to explain the nature of the phenomenon and to understand it as a whole. In other words, the subject under study is approached by interpreting the world without any normative goals aimed at solving the problem. (Neilimo & Näsi 1980, 35)

As Neilimo and Näsi (1980, 35) state, the empiricism of action-analytic research is usually involved through a few target units, such does this study, including a single case company. Hence, the research strategy of this study is called an intensive case study (Eskola & Suoranta 2005, 18). The definition is based on the classification of Harré (see Kovalainen & Eriksson 2008), according to which intensive case study focuses on one or few cases and aims at, from the inside of the case, providing a thick, holistic, and context-based description. This is achieved by understanding the perspectives of the participants included in the case (Kovalainen & Eriksson 20008). Conversely, an extensive case study, defined by Harré (see Kovalainen & Eriksson 2008) has seen as an opposite strategy. It deals with several cases and aims at testing and building generalizable theoretical structures by comparing the cases.

According to Yin (2009, 3–4), case studies can also be classified into three different categories: exploratory, descriptive, and explanatory. Exploratory research can be conducted when the examination of the research topic is at its early stages and the researcher may want to test the feasibility of conducting extensive research (Saunders et al. 2009, 139). This type of case focuses on ”what” research questions, and thus helps to develop hypotheses but also suggestions for further research (Yin 2009, 5). The biggest advantage of exploratory research is its flexibility and adaptability to changes. On the other hand, this means that the researcher has limited control over the direction in which the research will go. (Saunders et al. 2009, 140.)

Whereas the objective of exploratory research is to seek new insights into the phenomena, the descriptive approach aims to create an exact description of events, persons, or situations (Saunders et al. 2009, 139–140). Saunders et al. (2009, 32) state that “what” questions suit also descriptive study, as they prompt descriptive answers. These “what” questions linked to descriptive research are actually asking “how much” or “how many” although it is built behind the “what” question. In addition to these, “where” and “who” questions also fit for descriptive research if the objective is to achieve a picture of the prevalence or incidence of phenomena. (Yin 2009 5–6.)

The third type of case study, explanatory research, seek to establish a causal relationship between different variables and focuses on the current real-life phenomenon. (Saunders 2009, 140; Ghauri et al. 2020, 103.) It approaches the phenomena with “how” and “why” research questions (Yin 2009, 6).

Since the purpose of this study is to understand the extent to which the chosen inventory management model is suitable for the case company´s inventory management strategy, it can be seen as focusing on current real-life phenomena and therefore classified as explanatory research. In addition, since the study aims to also understand the relationship between the chosen inventory management model and operations of the case company, and the second research question also uses the “how” question, these factors can also be considered to support explanatory research.

4.2 Data collection

In qualitative research, the interview is the most commonly used method for data collection (Hirsijärvi et al. 2009, 205). Furthermore, Kovalainen and Eriksson (2008) add that it is also often used primary source of empirical data in business research. A benefit of an interview compared to other data collection methods has seen its flexibility - progressing according to the situation which means that an interview follows the direction in which interviewees take it (Hirsijärvi et al. 2009, 205; Bryman & Bell 2011, 467.) However, since the choice of data collection method must be justified, an interview method should not be chosen without considering its suitability for the research problem. The justification may be based on both scientific philosophies and concrete factors.

(Hirsijärvi et al. 2009, 205.) According to Hirsijärvi et al. (200, 205) an interview is selected as a data collection method often due to, inter alia, the following factors: a desire to emphasize the role of humans as a subject, the topic is less research, a desire to link the results to a wider context, and a desire to clarify the responses received.

The interview was a suitable data collection method for this study, as the case company´s current inventory management was approached from the perspective of three different strategic levels, which highlighted the importance of meanings that human being creates. In addition, since the study focuses on the feasibility of the inventory management model, the perspective of the SCM system reseller organization was necessary to include in. This was considered to be best available in the form of an interview. In addition, the interviews made it possible to ask for clarifications for the respondent´s answers. This was important as the purpose of the study was, in essence, to increase understanding of the chosen inventory management model which was a less well-known topic inside the case company.

The interviews were conducted as semi-structured interviews, but they also had features from the theme interview. A semi-structured interview refers to an interview that follows a pre-planned structure. In other words, the questions are the same for everyone and have the exact form and order. Furthermore, interviewees are allowed to answer questions in their own words, which distinguishes a semi-structured interview from a fully structured one in which interviewees choose the most suitable of the pre-given options. (Eskola & Suoranta 2005, 86.)

In order to provide a comprehensive picture of the case company's inventory management strategy, three interviewees were selected from different strategic levels within the case company. Consequently, two different interview structures were created as it was seen reasonable to approach the same themes from a slightly different angle as interviewees' adherence to inventory management varied depending on the role. Thus, it could be stated that the interviews included features from the theme interview, as the scope of themes varied between the two interview structures, and the themes were planned in advance, which according to Eskola and Suoranta (2009, 74) are the features of the theme interview. The interviews, however, had the pre-planned question-setting and a certain order, so they mostly conformed to the features of the semi-structured interview.

A separate interview structure was established for the interview of the SCM system X reseller organization to provide as accurate information as possible on the inventory management model. In addition, this was confirmed by the selection of two interviewees who had been working with the case organization and were therefore considered to be a representative choice for the study. This brought up one of the advantages of the interview method – the possibility of choosing people with experience of the phenomenon being studied (Tuomi & Sarajärvi 2009, 74).

In Table 2 below lists the dates on which the interviews were conducted, the job titles/roles of the interviewees, and the duration of the interviews. In addition, the interviewees were given anonymous names following the order of the interview. These names are referred to in the empiric section.

Table 2 Conducted interviews

Date	Data collected	Job title/role	Duration (min)
28.2.2023	**Interviewee 1**	**Supply Chain and Logistics Director**	**35:48**
1.3.2023	**Interviewee 2**	**Chief Executive Officer**	**26:08**
1.3.2023	**Interviewee 3**	**Head of Operational Excellence**	**40:05**
7.3.2023	**Interviewee 4**	**Consultant**	**53:33**
	Interviewee 5	**Consultant**	

As seen in Table 2 most of the interviews were conducted as one-to-one interviews and one as a group interview. Since the case company´s participants represent different strategic levels, it was justified to conduct interviews separately. Conversely, the group interview was justified to conduct the reseller organization, as there was only one interview structure created and both interviews represent the same organization and roles. In addition, according to Eskola and Suoranta (2009, 94), in group interviews, the interviewees also find support from each other, which may lead to more information being received than usual. Hirsijärvi et al. (2009, 211) point out that the group can also help to clarify misunderstandings which were seen as an advantage when dealing with a complex topic.

The consent of the interviewees to participate in the study was confirmed several weeks before the interviews and once the consent arrives, an hour of interview time was scheduled for each interview. As Tuomi and Sarajärvi (2009, 73) emphasize, the purpose of the interview is to obtain as much information as possible, and therefore the interview questions or topics should be given to the informants in advance for inspection. Hence, the main themes of the interviews were sent to the interviewees by e-mail one week before. Exact interview questions were not wanted to be given to interviewees in advance, as it was seen as a risk to exclude more spontaneous thinking.

The interviews were conducted in Finnish inside the case company as it was everyone's mother language, whereas for the SCM system X´s reseller organization, the interview was conducted in English. Two interviews were held face-to-face and the other two were conducted via Microsoft Teams. All interviews were recorded by phone.

Although the research material was collected only through five interviews, the material was considered sufficient and representative. In a qualitative study, there is no actual indicative amount for the size of the research data, but the main purpose is to understand a particular phenomenon and to derive a theoretically meaningful interpretation of it (Eskola & Suoranta 2005, 61–62).

4.3 Data analysis

According to Hirsijärvi et al. (2009, 221), the analysis, interpretation, and conclusions of the collected data are at the heart of the research. They also emphasize that this phase of the research is already being aimed at from the beginning of the study. Consequently, the choices made at the beginning of the research process determine partially how the research data is processed and analysed.

The purpose of qualitative data analysis is to create clarity in the data and thus generate new information on the subject under study. It aims to compact data without losing the information it contains. Conversely, the analysis attempts to increase the information value of the data by creating a coherent and meaningful whole. (Eskola and Suoranta 2005, 137.) The qualitative data analysis methods which contain both deductive and inductive approaches help to achieve this goal (Saunders 2009, 480).

The deductive analysis is referred to research in which a detailed theoretical position is developed before the data collection, whereas in inductive analysis the principle of developing theory is built after the data collection (Saunders et al. 2009, 41). It is also possible to pursue abductive analysis which combines characteristics of deductive and inductive analysis. Abductive analysis, which can also be defined as the approach of this study, has theoretical connections, but they are not based directly on theory. (Tuomi & Sarajärvi 2009, 96.) In practice, in this study, the theoretical concepts have been identified from previous research, with the help of which empirical data has been described and analysed. However, Tuomi and Sarajärvi (2009, 100) emphasize that abductive analysis can be seen as a subclass of both deductive and inductive analysis. In this study, the theory was introduced closer to the end of the reasoning, which justifies why the approach is closer to the inductive approach.

The analysis method of this study was theory-guided content analysis which is not fully empirical-driven or either theory-driven but a combination of these two approaches. The theory-guided analysis can be divided into a three-phase process: reduction of material, grouping of material, and incorporation of empirical material into theoretical concepts. Reduction of material is referred to the removal of non-essentials from the material. (Tuomi & Sarajärvi 2009, 108–109, 117.) In this study, this was done by extracting original expressions from the transcribed material. The reductions were done based on these expressions.

The second step, grouping of materials, followed the reduction step. In grouping, reductions are divided into subclasses based on their similarities, after which subcategories are still subdivided into unifying higher-level categories. (Tuomi & Sarajärvi 2009, 110) Since the approach conducted in this study was theory-guided, subclasses were grouped based on empirical data, whereas higher-level categories were grouped according to theory. Finally, higher-level categories were grouped into yet unifying categories.

The analysis was conducted with Microsoft Word and Excel, as empirical data was considered manageable by these tools. In Word, the interview was divided into parts and grouped into sublevel, higher-level, and unifying categories. Excel, conversely, was used to record that all interview questions and related answers had been analyzed. When the empirical data was categorized, it was analyzed in greater depth in a theory-guided manner.

4.4 Research trustworthiness and ethical considerations

According to Hirsijärvi et al. (2009, 231) when conducting research, the aim is to avoid creating mistakes. However, despite of that trustworthiness and validity vary between studies. Therefore, trustworthiness is important to assess in every research. However, Eskola and Suoranta (2005, 208, 210) argue that the question about trustworthiness builds differently between qualitative and quantitative research, and thus, qualitative studies have been criticized for obscuring trustworthiness criteria. In other words, the analysis and evaluation of trustworthiness are not possible to separate in the qualitative study as in the quantitative approach this can be done. As in quantitative research, trustworthiness is assessed on a measurement basis, but in qualitative research, can be said that the researcher is a central research tool. Therefore, it is justified that the review of trustworthiness covers the entire research process in qualitative research.

Two key concepts related to the assessment of trustworthiness are reliability and validity. Reliability is referred to the reproducibility of measurement results whereas validity means the ability of the research method or measurement to measure what is intended. (Hirsijärvi et al. 2009, 231.) However, the relevance of these concepts for qualitative research has been questioned, as they were originally developed for the evaluation of quantitative research (Hirsijärvi et al. 2009, 232; Bryman & Bell 2011, 394). Alternatively, in a qualitative study, trustworthiness has been proposed for review through credibility, transferability, dependability, and confirmability which were originally proposed by Lincoln and Cuba (1985) and Cuba and Lincoln (1994) (Tuomi & Sarajärvi, 2009, 138; Bryman & Bell 2011, 395).

Credibility refers to whether the reconstructions produced by the researcher correspond to the original constructions of the participants' reality. On the other hand, it also means an adequate description of the participants of the study. (Tuomi & Sarajärvi 2009, 138.) In this study, the results were presented supported by direct quotes from the interviewees which support credibility, as those quotes allow the reader to consider how the researcher has advanced to his or her interpretations. In addition, participants´ job titles or roles were described in subchapter 4.2. However, as the case company´s interviews were conducted in Finnish and translated into direct quotes in English, the constructions created by the interviewees could be weakened.

Transferability refers to the transferability of results to a similar context outside the research context (Tuomi & Sarajärvi 2009, 138). From this perspective, the trustworthiness is on a lower level, as the companies´ inventory management strategies vary from one organization to another. However, a detailed description of the data collection and analysis has been pursued, which acts as an enabler for transferability (Bryman & Bell 2011, 398).

Dependability means that the research has been carried out following the general guiding principles of scientific research (Tuomi & Sarajärvi 2009, 139). In this study, dependability is confirmed by the fact that all approaches and methodological decisions are justified to solve the research problem. Instead, Confirmability means that the decisions and conclusions made are justified and not influenced by, for example, the researcher's personal values or theoretical inclinations (Tuomi & Sarajärvi 2009, 139). In this study, the confirmability may have been weakened because the conclusions drawn from the results can only be justified to a limited extent by previous literature since the approach of the study differs from previous studies.

In addition to trustworthiness, ethical issues also arise when conducting research. Essentially, the protection of human participants in research forms the basis for these questions (Tuomi & Sarajärvi 2009, 131). A key division in the examination of ethical issues can be made between the collection and use of data (Eskola & Suoranta 2005, 52). When collecting data, the objectives, methods, and potential risks of the study must be explained to the participants. In addition, participants in the study must have voluntary consent and they should also know what the study is about. (Tuomi & Sarajärvi 2009, 131.)

In this study, participants consent to the study and interviews were confirmed in advance via email several weeks before the interviews were conducted. In addition, the subject of the study and objectives were told in the same emails, and the interview times were booked. A week before the interviews were conducted, the interviewees were also sent more detailed interview themes by email and the intention to record the interview was mentioned. However, two interviewees told that they didn´t receive the email in question, which has weakened the transparency of information sharing for them. On the other hand, the unreceived email mainly intended to deepen the information provided on the research topic, so it was not so critical in relation to the first e-mail, which, however, the interviewees had received.

At the beginning of the interviews, it was mentioned again that participation in the research was voluntary. Furthermore, the consent for the recording of the interview was confirmed again. Recordings were recorded on the devices of the case organization to ensure data security.

From the perspective of data use, ethical issues were confirmed by the confidential use of data, which means, according to Tuomi and Sarajärvi (2009, 131) that the data obtained in connection with the research will not be disclosed outside but used only for the promised purpose. In addition, the anonymity of the interviewees was maintained since the names of the interviewees and the organizations they represent were not mentioned in this study (Tuomi & Sarajärvi 2009, 131).

5 RESEARCH FINDINGS

The findings of the study are presented in this chapter. First, based on the case company´s three internal interviews, product group, and product-specific characteristics are performed, and after that overall picture of the current inventory management of the case company is created. Second, the case company´s selection of the SCM system and assumptions for the selected SCM system X are reviewed. Third, the SCM system X and the logic of its inventory management model are presented based on the interview of two representatives of the SCM system reseller organization. Finally, the impact of the SCM system and the inventory management model will be reviewed from the perspective of all interviewees.

5.1 Characteristics of selected product group and products

The characteristics of the selected product group and products were first examined before moving to the actual inventory management of the case company. The chosen product group was described in the interviews as a core of the case company as it has the highest number of transactions and also creates the most economic value compared to the other product groups. Furthermore, the product group is used in operations where demand is moderately predictable.

One specific feature of the product level mentioned by the interviewees was the production of the selected products in two different manufacturing locations: Location 1 and Location 2. The D products are produced in Location 1 whereas E and F products are manufactured in Location 2. Demand for products was also mentioned to be global. In addition, especially for D products, but also for other products, the product range was seen to be wide in relation to the size of the case company. This is the result of the company's positioning on the market, which, together with the global market, has posed a challenge for inventory management. However, it has also led to strong and permanent relationships with customers and distributors, which enable statistical modelling and data-based planning for products. Moreover, many customers and end-users are big operators with a stable demand, which is an advantage from an inventory management point of view.

In addition to these characteristics, two interviewees also pointed out from a logistical point of view that E and F products are long products, which makes handling and stocking challenging, and it is also expensive to transport them by air freight. Especially regarding the product value, the use of air freight does not make much sense economically.

5.2 Case company´s inventory management

Inventory management of the case company is a comprehensive process that flows through the supply chain. Interviewees outlined that the operational excellence team (*OPEX*) is a central part of the process as it gathers information from other parts of the chain and converts it into an inventory management perspective. The information is produced for the process by sales teams of subsidiaries as well as product line managers of different sales business units while purchasing function place orders and customer service teams are responsible for the order-to-delivery process.

From an information technology point of view case company´s inventory management was carried out using NetSuite data which is data from an enterprise resource planning (*ERP*) system. In addition to NetSuite, the SCM system X and its optimization and order management tools were used. Also, a system called OptimizeR was mentioned to be used to some extent. It is a previously developed tool that has been used to monitor whether the placed orders meet customer orders or order points as planned. As a common feature for the SCM system X and OptimizeR was emphasized that they both import data from NetSuite and enrich it. Interviewees also described that the case company is processing data from all the systems mentioned above and creating Excel-based analyses as a part of their inventory management practices.

5.2.1 Strategic level

The case company´s vision, which controls the organization´s operations, is a 15% growth per year. To achieve this objective, inventory management must be carried out in a capital-efficient way, which means that financial capital should not be overly tied to inventories. At present, however, inventories, all from raw materials to finished products, were seen as being over-capitalized in the case company. Furthermore, excessive capital committed to inventories was stressed to be also a risk of worsening the situation.

> *"Networking capital, or a kind of committed capital, where inventories play a central role should be around 33% when it is at the moment, or the beginning of the year it was around 44–46%."* (Interviewee 1)

"If there are a lot of goods in stock, the risk of slowly circulating and unsaleable goods increases." (Interviewee 2)

The interviewees described the effectiveness of inventory management being regularly examined through financial KPIs, which follow up an inventory turnover, and networking capital in relation to revenue. In addition, at an even more precise level, the value of inventory was compared to networking capital but also to sales. In terms of inventory management, these KPIs were named to be the most important goals for this year. The review of them was told to be made from different perspectives.

"On the financial administration side, the development and rotation of inventories is continuously measured on a weekly and monthly basis." (Interviewee 3)

"The matter is being looked at from different angles, from the perspective of the company as a whole, or the perspective of individual entities, or the sales business units´ point of view." (Interviewee 2)

The interviews pointed out that inventory management cannot focus solely on tied capital, availability must also be considered. However, availability was not a key measurement at the strategic level as financial reporting only covered the inventory cycle and networking capital in relation to turnover.

"Financial reporting relates to the inventory cycle, working capital in relation to revenue, not so much to availability." (Interviewee 2)

5.2.2 Tactical level

Objectives concerning inventory management are consistent from strategic to operational level, although there may be differences in perspective. This is achieved through cooperation between top management and the supply chain director.

"They are synchronized, operational and financial indicators are not in themselves different goals, okay, things can be viewed from a different perspective, but there are uniform objectives." (Interviewee 2)

The strategic objective of reducing networking capital in relation to revenue was described at a more precise level as the target of reducing all inventories by a total of 10 million euros. However, the development of sales was mentioned as having an impact on the level of the sum sought. In addition, it was stressed that the reduction must be made without undermining the availability.

> *"If the sales are starting to grow well, then there is also room for a small increase in stocks. Although it usually goes in another direction. If the sales start to develop, you can´t keep up and stocks decrease. And then again if the sales slowdown below the planned level, then usually stocks rise."* (Interviewee 1)

> *"Stocks should be lower by 10 million euros at the end of this year or the beginning of the coming year. It´s a big and challenging goal, but it must be done in such a way that way we don´t weaken our availability."* (Interviewee 1)

The definition and calculation of availability, however, were considered challenging. Firstly, decision-making on what is decided to keep available creates a challenge to draw the line between MTS and MTO products. On the other hand, the decision to which extent products are categorized as MTS products also impacts capital tied to stocks. Secondly, if a certain group of products has a specific availability target, it was seen as challenging to determine at which stage the availability measurement is carried out, at a particular location or the factory.

Interviewees brought up that availability is currently determined and measured as on-self availability, but also the number of excess and obsolete in relation to stock. In addition, service level and delivery reliability were reported as an important part of availability.

> *"For products held in storage, availability should be more than 90%"* (Interviewee 1)

From the point of view of availability, the customer segments were placed in two categories. The first category includes customer segments where the product must be on the shelf for the sale to take place or otherwise the contractor go elsewhere. The second category consists of contractual business, which is a continuous trade in which delivery reliability must be good and availability guaranteed continuously. Hence, availability was described to have a significant impact on customer retention.

> *"And then there are customers and products where availability should be close 100%, so, goods can´t run out. Usually, this kind of cases have been handled with consignment warehouses." (Interviewee 1)*

> *”If the operations would stop because of product´s stock out situation, it´s like disproportionately expensive in relation to the value of our product, I mean the value of the part that is being consumed. The relationship with the customer also requires that there is continuity, that we have good availability.”* (Interviewee 1)

5.2.3 Operational level

The first step of the case company´s inventory management is a forecasting process that captures past demand and mirrors future demand based on past demand but also on the market situation. One interviewee brought up that the supply chain planning system X has been introduced in the last 1.5 years, but even before its use, the case company has had the practice to share a forecasting platform with sales companies and sales teams within the company, which has facilitated the forecasting process. The forecasting platform that the case company has used describes item-level demand information. When the OPEX team receives the forecast platform back from sales companies, the validation process begins.

> *“When we get the forecast, we compare it, for example, to the budget and the historic demand and try to understand that where problematic or major changes appear and consequently enable a risk.”* (Interviewee 3)

The decision of what to keep in stock follows the forecasting process. Interviewees describe that in practice, sales business unit heads (*SBU heads*) make the final decisions on classifications of SKUs as MTS and MTO products. Eventually, after the validation of OPEX and SBU heads, the forecast data acts as a parameter for the SCM system X.

> *“Based on the forecast and the further discussion, they will be turned, I mean that forecast will be turned. In the past, they were turned into a so-called order point in our ERP… And now when we don´t have a sort of order point system anymore, we have a more dynamic SCM system X.”* (Interviewee 3)

Interviewees emphasized that the case company currently applies the hybrid model for its inventory management. In other words, order point and safety stock calculations are imported from the SCM system X to the old model. Hence, inventory replenishment orders are placed based on the SCM system X but they require validation and cannot be accepted as a given, as the logic of the SCM system’s inventory management model is not yet sufficiently understood.

In addition to the forecast and validation process, the case company´s inventory management also includes SKU classification which is carried out based on product characteristics. According to one interviewee, the case company uses ABC classification, which guides the identification of the business value of the products and thus guides the setting of the availability targets. The classification is based on the cumulative percentage of order lines in the case company. In other words, this means that the number of order lines of a certain product is added up the order at a time, and ultimately the sum of the accumulated order lines of different orders is compared to the number of order lines for all SKUs. Consequently, cumulative percentages can be established for SKUs, which eventually define ABC classes.

> *"..which is categorized by such a traditional ABC classification, but we call it RRS; products are classified as runners, repeaters, and strangers.."* (Interviewee 3)

> *"So, the products in a particular product group, let´s use product D as an example, first, it´s taken the number of order lines, and then it´s taken the cumulative percentage of it. I don´t remember exactly what we have been used last time, but I guess that the cumulative percentage for runners was 70, for repeaters 70-90, and the last 10% for strangers."* (Interviewee 3)

The classification of RRS was updated once a year: OPEX was mentioned to provide data and SBU heads to make final decisions on the classification of SKUs. This was seen as an important part of the process as SBU heads have a strategic perspective on market development. Therefore, RRS categorization was found to be balancing between the number of transactions, turnover, and strategic aspects. In terms of availability, it was also important that SKUs were classified in the right categories, as the availability information was eventually added in the form of a service level to the SCM system X.

5.2.4 Strengths

In essence, the case company´s inventory management was seen to be in a transition phase with the introduction of the SCM system. However, the basic elements of current inventory management were mentioned to be at a good level and the interviewees described inventory management as moving in the right direction all the time.

"From a process perspective, it has gone all the time to a better direction when tools have developed, and understanding has increased. I would say that consciously the inventory management is on a good level." (Interviewee 3)

According to the interviewees, the team dedicated to inventory management, long-standing processes, and tools that meet the process needs, were seen as strengths of current inventory management in the case company. In addition, the network was not considered to be very complex and master data was also seen to be on a level that allows good inventory management.

"From the process and maturity perspective, we have quite a lot of processes that have been continued a relatively long time and are related to forecast and its accurate, or proportional to business volumes." (Interviewee 3)

"Our network isn´t very complex, of course, it´s global, but we usually have one factory that produces one product, so from the perspective of planning and optimization it is quite easy." (Interviewee 1)

5.2.5 Development areas

The current change process in inventory management aims to achieve the monthly sales and operation planning cycle. As the main development area to achieve this goal, the interviewees highlighted the development of the forecasting process. At present, the forecast was not seen to be transparent throughout the whole supply chain, and deviations in demand were also detected too late. Hence, for the forecast to be more accurate and well-timed, the whole process around forecasting should be developed and responsible areas reorganized between teams.

"The responsibility for what is stored and where, and how much, should be transferred to the Supply chain from Sales. The focus of the Sales should be what they are going to sell, and what the demand forecast is. When that information is as good as possible, the Supply chain can calculate with the existing tools what is worth to store and how much and where, and how to build an availability." (Interviewee 1)

On the other hand, the conversion of forecasts for production and delivery was also seen as a challenge. Therefore, understanding of SCM system X should be improved. In particular, the understanding of the calculation logic of the SCM system X inventory management model was identified as the main development target.

> *"Perhaps the biggest challenge we face is how we will then translate those forecasts and orders into actual production and deliveries, and then improve the production accuracy, and that it´s really on time, exactly just in time, not too early. It´s like developing its timing, it's really important from a production and ordering point of view." (Interviewee 3)*

In the wider picture, an in-depth understanding of the case company´s business was highlighted as an important factor to consider when building an understanding of the inventory management model as it finally creates a basis for the optimization. Furthermore, it was seen as necessary to consider how the organization's processes work and to address development targets.

> *"Have to understand business in depth and try to understand what is being optimized, what kind of customers, what kind of business needs, what kind of customers ways of working that need to be considered."* (Interviewee 3)

Concerning the organizational processes and ongoing change phase of inventory management two interviewees also pointed out the importance of change management. For example, cooperation with different sales areas was identified as an important development area, as their employees make order replenishment through the SCM system X.

> *"But one thing that seems to be a challenge here is that our subsidiaries that are heavily involved in the inventory management, have experienced that they have lost transparency. This (The SCM system X) is a bit like a black box, maybe not quite understood, and when there's no transparency, there's no understanding, and there's no trust either."* (Interviewee 3)

In addition, product management and life cycle management of the product were also identified as development areas. One of the interviewees described the current product range as too wide and specified that there are too many custom-made products. The interviewee also pointed out related to a product life cycle that when contracts for customers are approaching an end, product dismantling should be better managed.

5.3 The SCM system selection and case company´s expectations

The SCM system X was selected for the case company through a tendering process involving a total of four different service providers. According to interviewees, the case company had created a list of requirements that reflected the company´s needs. The SCM system X was the most comprehensive compared to other options and met the most requirements of the list. However, other systems were described as having fairly similar executions, but visual usability seemed to be the best in the SCM system X.

According to interviewees, the case company wanted to, essentially, achieve working capital efficient inventory management and better availability with the introduction of the SCM system. Therefore, by the use of the SCM system X is expected to gain a reduction in inventories as well as a better service to customers through availability. Furthermore, the inventory cycle is expected to improve. However, interviewees emphasized that the SCM system does not solve the problem alone but acts as an enabler. In other words, it is supposed to identify risks and problems more dynamically and increase the overall inventory management frequency.

> *"And then kind of responsiveness, which I referred to earlier. We should sooner be able to spot changes in demand, as I mentioned in the beginning, it is really expensive to fly products E in particular, and the earlier we find that now demand differs significantly from the forecast, the better the chances we have of keeping the customers happy and business result good."* (Interviewee 2)

5.4 SCM system X

The SCM system X is an information technology-based supply chain planning tool whose main purpose is to offer a higher level of service with lower inventory costs. The SCM system X, which the reseller organization has been selling and consulting its use already over 10 years, was mentioned to be originally developed for spare parts in the industrial field. Interviewees also highlighted that their customers are operating the most commonly in the industrial field. However, they also have customers from many different fields, such as food, beverage, and retail.

In terms of technological integration, the SCM system X was told to be compatible with every information system that can output data. However, other information systems are easier and cheaper to integrate than others depending on the structure of the ERP and a customer organization´s ERP consulting. The reseller organization has also developed an integration platform that helps the integration process of the SCM system X into the customer organization´s information systems. In addition, an extension of integration has been specifically developed for a certain ERP system.

> *"Some ERP systems are set up with a philosophy of very integrable while others are more protective and want you to remain the inters of functions."* (Interviewee 5)

> *"Then there is specifically developed integration for AX (Microsoft Dynamics AX) or D365 (Microsoft Dynamics 365). So, they install an integration kind of extension to the information system to make an integration between AX and SO99. But it´s, it´s supported with any information system that allows for an output of data."* (Interviewee 4)

In the case company, according to interviewees, the SCM system X was integrated with NetSuite, and the integration process with PowerBI was told to be beginning in the future. Although NetSuite was less used as an ERP system among interviewees´ customers, NetSuite was found quite easy to integrate with the SCM system X except for the exporting of data from the SCM system to Netsuite.

> *"My experience with the ERP consultants that the case company has been using, they are very good and very fast, and they get the data out. And they are sent to us in the format that´s very easy to use. So, that makes integration very easy. And then sending back, I mean we haven´t been so involved in that but that seems a little bit more difficult."* (Interviewee 4)

5.4.1 Logic of inventory management model

Interviewees pointed out that the inventory management model is usually approached from a stock and service point of view. In other words, the SCM system X was described as creating a stock and service curve for each SKU and the curve reflects the cost in relation to maintaining a certain level of service. This, in essence, means how much an organization has to store items to achieve the desired service. The factors affecting the stock and service curve were the variability of demand, the frequency of sales, lead time, and lot size. These planning parameters and their impact on inventory level are described in Table 3.

Table 3 The SCM system X´s planning parameters and their impact on inventory

Planning parameter	**Impact**
The variability of demand	High -> Increase stock Low -> Decrease stock
The frequency of sales	Frequent -> Decrease stock Infrequent -> Increase stock
Lead time	Long -> Increase stock Short -> Decrease stock
Lot size	Big -> Increase stock Small -> Decrease stock

In addition to these parameters, interviewees also pointed out that expected delays are also possible to input to the SCM system X and they will have an effect on the stock and service curve. Finally, as the sum of all these parameters, the SCM system X forms the stock and service curve for each SKU. Then the SCM system X groups SKUs in the service class and optimize the inventory for each SKU in a way that the target service is achieved. At this stage, the determination of the stock level of the SKUs will be determined in a price-oriented manner.

> *"So, if you have a very cheap item, we will start to increase service on that item first with running the optimization until it´s cheaper to increase service on another item, and then optimization work like that, that we increase all the items that are cheap until we reach the target of the group."* (Interviewee 4)

According to interviewees, optimization is applied only for MTS products, but MTO products are also added to the SCM system X as they also capture the consequences of certain parameters. The logic of the stock optimization model was described as favoring the allocation of strategically meaningful products into service classes if it is necessary to classify them at all. This ideology was highlighted as different from, for example, the traditional ABC classification. Conversely, there was a desire to move away from the ABC classification approach, as optimization was most cost-effective the fewer products are divided into groups. Furthermore, the optimization of the SCM system was automatically seen to have similar effects as the ABC classification.

> *"We don´t need ABC classification because items that company would normally classify as an A item would normally exists in stock optimization have a high service. So, what we wanna do instead is assign items into groups that make sense from strategic business point of view, and if you don´t have any reason to split items into different groups, best from the optimization point of view is to put all items in one group. From the mathematical point of view that makes the most sense because that will give you the lowest stock because then you allow for the SCM system X for the free optimization."* (Interviewee 4)

Usually, the SCM system X optimizes a better service for cheaper high-frequency items whereas for expensive items it pushes the service down. However, since from the business point of view, this does not necessarily make sense, the SCM system X also enables the entry of a minimum service for strategically important items. In this case, picking up these items into separate service classes was seen as reasonable. In addition to the price of the products, for instance, restrictions on the space were also identified as a possible reason for setting a minimum service.

5.4.2 Safety stock and re-order point calculations

From the mathematical point of view, the safety stock and re-order point calculations were described as unknown areas for the SCM system reseller organization, as the developer of the system has patented the model. However, historical demand was reported to create a base for the probability curve for the forecast period and to be used in safety stock calculations.

> *"So, we are looking at historic demand, everything is converted to a distribution curve or a probability, like if you worth to take demand and put it into a histogram and what would be the probability distribution, that fits best with the events that we had have. And then that´s being used in the safety stock calculation to draw those to stock to service curve, so based on my probability of getting something, how much I need to put in stock."* (Interviewee 4)

So that the SCM system is able to produce calculations, interviewees described that users have to add their target service level as input data into the system. Correspondingly the user will get the safety stock and other results of optimization output data.

> *"The way we see things is that you input the service level that you want to your item and location, and the output of that is the safety stock you should have. You do get a bunch of other outputs as well, but we normally are interested in and what we normally send back to an ERP system is the safety stock, so, that will be the output"* (Interviewee 5)

5.4.3 Impacts on organizational processes

The actual product that the reseller organization of SCM system X provides is service optimization which means increasing service and reducing inventories. However, interviewees brought up that SCM system X also automates and standardizes processes. Hence, the biggest benefit was seen in the stability that the company achieve through SCM system X.

> *"I have a customer, I don´t think they even know it. But their supply chain team has changed a lot in the past three years, it´s just keep coming new people and they have consults in and everything, and no one really understands the SCM system X but it´s kind of running alone, and in the background and supplying all of the stores.. and it´s possible to do that because kind of standardization of processes."* (Interviewee 4)

Interviewees stated that the visibility in the case company has improved. As a result, the case company's understanding of its network structure has also increased. This can be seen as a consequence of partially decentralized data management.

> *"But should not underestimate the value of the project that sits to decentralized, partially decentralized data management and different cost assessing stuff relating to forecasting and inventory management. So, consolidating all those different ways of working and managing that into one single solution that even itself is strong, the value in that is quite high, and that uses one common language to speak within the company.. and that itself will boost other parts."* (Interviewee 5)

The case company´s interviewees also agreed that visibility has improved with the introduction of the SCM system, both for total inventory management and for the supply chain in general. Consequently, the SCM system X has enabled the identification of risks and problems earlier in the case company. In other words, the case company´s inventory management has taken a step towards more proactive actions whereas it has been earlier quite static and reactive. This was seen as a result of decentralized data.

> *"This new system is dynamic and exception-based, which means that when billing changes happen and there is a possibility that stock will run out, we will be able to potentially catch up with it much earlier."* (Interviewee 3)

5.4.4 Challenges in the implementation

Interviewees pointed out that usually challenges that their customers have faced during the implementation process are linked to optimization. In particular, setting service classes that reflect business targets in a meaningful manner was seen to be challenging. In addition, past inventory management practices of customer companies may have an impact on the internalization of SCM system X practices.

> *"Normally customers, they have used ABC classification. So, they are used to think A, B, and C items. And getting them to understand what the SCM system X is and that difference."* (Interviewee 4)

At the beginning of the implementation process advising the customer how to model their network and business strategy in the SCM system X was also seen as problematic. Since the SCM system X requires that the customer organization have enough understanding of the system as well as the SCM system reseller organization´s consultants have sufficient knowledge of their client business, the implementation process will take time. In other words, a common understanding between the customer and reseller organization has to build before it is possible to make strategically right choices in the SCM system X.

> *"We have a company who sold the baby´s strollers and they sold access wheels to those baby´s strollers. So, what we did, in the beginning, was to put both of those types of items within the same service group. And as mentioned before it´s during post optimization, so whatever is cheap and easy to that form, we put the high service on, and whatever is costly and difficult to that form, we put low service on. And that happened to be exactly the opposite of what we wanted. So,*

the strollers that sell are very expensive compared to access wheels, but you cannot sell any access wheels unless you sell the stroller first." (Interviewee 5)

"..and as Interviewee 5 said, we need to explain to SCM system X that the strollers are the ones that are important and we need to put high service on, and we cannot explain this to the customer because it takes some time to understand your business. So, they need to understand the SCM system X and be able to explain that to us. And that´s normally the hardest in the beginning." (Interviewee 4)

In addition, interviewees highlighted that customer companies may have difficulties accepting the output of optimization of the SCM system X. However, if all constraints and strategically reasonable service levels are set, the SCM system will provide as the output of optimization the most optimal proposal of stock levels. Hence, if the result of the optimization does not seem reasonable from the customer company's point of view, one should consider whether all the constraints have been set or whether the service level has been set at the right level.

"You have inputted all your restrictions, all your business strategy, everything is in there. I have a minimum service on my most important items, all of that is in place. And still, I have some items that have optimized too high. And then okay, then you have too high general target of service, you need to lower that." (Interviewee 4)

6 DISCUSSION AND CONCLUSIONS

In this chapter, the empirical findings are summarized, and the research findings are connected to the literature review. Furthermore, the research questions are answered, and the theoretical and practical contribution is justified. The limitations of the research and the ideas for further research are also highlighted at the end of the chapter.

6.1 Main findings

The aim of this study was to examine the feasibility of the chosen inventory management model in the case company. In addition, the study aims to identify how the chosen inventory management model affects the case company´s operations. These objectives were approached through two research questions:

1. To what extent does the chosen inventory management model fit the organization´s inventory management strategy?

2. How does the chosen inventory management model affect the operations of the case company?

To answer these questions, the topic was investigated firstly by outlining the case company´s inventory management in terms of a strategic perspective. Secondly, an understanding of the chosen inventory management model was created. The inventory management model was approached at the level of the entire supply chain system X so that it was possible to capture the effects obtained from the use of the information system holistically.

To create a picture of the case company´s inventory management strategy, and on the other hand, to gain an understanding of the inventory management model of the SCM system X four interviews were conducted. Three interviewees were selected from different strategic levels within the case company and two interviewees from the SCM system X´s reseller organization. Since a semi-structured interview format was used and the case company´s inventory management strategy wanted to be examined from different angles, interviews within the case organization were conducted as individual interviews. Instead, the SCM system X reseller organization´s interview was considered a group interview.

To understand the feasibility of the chosen inventory management model in terms of the case company´s inventory management strategy the framework was created based on previous research results. Based on empirical data, it can be concluded that the framework works quite well in its context, as most of its elements came up in the interviews, and connections between them were possible to outline. However, the interviews also raised characteristics outside the framework, and thus the framework can be supplemented. In addition, it should be noted that the framework only serves as a tool for understanding the feasibility of the selected inventory management model in the case organization. Hence, in order to conclude to what extent, the model fits into the organization's inventory management strategy, and what impact it will have on the organization's operations, it must be derived separately through the modelling of the results. It was therefore considered appropriate to summarize and review the empirical results of the inventory management of the case company before proceeding to answer the research questions.

6.1.1 Results review and completed theoretical framework

Figure 13 shows the framework completed with the main research results.

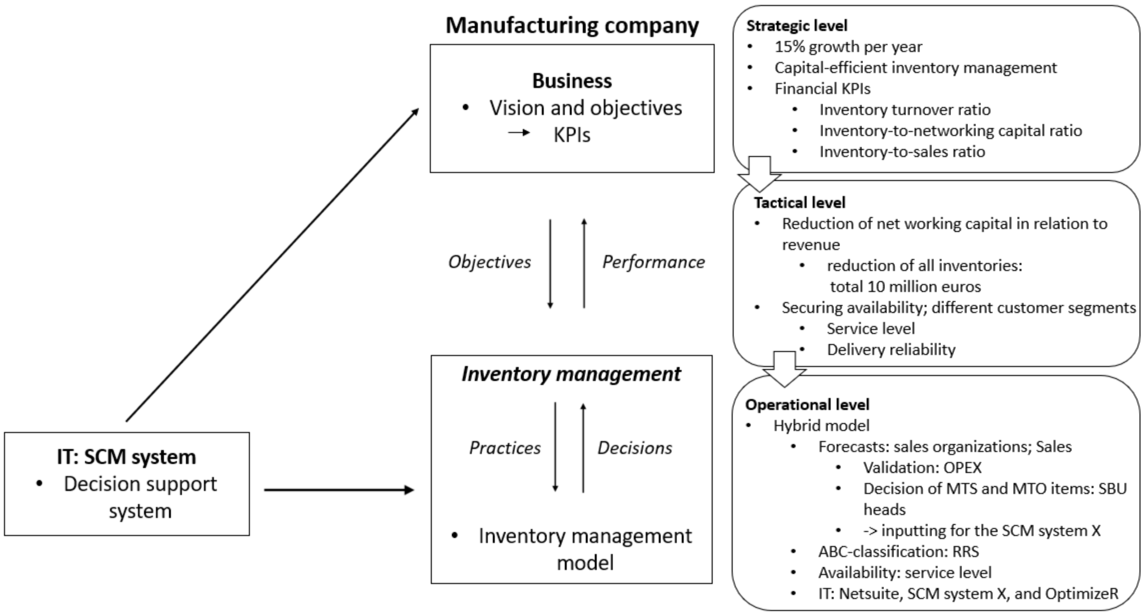

Figure 13 Completed theoretical feasibility framework

When an inspection of the framework is started at the top of the figure, it can be noted that strategic level results adapt to the characteristics of the original framework. At the strategic level, the goal of the upper level was seen as 15% growth per year. To achieve this goal, capital-efficient inventory management was identified as one development area, and thus the goal was to reduce all inventories relatively by 25% in relation to networking capital. To track this goal, the effectiveness of inventory management was regularly followed on a weekly and monthly basis through financial KPIs. The main KPIs were, in terms of inventory management, networking capital in relation to revenue, inventory turnover, and inventory in relation to networking capital and sales.

At the tactical level, following the original framework, the business strategy was transformed into operating objectives. Hence, the reduction of networking capital in relation to revenue was defined at a more detailed level as a target to reduce all inventories by a total of 10 million euros. However, the development of sales was mentioned to affect the amount of targeted level. In addition, it was highlighted that the reduction must be made without undermining the availability. The measurement of availability was determined as on-self availability, but also a number of excess and obsolete in relation to stock. Furthermore, service level and delivery reliability were defined as an important part of availability.

Availability was also seen to have a direct impact on customer retention. On this basis, customers were divided into two groups. The first segment includes customers who will end the customer relationship if the product is not available. This is explained by the nature of business operations, where the interruption of operations is disproportionately expensive in relation to the cost of the product. Another group of customers can be classified as contract customers. Contractual business is a continuous trade in which delivery reliability must be continuously at a good level.

At the operational level, as highlighted in the original framework, key practices emerged as defining the production strategy and SKU classification. However, forecasting was also highlighted as one key practice in the interviews alongside these, so it was added to the framework figure. In addition to these, the framework was supplemented by information technology and internal stakeholders.

The forecast process starts with sales companies where sales teams make the forecasts, after which the OPEX team validates them. Then SBU heads define production strategy by making the classification of SKUs as MTO and MTS products. Finally, the forecasts are added to the SCM system X. However, as an understanding of the SCM system´s inventory management model is still incomplete, the case organization implements the hybrid model, which means that order points and safety stocks are imported from the SCM system X to the old model. Therefore, inventory replenishment orders are placed based on the SCM system X by purchasing functions, but they require validation by OPEX and cannot be accepted as a given.

SKU classification strategy that the case company uses was told to be a single criterion ABC classification which is updated once a year. However, the classification was called RRS based on the names of the categories: runners, repeaters, and strangers. The basis for classification is the cumulative percentage of order lines. In addition, SBU heads validate the decisions, so that strategic perspectives are also considered. After this, the availability of each class is added to the SCM system in the form of a service level.

Operational level inventory management practices were carried out with the ERP system NetSuite and the SCM system X. In addition, OptimizeR was partially used, which was a previously developed system for monitoring whether orders placed corresponded to customer orders or order points as planned.

6.1.2 Feasibility of the chosen inventory management model

Since the main targets of the SCM system X and its inventory management model were to increase availability and decrease inventories, the case company´s objectives on a strategic and tactical level are in line with these. This was a presumptive finding, as the case company had created a list of its needs, and the tendering process had been carried out for the selection of the SCM system. In addition, as one interviewee pointed out, the systems involved in the tendering process appeared to have quite similar executions compared to the chosen system. This view is also confirmed by the previous literature (Kang and Gershwin, 2005, 843; Dehning et al. 2007, 816) according to which for many companies with inventories, one of the key factors is the provision of high availability to customers while keeping inventory costs low. To meet these needs companies, tend to automate their inventory management processes.

However, in terms of availability, the case company needs to pay more attention to the requirements of the different customer segments, which were raised at the tactical level. The SCM system X enables to meet the requirements of strategically important customers, as the minimum level of service can be set for individual products on a location level. And as the representatives of the case company reported, availability for the customer whose service level needs to be close to 100% has usually been strengthened by consignment warehouses.

At operational level, the feasibility of the case company´s inventory management practices with the SCM system X´s inventory management model was more variable. Firstly, although the SCM system was reported to be compatible with all information systems that can output data, however, NetSuite was a less commonly used ERP system among the customers of the SCM system reseller organization´s representatives. Thus, this may likely cause more work and costs to make the system compatible with NetSuite for certain features. However, since ERP consulting was considered to be on a good level in the case company, potential compatibility challenges are likely to be solved.

From the optimization point of view, the central parameters that created the stock and service curve for each SKU were demand variability, sales frequency, lead time, and batch size. However, since the inventory model optimizes the inventory levels of products finally on a price-based basis within the set service class, consequently, it increases the service for low-cost products and decreases the service for high-cost products. This certainly reduces the capital committed to the stocks, but conversely, from a strategic point of view, this does not necessarily serve the needs of customers. Hence, setting minimum service levels for the most important customers and products is required so that stockout situations do not arise, and customers are lost, as the value of the products is more than the price from the customer's point of view. This, in turn, requires sales teams to be more aware and accurate in terms of sales and forecasting. Success also requires a transparent flow of information through the whole supply chain, both in terms of internal (OPEX & SBU heads) and external stakeholders (distributors & suppliers).

In light of the interviews, the case company should identify strategically important items, and should potentially abandon the ABC classification, because as the interviews showed, the optimization model produces the same effect naturally. In addition, since optimization was cited as most effective from a mathematical point of view if classification of service classes is made as little as possible, ABC classification may limit the potential benefits that can be achieved using the inventory management model. On the other hand, since the chosen range of products was reported to be wide, SKU classification is unlikely to be completely abandoned. Hence, if the classification of SKU is seen as necessary, based on the results of Yu's research (Yu 2011, 3420), it can be concluded that single-criterion

ABC classification should be replaced with multi-criteria classification so that inventories could be managed more efficiently.

6.1.3 Impact of the SCM system X on the organisation's operations

Although the actual product that the SCM system X reseller organization sells was told to be service optimization, which was promised to increase the service and reduce inventories, the introduction of the system would have seen much wider benefits. As mentioned by Dehning and Richardson (2002, 9) as impacts of the use of IT, the results of this study also revealed both direct and indirect impacts on the organization's business processes.

As direct impacts were seen better level of service, reduction in inventories, and consolidated data in the one system. However, because the case company´s representatives haven´t achieved a full understanding of the logic of the inventory management model yet, and the hybrid model is still used, the main impacts promised by the use of the system had not yet been achieved. However, this is in line with the reseller organization's experiences, as they pointed out that the implementation process will take time because it requires the client organization to have an adequate understanding of the operation of the SCM system. Moreover, the reseller organization must also have a sufficient understanding of the customer organization´s business.

As a result of the consolidated data, indirect effects obtained by the use of the system were achievable. As an indirect impact, visibility into supply chains and inventory management had improved in the case company. Consequently, risks and problems were also observed earlier, which led to more proactive actions in inventory management. In addition, the case company´s understanding of its network structure has also developed. The reseller organization´s representatives also mentioned, that, in essence, the biggest benefit the SCM system provides for a customer organization, is stability. This refers, for example, to automated and standardized inventory management processes. The results thus support Attadjei et al. (2018, 157) statement that the decision-making tool allows stakeholders to automate their processes. In addition, they suggest that this lowers the risk of errors in human actions, which was not brought up in the interviews but is undoubtedly also an indirect effect.

Despite the benefits, the introduction of the SCM system was also seen to have drawbacks. Although, the case company´s interviewees agreed that visibility was improved in the supply chain, it was also pointed out that subsidiaries had experienced that they lost transparency because they did not have enough information about the SCM system X.

6.2 Theoretical and practical contribution

The theoretical contribution of this study is related to the introduction of new perspectives to the previous literature. Nevertheless, theoretical contribution can be considered to be limited, as the main themes of the research have received a lot of attention in the literature from different perspectives. For example, information technology and its effects on inventory performance have been conducted in a lot of studies (Shah & Shin 2007, 769). However, Qrunfleh and Tarafdar (2014, 348) state that there is little academic knowledge of how specific information systems benefit certain types of supply chains. Thus, this study provides a new perspective on this topic by focusing on inventory management.

Because the topic of this study was very case-specific and there was a lack of the same type of studies in the literature, to assess feasibility, the basis for the framework was drawn from the performance literature. Consequently, this study brought a new aspect to the previous literature by looking at the feasibility of the inventory management model from a strategic perspective with the help of the framework created based on the performance literature. Thus, the study of feasibility also gained a new perspective, which is why the concept of feasibility has not been opened verbatim based on previous literature in this research. The feasibility framework was supported by empiricism and the framework also received some complements based on the results obtained from the interviews. The created feasibility framework also serves as a response to the statement by Nitsche et al. (2021, 234) that automated processes often focus on technical feasibility without considering the visions of companies, as contrary to this view, the framework in question specifically considers the company´s overall strategy.

The practical contribution of this research is to increase the case company´s understanding, in particular, the implemented SCM system X and its inventory management model. Consequently, the study aims to accelerate the transition to full use of the SCM system X and to abandon the current hybrid model. In addition, the study provides the case company with theoretical information on inventory management and decision support systems through previous studies. The study also challenges and encourages the case firm to update its inventory management practices around the SCM system X, such as Gunasekaran and Ngai (2004, 287) argue, that the implementation of information technology is not only a piece of software, but it requires some comprehensively changes in business processes and, in general, in the company's style of working. Therefore, the study proposed to update the SKU classification so that strategic needs would be better met. This would help to identify strategically important products, allowing them to be placed in separate service classes in the SCM system X and set the appropriate minimum limits for them.

6.3 Limitations and future research

There are several limitations to this study. Firstly, a limitation of this study is one case, and hence, there is a lack of generalization of the results which is typical for an intensive case study. However, instead of generalizability, the main purpose of an intensive case study is to understand a phenomenon and create a context-based description of it. (Eriksson & Kovalainen 2008.) In this study, the emphasis was on increasing understanding of the chosen inventory management model and its feasibility for the case organization´s inventory management strategy. Therefore, the results of the study cannot be generalized to all manufacturing companies, as inventory management models and organizations' inventory management strategies differ.

Secondly, the small number of interviewees created also constrains this research, so that one cannot talk about the saturation of the research material, which refers to the adequacy of the material. Although the number of subjects did not reach the saturation point, in qualitative research by examining an individual case with sufficient precision, it is possible to make visible what is significant in the phenomenon. (Hirsijärvi et al. 2009, 182.) Hence, since each strategic level was represented in the interviews of this study, sufficient research material was considered to be available to understand the research problem from the point of view of the topic of the study. In addition, the size of the company also created a limit on the number of interviewees, and in this light, it was considered to be as representative as possible within the constraints chosen for this study. However, in the future, the research results could be confirmed with more extensive material by involving the subsidiary sales organization´s representatives and SBU heads which would allow the organization's global operating environment to be better taken into account. This would also provide a broader perspective on the impact of the SCM system X and its inventory management model on the organization's operations.

Thirdly, the extent of the research results was limited by the fact that the inventory management model has been patented by the system developer. Hence, the study did not provide clarity on the operational logic of the optimization model at the mathematical level. Therefore, the results of the study remained more superficial than expected.

Because research results showed that with the implementation of the SCM system X, the organization's inventory management practices should also be updated, as a further study, one could find out which SKU classification model would best suit the needs of the organization from a strategic perspective. In other words, what criteria should be considered in the classification to limit the most strategically important products to the same group in terms of the nature of business. To get a comprehensive picture of the case company´s inventory management, it would also be interesting to explore forecasting practices as the case company´s representatives emphasized forecasting as one of the key processes in inventory management. Furthermore, since demand forecast is an input parameter of the SCM system X´s inventory management model, it is important to be as accurate as possible so that the inventory management model can work optimally.

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APPENDICES

APPENDIX 1 INTERVIEW STRUCTURE 1

1. What are the characteristics of the selected product group and products (e.g., value, consumption)?
    a. From the inventory management point of view?
2. How would you describe the current inventory management in the case company?
3. What are the main objectives of inventory management in the case company?
    a. How are these objectives monitored?
    b. How often?
4. What are the practices used to apply current inventory management?
    a. MTO and MTS products
    b. SKU classification
    c. Determination of safety stocks
5. Which stakeholders are involved in the execution of inventory management?
    a. What are their roles?
6. What tools are used in inventory management?
7. What elements do you think are particularly good in current inventory management?
8. What would you develop in current inventory management?
9. What does the case company want to achieve with the introduction of a new inventory management model?
10. What has been achieved so far with the SCM system in question?
11. On what basis has the case company chosen the SCM system of this service provider?
12. Describe the factors that you think would be important to consider when introducing a new inventory management model?
13. What factors do you think to pose challenges for the introduction of a new inventory management model?
14. Would you like to add something to the topics discussed above?

APPENDIX 2 INTERVIEW STRUCTURE 2

1. What are the characteristics of the selected product group and products (e.g., value, consumption)?
2. How organization´s strategic objectives relate to inventory management? How are these objectives monitored?
   a. Which KPI is used to monitor these goals?
   b. How is monitoring done? (Generally, in terms of information technology)
   c. How often?
   d. Who follows?
   e. Reporting
3. What are the main objectives of inventory management?
4. How would you describe the impact and importance of inventory management from a strategic perspective?
5. Which stakeholders are involved in the execution of inventory management?
   a. What are their roles?
6. What elements do you think are particularly good in current inventory management?
7. What would you develop in current inventory management?
8. What does the case company want to achieve with the introduction of a new inventory management model?
9. On what basis has the case company chosen the SCM system of this service provider?
10. What factors do you think to pose challenges for the introduction of a new inventory management model?
11. Would you like to add something to the topics discussed above?

APPENDIX 3 INTERVIEW STRUCTURE 3

1. How long has your organization been acting as a reseller of the SCM system X?
2. Which industries are the customers who have introduced the SCM system X operating in?
    a. Which of these sectors is the most common?
3. Which information systems can be integrated with the SCM system X?
4. How would you describe the purpose of the SCM system X?
5. How does SCM system X inventory optimization model work?
    a. Input data
    b. MTO and MTS products
    c. SKU classification
    d. Safety stock and re-order point
    e. Output data
    f. Other characters
6. How does the system indicate whether the targets set by the inventory optimization model have been met?
7. How would you describe the business impacts of the SCM system X?
8. What challenges have your customers faced in the implementation of the inventory management model?
    a. what about the use of SCM system X in general?
9. Is there anything else you would like to add to the topics discussed?