University of Twente

FACULTY OF BEHAVIOURAL, MANAGEMENT AND SOCIAL SCIENCES

Track Purchasing and Supply management

Master Thesis

‘

Topic	Business case: Process improvement of the material planning process at Company X.
Submitted by:	E. J. A. Vincent (Elisa)
Contact e-Mail:	e.j.a.vincent@student.utwente.nl
1st Academic Supervisor	Dr. ir. P. Hoffmann (Petra)
	University of Twente
2nd Academic Supervisor	K.P.M. Stek (Klaas)
	University of Twente
External Supervisor	Confidential
Document details	Number of pages/words: 47/14918
	Bibliography program used: Endnote

Enschede, 12 February 2020

Abstract

Purpose: The purpose of this study is to give Company X recommendations on how to improve their material planning and how these improvements can be implemented.

Design: In this research, a practical problem is addressed and is answered by using theory. Through semi-structured interviews with the employees involved with the material planning at Company X, the current state of the situation was determined. As this research included an internship at the case company, the observation method was used to collect data. After establishing the current situation, a structured literature review on material planning and change management were conducted to design the ideal situation.

Findings: Instead of providing a new MRP process, it is recommended to adapt the current material planning process. To find the best fitting and working process for the current employees at Company X, they should be involved in designing the new process. An implementation plan was designed by combining Lewin's Three-stage process model and combining it with the Kubler-Ross curve, which was adapted by Kumar.

Value: This paper is academically relevant, as it combines three research topics, MRP, change management and SMEs, which are underrepresented in academia. Small- and medium-sized enterprises believe they cannot afford the same systems and processes that many large companies can.[1] Although it was revealed in the literature that SMEs benefit from material requirement planning (MRP), which is the most common method for material planning, there is a high risk when MRP is not implemented correctly people would likely revert to their old habits shortly.[2] To tackle that problem, the topic of change management was introduced to this paper and an implementation plan was designed. The bottlenecks found at Company X are undoubtedly also found in other business cases, for that it is expected that the implementation method described in this research can also be generalised towards SMEs in general.

Keywords: Material planning, Change management, Small- and medium sized enterprises, Business case study, Implementation plan for change in SME.

---

[1] See Federici (2009), p. 82.
[2] See Petroni (2002), p. 331.

Management summary

This research is focused on giving Company X a way to improve their material planning process. To achieve process improvement, Company X should, with the help of change management, find a suitable process that they can implement in their ERP system AFAS. The current system has some flaws but is, in its core, not a poor one. It is expected that with teamwork, a better process flow can be generated, which can then be implemented by the AFAS firm. It is recommended to do so, following the implementation method with Lewin's three-stage model, combined with the Kubler-Ross curve, which was adapted by Kumar.

The bottlenecks found in the current material process are, among others, the inaccurate forecast and the consequently changing production planning, leading to daily effort made for material planning. Furthermore, some purchasers do not agree with the approach from the parent company, which effects the working atmosphere. One of the most significant bottlenecks is the small inventory, which does not allow for extensive preparation for several days of production, and these inventories are checked only manually. According to the involved employees, three have been working at Company X since the founding and are familiar with how the company worked when there was only one production line. Even though the process appears to work currently, future risks include losing the tacit knowledge held by the involved employees. This can also be described as a bottleneck, in that there is too much tacit knowledge held by an individual employee. Furthermore, the current process takes up a great part of their weekly tasks to some even being daily tasks and the different steps take a substantial amount of time, especially for the purchasers of cardboard, crates and packaging materials. When applying the maturity levels of Macintosh as mentioned by Aguilar-Saven (2004) to the current processes of Company X, it appears, that Company X is still on the first stage of maturity as their processes can only be repeated by the individual who works with the process, but cannot be used by a different person.

Currently, Company X already dispose most of the elements described as components of MRP in their material plan, such as the master production schedule which is now the basis for the material plan. It seems as if Company X is using all the steps, but not to their fullest reliable potential. The material plan for Company X can be improved on forecast, inventory lists, and especially reports. There are efforts to come up with decent reports, but these are complicated to set up and to read. Looking at the three different enhancing methods it seems that JIT is another aspect of Company X difficulty to manage what they already have properly. The technique would help Company X managing their inventory, however when

analysing the current material plan JIT is what they are doing for all the materials needed in the production of bread. An improvement for Company X could come from the lean manufacturing, which is similar to JIT. Especially when using a value stream map for their supply chain, which could give Company X insight in where logistics can be improved. The re-order point method is difficult to apply to Company X as they almost have no room to keep a safety stock. If the inventory room is elaborated, this could have a positive impact. Software systems have made MRP accessible to many companies, especially in large corporations, in which it was revealed to be a beneficial process enhancer. Still, in SMEs, MRP can be highly valuable, provided that it is implemented correctly. In a company such as Company X, an MRP software is particularly difficult, as Company X handles a stochastic environment due to their dependence on the weather. Nevertheless, it should be implemented when Company X wishes to improve. Aforementioned studies already discuss the benefits of change management when implementing new processes into a small- or medium-sized company, which is how Company X sees themselves. As Company X already uses an ERP system from the firm AFAS, this should be enhanced to use the new material plan. The study by Petroni (2002) concluded that management support, level of integration and data accuracy are variables that are necessary for successful implementation. With a detailed change management plan, there are higher chances of a successful implementation.

To implement the change Company X first, need to unfreeze their current processes by evaluating them and pointing out bottlenecks, this is partially done in this research. In this time the project change team made up of the six involved employees concerning material planning will meet up to discuss what they believe is their process and what they believe the bottlenecks are. Then they will come up with solutions to solving these bottlenecks. The research done in this paper comes in handy there are well. They need a detailed MRP process. In this research indicators are given as the current state of BPM and MRP were already applied to Company X. In the change process the company responsible for the AFAS implementation at Company X has implemented the new process and the employees start working with it. There should be regular feedback meetings, first every two weeks and later once a month until the process is satisfactory, and bottlenecks are solved. With that happening the change is processing into its third stage and the process is refrozen again. To guide the change process, a change agent could come in conveniently. The change agents could additionally make sure, that all the involved employees, also the managers stay committed to the change.

Table of contents

List of Figures

List of Tables

1. Introduction: The need to adapt processes to growth.

The need for straightforward material planning was discussed by Company X, a medium-sized bake-off bread supplier in the Netherlands. Company X is a subsidiary of the holding Company Y but enjoys great independence, which is why they classify themselves more like a small and medium-sized enterprise (SME). Company Y, however, does support Company X in the negotiations with the supplier as Company Y covers markets worldwide and thus has access to better resources. The interference of Company Y influences the employees involved with material planning, especially when considering that most employees who work at Company X have been working there for 20 or more years and know the company extraordinarily well. The most significant cause of complication is the substantial growth of Company X since 2010, where the supply chain processes have failed to grow accordingly. Company X has the desire to work with a clear, simplified and easy-to-implement material planning process. This paper establishes a business case to find a solution to achieve that desire.

In studies by Federici (2009) and Assarlind (2015), among others, it is mentioned that broad material planning methods, such as material requirement planning (MRP), are perceived as overdone for SMEs. It was recognised by studies from Federici (2009), among others, that SMEs do not have the resources for the execution of MRP, as in a large organisation. However, adapted versions of MRP can be implemented in SMEs and create many benefits for the company.

This paper provides recommendations for an improved process of material planning in an SME, with a focus on how to implement the new process. While the primary goal is to find a clear process with a corresponding implementation plan for Company X, the researcher anticipates that the results could be applied to similar companies. However, general application in the context of an SME is challenging, as SMEs have individual characters which are difficult to generalise.[3]

Currently, there is a lack of literature that focusses on operational improvement in SMEs, including MRP and change management, which is odd, considering that 99 percent of companies in the EU are SMEs.[4] This paper is academically relevant, as it combines three

[3] See Assarlind (2015, p. 1107).
[4] See Assarlind (2015, p. 1107).

research topics, MRP and change management in SMEs, which are underrepresented in academia. Small- and medium-sized enterprises believe they cannot afford the same systems and processes that many large companies can.[5] Although it was revealed in the literature that SMEs benefit from material requirement planning (MRP), which is the most common method for material planning, there is a high risk when MRP is not implemented correctly people would likely revert to their old habits shortly.[6] To tackle that problem, the topic of change management was introduced to this paper by the researcher. Change management is known for slowly changing the employees involved where they either come up with the new processes themselves or, can be adjusted to the new process by understanding the different steps it takes.

To answer the research question '*How can the material planning process at Company X be improved?'.* This paper is arranged according to the following structure: First, the company is introduced, and the current situation is elaborately sketched. Subsequently, the research questions are presented. Afterwards, the methodology is explained, followed by the theoretical framework on business process modelling, material planning and change management. In the analysis chapter, the results from the literature review are presented and applied to the bottlenecks of this business case. After examining the results in the results chapter, other possible solutions and limitations are discussed in the discussion. Finally, the paper is concluded.

[5] See Federici (2009), p. 82.
[6] See Petroni (2002), p. 331.

1.1. Company introduction: Company X produces bake-off bread.

In this chapter, the company is introduced. Founded in 1992, Company X switched ownership three times before becoming part of Company Y in 2015. Company X operates in the bread and bakery product market, which includes fresh bread and bread rolls. SMEs continue to dominate the market, even though large manufacturers are increasing in number.[7] A company is medium-sized when the staff headcount is less than 250 and the turnover is less than 50 million euros, or the staff headcount is less than 250 and the balance sheet total is less than 43 million euros, according to the EU.[8] Company X work in a business-to-business (B2B) environment, where they sell their products primarily to supermarkets, in which the products are eventually sold to the end costumer. Company X is a medium-sized enterprise with 240 employees, and the management team consists of four managers who manage eight central departments, as depicted in the organogram (Figure 1).

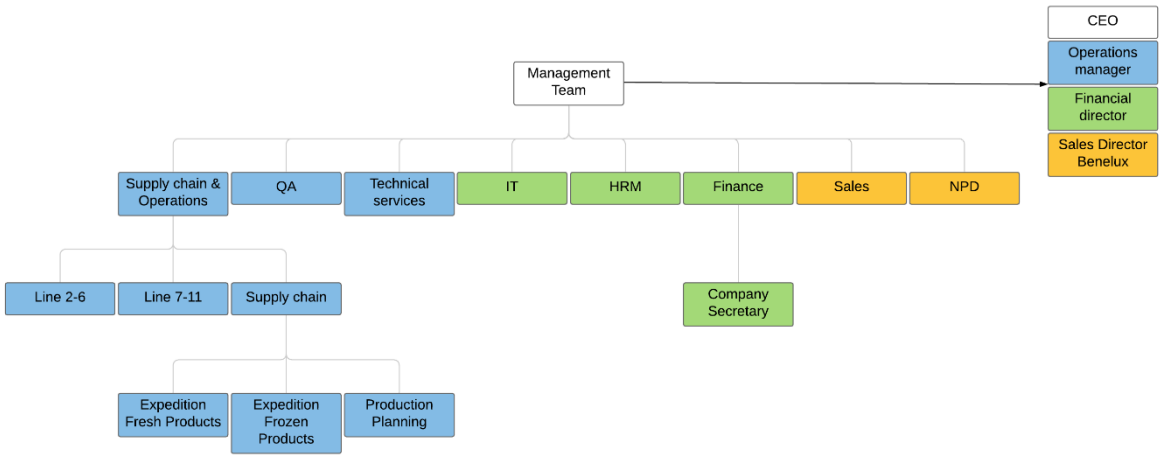

Figure 1—Organogram Company X

Company X deals in two major product categories: fresh products and frozen products. As of May 2019, Company X handles 101 different fresh products and 393 different frozen products. Since 2006, Company X grew substantially from only six assembly lines to eleven assembly lines; however, line 1 was closed several years ago, and lines 2 and 3 were merged into a single assembly line, giving Company X a total of nine operating assembly lines. Company X follows a cost leadership strategy with an extra focus on quality. As defined by Porter,[9] this is a rather broad definition of strategy which relies on the ground, that Company X operates in several subbranches of the bakery industry. Company X bakes private label

[7] See Statista (2019).
[8] See European Commision (2019), p. 1.
[9] See Porter (1997), p. 16.

bread for Dutch supermarkets and additionally bakes deluxe loaves of bread for British supermarkets. Company X has received certificates for food safety from the British Retail Consortium (BRC), International Food Standard (IFS) and GMP+, which specifically requires having the residuals of the dough as silage. Furthermore, Company X delivers to the Dutch and international food-retail and service markets. Examples of their customers include well-known supermarkets in the Netherlands, Germany and Great Britain, where the bread is sold as the own brand of the supermarket.

1.2. Current situation: Risk of losing tacit knowledge and too much flexibility.

As Company X is a production firm, the supply chain process is the primary process on which to focus. Consequentially, it is where the most efficiency can be created. In Figure 2, the process of the supply chain at Company X is visualised. In this research, the researcher is focussed on material planning, which belongs to the process step production and is highlighted in red in Figure 2.

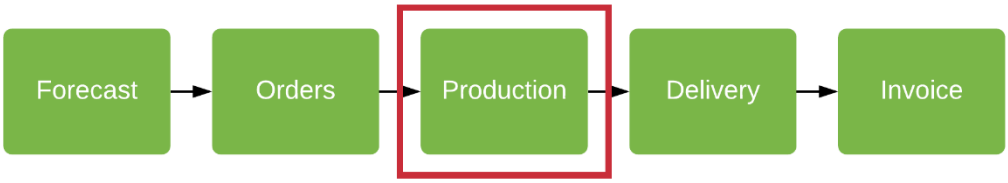

Figure 2—Supply chain process at Company X

In the process step 'production', the production planning is achieved by considering the forecast, seasonality, stock and discount actions. If the actual daily orders differ greatly from the forecast, the production planning is changed to suit the order. Unpredicted changes can occur, such as weather influences. For example, predominantly in the summer, high numbers of baguettes are ordered due to consumers organising barbeques. However, if the weather disappoints, the forecast may be unpredictable, as good weather was expected but did not occur. Another reason the production planning could be changed is due to the low capacity of inventory space. For the finished frozen products, there is room for only one week's worth of production in the freezer. If the order numbers disappoint, the production cannot be stored. The stock problem is partially solved with external stock; however, as the registration of the external stock is done by hand, this leaves room for human error. Each day, the stock numbers are sent via email in a spreadsheet. Unexplained stock, an example of which is a pallet of product at the external storage, of which the intended product number is not known, remains a point of confusion for several days, if not weeks. External stock also demands

extra costs. In addition, the inventory room for the raw materials presents challenges for the people involved with the material planning, as raw materials cannot be bought several weeks in advance, since the raw materials inventory space holds enough room for only a maximum of two days of production. The planning—including stock numbers, making orders and production planning—is tracked in a software ERP system called AFAS.

Based on the production planning, material planning is done. The current material planning is depicted in Figure 3. Three employees with the titles purchaser raw materials, purchaser special ingredients and production line manager buy the ingredients for the bread production. To package the bread, the production planner also purchases the cardboard boxes. In addition, there is a purchaser of packaging materials, such as foil, and a purchaser of crates, which are used explicitly in the fresh production. To execute the planning, no mutual collaboration is necessary. Only the purchasers of the direct bread production choose to work following the four-eye principle, in which the line manager always checks the receipts. The mutual collaboration for material planning is not necessary as long as the production planning is set and will not change. In the event of changes, all employees involved are notified as soon as possible. Currently, the six employees concerned with the process must handle this daily due to the limited stockroom and changes in production planning; this is challenging, as the involved employees have only one person who could replace them in case of their absence. Unfortunately, the officially absent employee must still provide an update to the person who is replacing him or her.

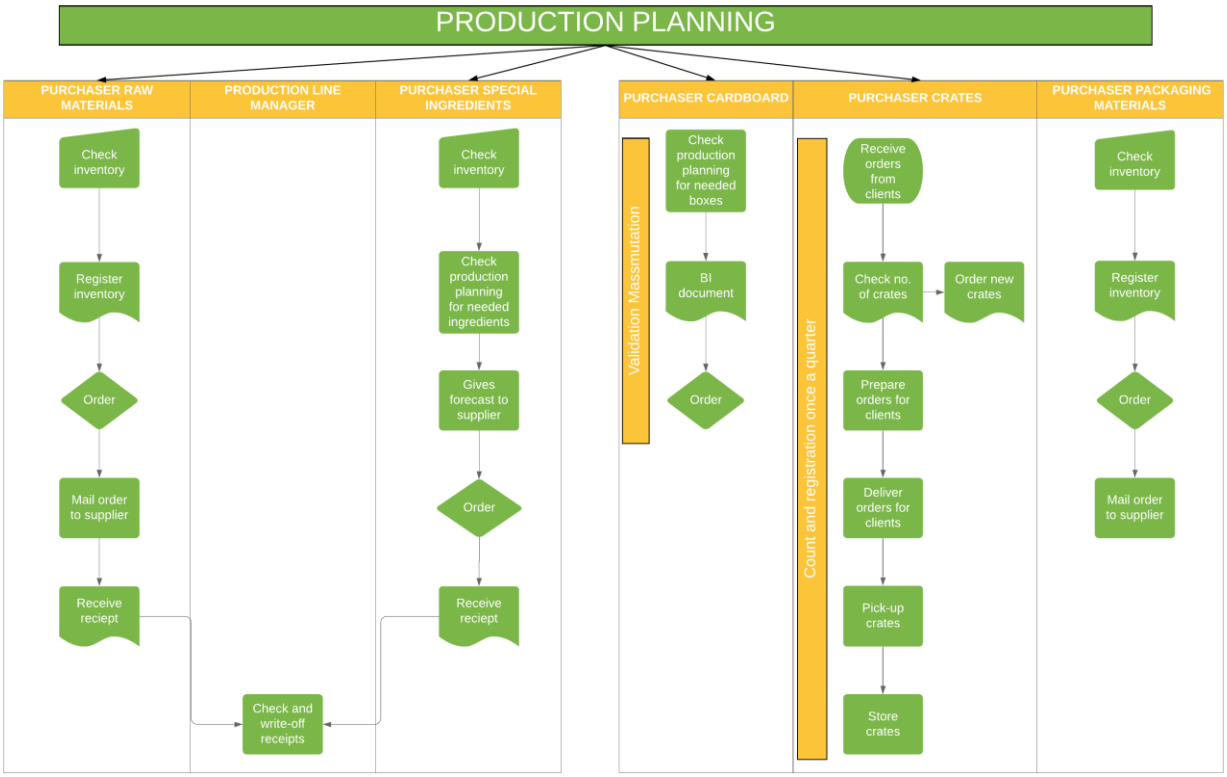

Figure 3—Current material planning process at Company X

The involved persons have been highly committed for many years to the firm. As the company has been following this process for a long time, the employees are willing to do the extra work, since they have not known any other way. For the risk that something unexpected could happen to one of the involved employees, Company X would have the challenge of determining what needs must done. Therefore, the current process is too flexible and dependent on individual tacit knowledge. Tacit knowledge is practical, action-oriented knowledge or know-how based on practice, acquired by personal experience, seldom expressed openly and often resembles intuition.[10] It is said, that 90 percent of the knowledge in any organisation is incorporated in the employees.[11]

In the following, a short description of each involved employee is portrayed.

During material planning, the production line manager checks the receipts and orders following the four-eye principle for the raw and special ingredients of bread production. This is less important for bulk ingredients, which are ingredients of high volume such as flour and yeast, but highly important for special ingredients. If there is insufficient stock of special

[10] See Smith (2001), p. 314.
[11] See Smith (2001), p. 311.

ingredients for the particular types of bread, the company cannot produce. If there is too much stock, the leftovers must be thrown away, as there is no inventory space, and the ingredients will expire. Apart from that, there are no exact known numbers of the inventory; rather, it is more of an accurate guess. At the moment, the stock of special ingredients is ordered for the subsequent two days.

An essential factor that must be traced is the brand of plain flour used, as there are three plain flour suppliers. If there is a reclamation regarding the flour in production, the company must know which flour supplier to hold accountable. Thus, the bakers must ensure that the flours are not mixed, which is manually recorded when the supply is delivered. Each time the flour supplier changes, the container is thoroughly cleaned to avoid mixing the flours of different suppliers with one another.

Every other day, the purchaser of raw materials visits the stockroom, where the inventory is manually counted. In an Excel file, the inventory is registered, and based on the file and production planning, the order is set up in the ERP system. An export of the order is sent via mail to the supplier. When the order arrives, the receipt is checked by the production line manager because they work with the four-eye-principle, meaning that another person must review the receipt. This person will additionally check whether the order was logical to be made, which is done after the delivery.

At the beginning of every week, the purchaser of special ingredients determines the purchasing orders. Due to the possible changes in production planning, the purchaser is forced to check whether the orders are still appropriate or must be adjusted. The greatest challenge for the purchaser of special ingredients is to coordinate the orders, as the warehouse capacity is meagre. For some ingredients, there can only be a single day of stock, which means that the warehouse must be checked every morning.

Next to the purchasing of cardboard boxes, the purchaser's most significant responsibility is to compose the production planning. The production planning is the basis for all the employees involved in the material planning process and employees involved in the supply chain. The production planning states the times and quantities at which the bread is produced and provides information to the material planners about the ingredients, the amounts of ingredients and the amount and type of packaging materials, which are needed for the production. Cardboard boxes are ordered daily, and an employee of the expedition takes the inventory of the cardboard boxes each morning. Based on the inventory and planning, the

purchaser calculates how many cardboard boxes must be ordered. A business intelligence tool had been installed to oversee the calculations; however, this does not work correctly. The purchaser for the cardboard boxes also has the challenge of insufficient stockroom space; there is room for about two days of stock. As the space is limited, there can be no more than 72 pallets of cardboard due to fire safety requirements.

The purchaser of crates is responsible for the crates in which the fresh bread is delivered. The daily orders for fresh bakery, which is the production that is not frozen, arrive the morning and afternoon. Only when the orders are known can the deliveries be planned and prepared. There are multiple deliveries per day, and deliveries happen seven days a week. Company X works with three types of crates. The Broban crates belong to Company X themselves, but the CBL crates, in sizes 17 cm and 23 cm, are rented from an external company. These must be ordered two days in advance, but since the orders only arrive on the day itself, the final number required is always unclear. However, as Company X has a good relationship with the supplier, this allows the purchaser to adjust the order the day it is needed. The order number of the crates is sent immediately after the order, and this number is used on the schedule provided to the drivers so that the drivers can know what order they will pick up. The driver planning is scheduled before the order is confirmed, and the order is not accepted or rejected until the following day. Each day, the number of crates in circulation are tracked. On average, the crates are in circulation for five days, though after a holiday, this can be extensively longer.

The purchaser is responsible for the packaging materials orders packaging materials such as foil and labels. Contact is made with the supplier, though not concerning negotiations. The holding, Company Y, revises the suppliers every two years and negotiates the prices with current suppliers and new suppliers. Due to the frequent revision, the suppliers change intermittently. Company Y does this for all suppliers, but most employees of Company X do not agree with Company Y, as they have long-term relationships with the suppliers. In contrast with his colleagues, the purchaser of packaging materials does not have a close relationship with the various suppliers with whom he interacts. According to the packaging materials purchaser, it is pleasant to work with Company Y, and he is receptive to their suggestions concerning the suppliers. The purchaser’s process is as follows: a purchase order is made and sent via mail to order the packaging material. The purchaser then makes an inventory list in a spreadsheet to determine the stock, which is counted manually by walking

through the production site once a month. Depending on the current stock and the production planning needed, materials will be reordered.

The packaging material stock is dispersed throughout the production facility, with no space for a buffer. A challenge arises when the previous pallet is not yet empty; in such a case, the incoming pallet is placed in the hallway, blocking walkways. This problem is partially solved with an external stock at the supplier, but this is not the best solution, according to the purchaser. He would rather have a more elaborate stockroom at Company X, as it would save on transportation and storage costs.

In general, the employees involved would like to see more automation, primarily concerning the inventory. It would enhance the efficiency if the employees did not need to manually count at the high frequency, as they do currently. The line manager expressed that they would benefit from a modem in the container where the flour is stored. This modem would measure the level in the container and display an indicator or even automatically reorder the flour once it reaches a certain level within the container. The purchaser of special ingredients contradicted this statement, believing that the modem would not work, as the modem would not be able to consider the production times.

Furthermore, all employees desire static production planning, such that the material planners would not need to be involved with it every day but could plan for several days ahead. It was observed by the researcher during the stay at the company that on average, the involved employees spend approximately 50 – 60 percent of their workweek on material planning. This estimate is based on the information provided during the interview, in which the employees stated how much of their day they spend on material planning. The only person who expressed doubts about implementing automation in material planning was the purchaser of the packaging material. He was afraid that with automation, there would be more room for errors, such as when a factory worker takes from the inventory but does not correctly register it.

By studying the current situation, it is clear that the current material planning process is not appropriate for the company given the several bottlenecks and the company's recent substantial growth. The bottlenecks found in the current material process are, among others, the inaccurate forecast and the consequently changing production planning, which leads to a daily effort made for material planning. Furthermore, some purchasers do not agree with the approach of the parent company, which influences the working atmosphere. One of the

most significant bottlenecks is the small inventory, which does not allow for extensive preparation for several days of production; furthermore, these inventories are checked only manually. According to the involved employees, three have been working at Company X since the founding and are familiar with how the company worked when there was only one production line. Even though the process appears to work currently, future risks include losing the tacit knowledge held by the involved employees. This can also be described as a bottleneck, in that too much knowledge is held by an individual employee. Furthermore, the current process takes up a great part of their weekly tasks to some even being daily tasks and the different steps take a substantial amount of time, especially for the purchasers of cardboard, crates and packaging materials. The bottlenecks in the process are presented in Figure 4.

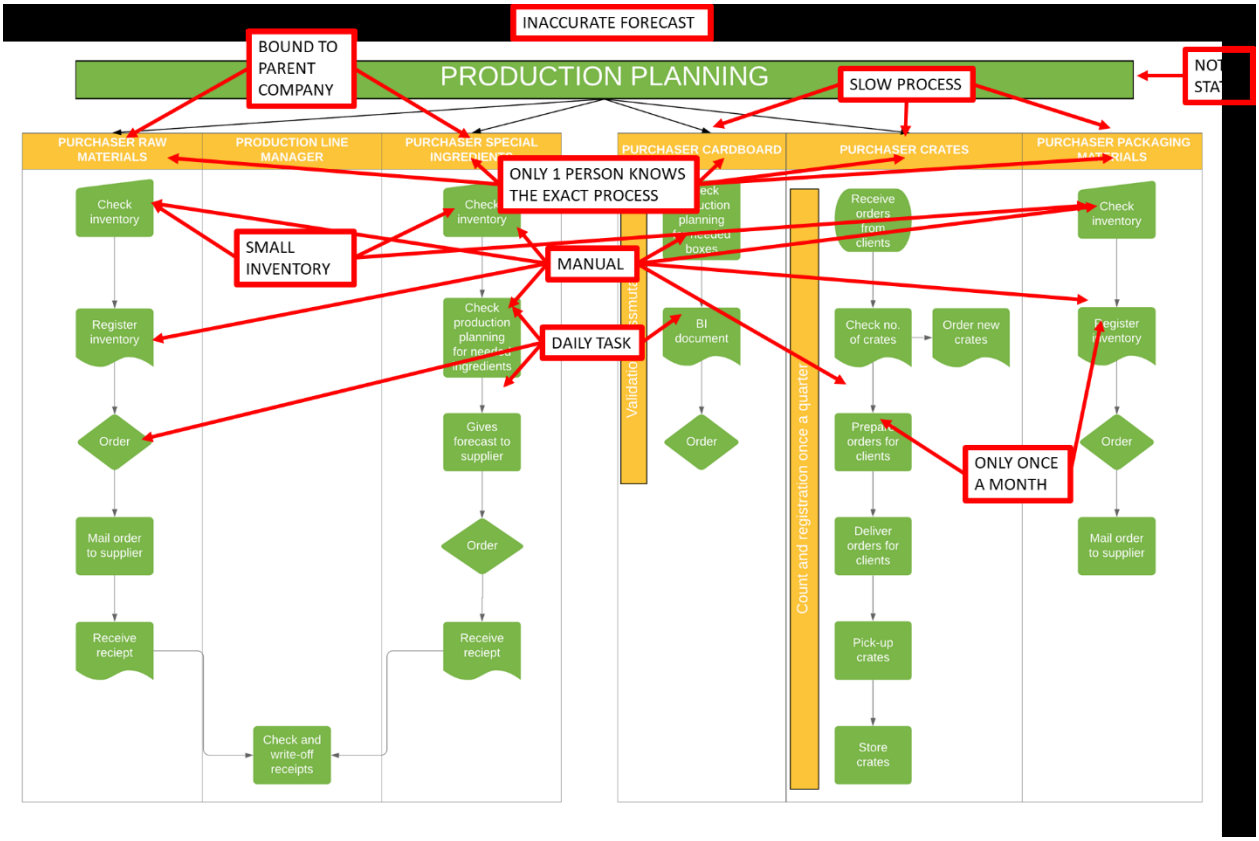

Figure 4—Current material planning process, including the bottlenecks

In an improved version of the material planning process, the bottlenecks should be reduced, and the overall process must require less work and be more straightforward to transfer tasks to colleagues. In Table 1 the bottlenecks and the desired situation by Company X are described.

Current situation	**Desired situation**
Daily process with only one person to possibly replace the responsible person.	Less workload on a single day and easy takeover by another employee in case of missing.
Dependence on individual tacit knowledge	A small dependence on a single employee.
Too high flexibility	Less flexibility with a static production planning.
Limited stockroom for all stock.	More elaborate stockroom at Company X; save transportation and storage costs.
External stock, which is not correctly registered.	Register external stock with a track and trace system.
Manual count of stock	Digitalise the stock numbers with a track and trace system hung up in the inventory.
Manual record of delivery flour.	Registration of the delivery by using the track and trace system.
No exact known numbers of the inventory.	Digitalise the stock numbers with a track and trace system hung up in the inventory.
Continuously monitor the possible changes in production planning and the consequent adjustment.	A static production planning which does not need a reschedule after every interruption.
Business intelligence tool for cardboard does not calculate the numbers correctly.	A static production planning based on a more reliable forecast.

Table 1—Current situation and desired situation at Company X

1.3. Research questions: the need for improved material planning at Company X

The goal of this research is to provide recommendations for an improved process of material planning in an SME, with a particular focus on how to implement the new process. Company X is an excellent example of an SME which requires a more straightforward process. The most important goals for this research are to have a process in which fewer responsibilities are placed on a single employee and for more efficient ordering to be done. The main research question is as follows:

How can the material planning process at Company X be improved?

The sub-questions are as follows:

1. What is the current situation concerning material planning at Company X?
2. What is the ideal situation for material planning at Company X?
3. What must Company X do to achieve the ideal situation for material planning?

For the material planning process to be successful, it must comply with the following requirements established by Company X:

1. The new material planning process must be compatible with the ERP system that Company X currently uses.
2. The employees must spend less time on material planning.
3. The material planning must be less error sensitive.
4. The material planning must be straightforward to follow.

The requirements will be satisfied as follows: (1) when the new process can be easily implemented in AFAS by the external firm, (2) when, rather than spending an estimate of 50 – 60 percent of the workweek on the material planning, this number should be reduced to 10 percent, (3) when errors are reduced to weekly or even monthly occurring. Currently, there are no exact numbers of how many errors are made in the material planning. However, during the observation time, it was seen that errors occurred daily; Finally, employees should require at most one training session and one week of practice to work with the new process. The requirements should be assessed after the implementation of the new material planning process at Company X in regular feedback meetings which are targeted as hitting these requirements as goals.

2. Methodology: Qualitative research with two literature reviews

In this research, a practical problem is addressed and is answered by using theory. Before the theoretical perspective could be understood, the current situation needed to be sketched. Through semi-structured interviews with the employees involved with the material planning at Company X, the current state of the situation was determined. As this research included an internship at the case company, the observation method, as defined by Marshall and Rossmann (1989), was also used to collect data.[12] After establishing the current situation, a structured literature review on material planning and change management was conducted to detect the ideal situation. A revised material planning process and an implementation plan for Company X are the goals of this research.

The data collection was conducted over three months, during which a full-time internship took place. The six interviewees of the study are employees of Company X. They are involved in the current material planning process as the purchaser of raw materials, production line manager, purchaser of special ingredients, purchaser of cardboard, purchaser of crates and purchaser of packaging materials. In an introductory meeting with the participants, the current situation was determined. The interviews were semi-structured, as it was expected that the employees would share the most information with the researcher in such a setting. The meetings lasted about half an hour to an hour, and notes were written. The notes were transcribed into a full summary of the meeting, which can be found in Appendix 1. The questions asked during the introductory meetings were as follows:

1. What is your current work process?
2. What could be improved in your process?
3. What would you not like to change about your process?
4. What do you expect from this research?

The second part of the data collection was executed by a structured literature review following the protocol of Webster and Watson (2002) and Tranfield, Denyer and Smart (2003). The review was performed in a two-stage process. First, a review protocol was established, with criteria to which relevant literature must comply, to determine what

[12] See Marshall and Rossman (1989), p. 1.

material planning processes are used, especially in SMEs. Second, the results were analysed, and an ideal material planning process was set up.

The exclusion and inclusion criteria are listed in Table 1.

Nr.	Criteria	Reason for Exclusion
1	Pre-1983 articles	Even though Joseph Orlicky first mentioned the material planning process in the form of MRP in 1964, Oliver Wight made a more applicable and currently most-used version in 1983.
2	Mathematical	As Company X already uses the software system AFAS for their MRP, which provides the mathematical formulas, the papers focussing on the mathematical formulas behind MRP were too specific and could not be applied to the case.
Nr.	**Criteria**	**Reason for Inclusion**
1	Empirical papers with samples containing small and large firms	As Company X is a medium-sized company, it is useful to consider multiple sizes and filter the best results.
2	Manufacturer	Company X is a manufacturer, but there are material planning methods for several fields. With including this criterion all other irrelevant fields will be excluded.

Table 2—Exclusion and inclusion criteria for material planning literature review

When the criteria were set, a search for relevant literature was conducted on Scopus and Web of Science. Google Scholar was purposely omitted, as this platform includes many low-quality academic papers.[13] Only peer-reviewed articles were considered, and the articles found in Scopus and Web of Science were exported to Endnote.

In Table 2, the overview of the review process with the explained criteria from Table 1 can be found with the number of applicable papers. These papers were first reviewed based on their abstracts to determine whether they would provide relevant information for this research.

[13] See Bornmann, Thor, Marx, and Schier (2016), p. 2779.

Search string	Scope	Date of search	Date range	Nr. of entries
Search protocol for Scopus				
"Material Planning"	Title, keywords and abstract	6 September 2019	1983-NOW	656
AND Manufacturer	Title, keywords and abstract	6 September 2019	1983-NOW	118
AND Implementation	Title, keywords and abstract	6 September 2019	1983-NOW	146
Search protocol for Web of Science				
"Material Planning"	Topic or title	11 September 2019	1983-2019	945
AND Manufacturer	Topic or title	11 September 2019	1983-2019	47
AND Implementation	Topic or title	11 September 2019	1983-2019	135
NOT Mathematic	Topic or title	11 September 2019	1983-2019	19
Total in Endnote				1,006
Selected based on exclusion criteria				46
Removed duplicates				-5
Removed after complete reading				-14
Total selected for review				27

Table 3—Overview of the review process for material planning

After the selection of the articles, the articles were read by chronology. This approach is unusual, but it offered the researcher an overview of the development of material planning in the past 30 years, including an understanding of the basics of MRP, before the more recent detailed papers were read. The first scan was performed to obtain an overview of the main

topics and to filter out articles that were not relevant for the study or were of low quality. In the second scan, the main takeaways of the articles were filtered and arranged in a table for analysation in the third stage. By placing the takeaways in a table, similarities between articles could be determined, and reoccurring topics could be identified.

In the findings of the literature review, the three sub-questions will be answered. In the current situation, the bottlenecks in the current material planning process were revealed. Based on the literature, the bottlenecks were solved theoretically, but it came to attention that only solving theoretically would not solve the problems in the long term. Thus, to solve the third sub-question, a literature review on change management was added.

During the data collection period, it was revealed that writing only a material planning process would not be sufficient to introduce a lasting solution to Company X Due to the distinct characters of the employees involved, it appeared that including the aspect of change management would be helpful in this situation. Additionally, during the first systematic literature review of MRP, the topic of change management appeared several times. To learn how change management would be best included in the new framework, a smaller systematic literature review was conducted.

In Table 3, the inclusion criteria are listed. There was no need for exclusion criteria, as the inclusion criteria were strict.

Nr.	Criteria	Reason for Inclusion
1	Empirical papers with samples containing small and large firms	As Company X is a medium-sized company, it was useful to consider multiple sizes and filter the best results.
2	Advantage	It needed to be confirmed that using change management would be an advantage for the company.
3	Implementation	Studies on how to implement change management were necessary to understand what would be best for Company X.
4	Material planning	It was beneficial for the paper to focus on change management for material planning to directly observe the impact that change management had on the main topic of this research.

5	Manufacturer	Company X is a manufacturer, but there are material planning methods for several fields. With including this criterion all other irrelevant fields will be excluded.

Table 4—Inclusion criteria for change management literature review

As with the first literature review, Scopus and Web of Science were assessed to search for relevant literature. Google Scholar was purposely omitted, as this platform includes many low-quality academic papers[14]. Only peer-reviewed articles were considered, and the articles found in Scopus and Web of Science were exported to Endnote.

Table 4 presents the overview of the review process with the explained criteria from Table 3 with the number of applicable papers. These papers were first checked on their abstracts to determine whether they would provide relevant information for this research. It was intentional to include many inclusion criteria, as the field is dynamic and the main topic of this paper is material planning. With many inclusion criteria, it was expected that the final number of papers would be low, though they would be highly relevant.

Search string	**Scope**	**Date of search**	**Date range**	**Nr. of entries**
Search protocol for Scopus				
"Change management"	Title, keywords and abstract	9 December 2019	2010-NOW	29826
AND Advantage	Title, keywords and abstract	9 December 2019	2010-NOW	5888
AND Implementation	Title, keywords and abstract	9 December 2019	2010-NOW	2414
AND Material Planning	Title, keywords and abstract	9 December 2019	2010-NOW	161
AND SME	Title, keywords and abstract	9 December 2019	2010-NOW	27
AND Manufacturer	Title, keywords and abstract	9 December 2019	2010-NOW	11

[14] See Bornmann et al. (2016), p. 2779.

Search protocol for Web of Science				
"Change management"	Topic or title	9 December 2019	2010-2019	11974
AND Advantage	Topic or title	9 December 2019	2010-2019	1085
AND Implementation	Topic or title	9 December 2019	2010-2019	157
AND SME	Topic or title	9 December 2019	2010-2019	3
Total in Endnote				14
Removing duplicates				0
Removed after complete reading				-4
Added papers				4
Total selected for review				

Table 5—Overview of the review process for change management

A similar reading method was used for change management as for the material requirement planning. After the selection of the articles, the articles were read from present to past. The first scan was performed to obtain an overview of the main topics and filter out articles irrelevant to the study or of low quality. In the second scan, the main takeaways of the articles were extracted from the article and analysed. By arranging the takeaways in a table, similarities between articles could be determined, and reoccurring topics could be identified. When considering the takeaways together, the main aspects of change management could be identified and applied to the case.

3. Theoretical framework: Organisational change must be carefully handled.

After collecting data regarding the current situation and identifying the bottlenecks in the current process, it was discovered that Company X requires a clear material planning process. To solve the bottlenecks in the current process, a literature review on the three main topics was conducted. The first section of this chapter concerns the business process modelling (BPM) to ensure the correct designing method is used in improving the process. Business process modelling is also first introduced to better understand material planning. It is answered how a process should be designed to adjust the process to Company X's work environment and to achieve long-term positive effects on the company. After the section on BPM, the core research of this paper is presented: the material planning review. In this review, the history of material planning and how material planning is used in SMEs are determined, which specifically applies to the business case mentioned in this research; this is then concluded by providing various ways to implement the improved material planning. During the data collection period, it was observed that only designing a new process would not be viable, as from experience the employees claimed they wanted change, but without them having to do anything for it. During the data collection it was observed, that the employees are experts in their field and do the job for several years, however they are also quite stubborn. To make sure the improved process would be accepted by the employees, it was decided to add another core research element to this paper: a literature review on change management. Change management is expected to benefit Company X in many ways, as it takes the employees by the hand and additionally give the employees a say in the process improvement.

3.1. Business process modelling (BPM): Techniques to design processes.

Hammer (1993) defines a business process as 'a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer'.[15] To develop a process, there must be an objective in which the process will result. To achieve this result, a more precise description of all the needed steps might be given through process decomposition. In addition to process decomposition, another way to enhance the clarity of

[15] See Hammer and Champy (1993), p. 35

a process is with a business process owner, an individual assigned to the process or subprocess.[16]

A process can be modelled via several techniques; a study was conducted to compile a list of all available techniques; however, it appears that the techniques exist in millions of variants, fashions and styles.[17] A PhD student sought to compile a list of the techniques currently used, and stopped at the count of 3000.[18] A common and modern way to model a process is with a business process modelling tool. These can help businesses to make their processes more transparent and centralised.[19] Most importantly, these tools help to analyse the current processes, thus adding to the refinement of these processes. Several tools are designed to be collaborative among employees, meaning that employees in a team setting can work on the process which they feel is most suitable for the work schedule.

To logically align the vast numbers of possibilities in BPM, they can be ordered into groups of similar aspects.[20] First are graphical standards, which use diagrams to visualise the business processes with their flows and transitions. In addition, there are execution standards, which computerise the formation and automation of business processes. The third are interchange standards, in which the flexibility of data is facilitated; this incorporates the various process designs and execution. Last is the diagnosis standard, which specifies the capabilities needed regarding administration and monitoring. It is meant to identify the bottlenecks and audit the processes in the company.[21]

---

[16] See Kirchmer (2017b), p.
[17] See Recker (2006), p. 33
[18] See Recker (2006), p. 33
[19] See FAN (2007), p. 1.
[20] See Ko, Lee, and Wah Lee (2009), p. 746-748.
[21] See Ko et al. (2009), p. 746-748.

A straightforward BPM life cycle, which consists of four steps, was created by van der Aalst et al. (2003); a visual representation of the cycle can be found in Figure 5.[22] The goal of this life cycle was to acquire a logical and concise overview of BPM, in alignment with the mentioned standards. The four steps are process design, system configuration, process enactment and diagnosis. The process design stage is characterised by digitalising the physical paper processes that exist in the business thus far but adapting the process to better suit automation and thus improve the process. This stage is linked to the graphical standards. In the second stage, system configuration, the core activity is to configure the underlying system infrastructure. Afterwards, during process enactment, the newly designed processes are modelled electronically. Last is the diagnosis, in which the tools are given to analyse and monitor the newly automated process, and if these are decent, the BPM analyst can identify and improve on the bottlenecks and potential fraudulent loopholes.[23]

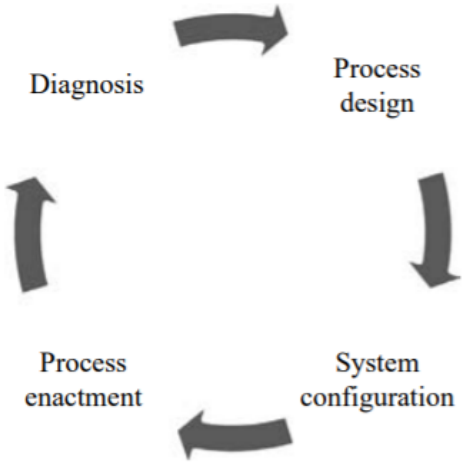

Figure 5—BPM life cycle based on van der Aalst et al. (2013)

To establish a functioning process, the levels of process maturity defined by Macintosh (1993) should be considered continuously. Five levels describe the maturity: the first level is initial and concerns the development of processes, the second level focusses on the repeatability of the processes, the third level is reached when the process is standardised within the organisation, the fourth level measures and controls the processes, and the fifth level concerns optimising the processes within the company.[24]

Business process modelling is the original step of all processes in a company. Material planning belongs to those processes, and before Company X can update their material planning accordingly, they must understand what business process modelling technique is most suitable for them. When looking at the standards mentioned by Ko et al. (2009) it can be said that so far Company X does not use the any of the named standards, which does not mean they should use all standards, for example the interchange standard does not apply to

[22] See Van der Aalst (2013), p. 748.
[23] See Ko et al. (2009), p. 746-748.
[24] See Aguilar-Saven (2004), p. 131.

them. Other standards, such as the graphical standard are also linked to the life cycle stages mentioned by Van der Aalst (2013) and are thus more relatable to a company such as Company X. In Table 5 an overview of the standards and life cycle stage are depicted including the question if they are applicable to Company X.

Even though the diagnosis stage is depicted as the last stage concerning the standards, but also the life cycle it is in this business case a good idea to do is as the first stage, as Company X have been working in a certain process for quite a while and so the bottlenecks can be found. The graphical standard is linked to process design, this is in relation to Company X as they need to design the process needed for the material planning. Furthermore, especially the execution standard is interesting for Company X as they need to computerise and automate their processes to be less dependent on tacit knowledge. The execution standard is linked to the system configuration and process enactment stage. Company X uses AFAS as their ERP system, it seems however, that the system is not used to its fullest potential. The goal is to include the improved material process in the AFAS system in such a way that as little tacit knowledge as possible is used.

Standard	**Life cycle**	**Applicable to Company X**
Graphical	Process design	✔
Execution	System configuration; Process enactment	✔
Interchange	-	**X**
Diagnosis	Diagnosis	✔

Table 6—BPM theories necessary for Company X

When applying the maturity levels of Macintosh as mentioned by Aguilar-Saven (2004) to the current processes of Company X, it appears, that Company X is still on the first stage of maturity as their processes can only be repeated by the individual who works with the process, but cannot be used by a different person.

3.2. Material planning: The core of the supply chain.

Material planning is the core theme of this research. The following section describes what material planning is, what it does and how it is used in SMEs and how it can be implemented in an organisation.

Material planning and material management are half of the core activities in the supply chain.[25] Material planning is primarily accomplished with the help of material requirements planning (MRP), which is a generic term for the production planning, inventory control system, and managing manufacturing processes, among others.[26] In general, this is accomplished with the support of a software system.[27] An MRP system is intended to meet three objectives simultaneously. First, it should be ensured that materials are available for production and products are available for delivery to customers. Second, the lowest possible material and product levels in the store should be maintained, and finally, the manufacturing activities, delivery schedules and purchasing activities should be planned.[28] Material requirement planning is best used as a platform for transferring and collecting product information.[29]

There are two versions of MRP, namely MRP I and MRP II. MRP I implies material requirements planning, while MRP II implies manufacturing resource planning. The terms are often used interchangeably, though manufacturing resource planning represents the inventory control, bill of materials, master production schedule, equipment maintenance schedule, accounting and financial planning, and forecasting demand. In contrast, MRP I represents only the inventory control, bill of materials, master production schedule and equipment maintenance schedule.[30] In this research the MRP I is applicable as Company X asked for a simple material plan, which is not too broad. When choosing MRP II this would be the case.

For the execution of the MRP, three necessary steps summarise the process and are visualised in Figure 6 below.[31] The first step is to identify the quantity requirements of the materials needed for production. The requirements must be established to execute the second

---

[25] See Tenhiälä and Helkiö (2015), p. 151.
[26] See Jonsson and Mattsson (2006), p. 972.
[27] See Wong, Cheung, and Lau (1999), p. 212.
[28] See Gallego (2001), p.1.
[29] See Spencer and Larsen (1998), p. 316.
[30] See Boehm (2019), p. 1.
[31] See Boehm (2019), p. 1

step, which are the calculations of the needed quantities for these materials. The third and final step is the completion of the orders. The calculations are based on several data inputs, such as the customer orders, forecast demand, production planning, bill of materials and inventory records. In addition, the calculations are on the input side of the MRP process. The calculated output includes the purchase orders, material plan, work orders and primary and secondary reports. Another manually needed entry in MRP is the quality improvements, such as reduced rework costs, reduced warranty costs and increased customer orders.[32] Primary reports include the analysis of the production, inventory and control. Secondary reports consider the detailed data, such as the errors, late orders and predictions.[33] Currently, Company X already dispose most of the elements used in their material plan, such as the master production schedule which is now the basis for the material plan. It seems as if Company X is using all the steps, but not to their fullest reliable potential. The material plan for Company X can be improved on forecast, inventory lists, and especially reports. There are efforts to come up with decent reports, but these are complicated to set up and to read.

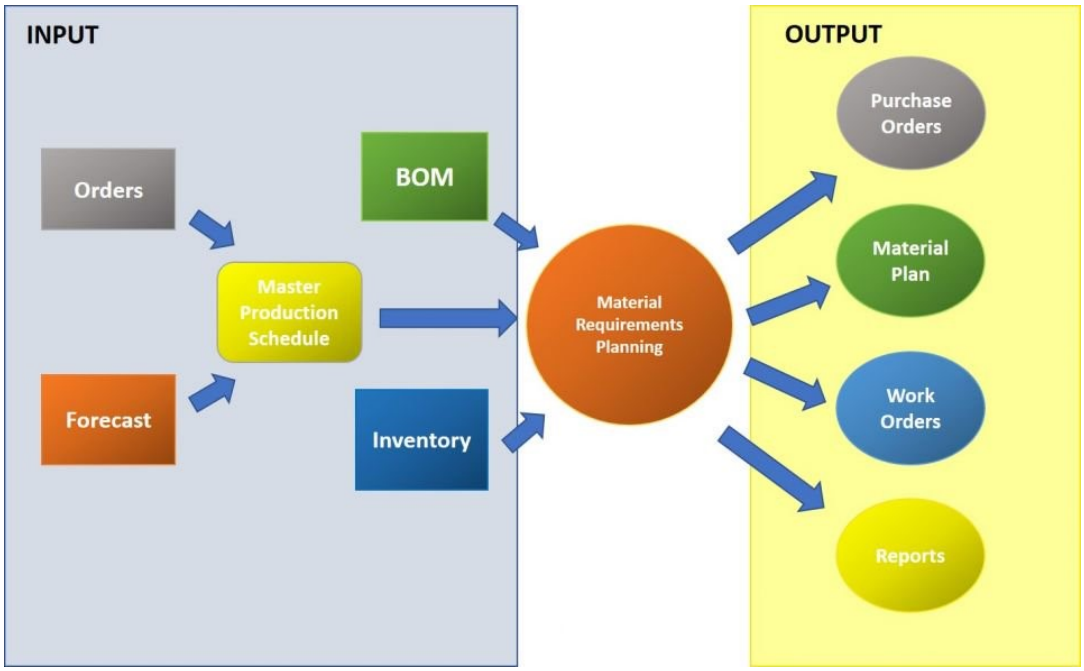

Figure 6—MRP process

[32] See Flapper, Wijngaard, and Miltenburg (1991), p. 338.
[33] See Boehm (2019), p. 1

It is argued in several papers that material requirement planning is a deterministic production control system, which has difficulties coping with uncertainty and should not be associated with the word 'simplicity'.[34] In a company such as Company X, an MRP software is particularly difficult, as Company X handles a stochastic environment due to their dependence on the weather. Nevertheless, it should be implemented when a company wishes to improve.

Many companies include a structured MRP system in their daily process because it carries significant advantages for the company. The greatest advantage is the reduction in inventory.[35] Many studies have demonstrated an increase in consumer services after the introduction of MRP to their company.[36] Furthermore, there was an overall increase in productivity[37] and a reduction in raw materials and manufacturing costs.[38] In general, companies reported that after the introduction of MRP to their company, they had better internal control.[39] As MRP regulates all actions across the supply chain, the highest effectiveness can be achieved using MRP if the human factor is adequately addressed, meaning that employees are involved from the beginning to the end.[40]

Unfortunately, if MRP is not executed correctly or is done so with a lack of interest, several disadvantages accompany MRP. A disruption will occur when the upper management does not fully support the MRP system.[41] A lack of user training will cause employees to quickly revert to their old patterns, as MRP can have a sophisticated system design.[42] Significant difficulty for the implementation of MRP occurs when the records are kept inaccurately, and therefore, there cannot be a proper MRP set. Another downfall for the implementation of a successful MRP system is the poor management of the master productions schedule.[43] However, the most significant advantage of MRP can also be its most considerable disadvantage, as personnel problems can arise. Personnel problems occur when there is a lack of communication, especially during the implementation of the new system.[44] Sudden

---

[34] See Bertrand and Muntslag (1993), p. 8 and Tenhiälä and Helkiö (2015), p. 150.
[35] See Hamid, Agus, and Mat Hassan (1991), p. 74.
[36] See Hamid et al. (1991), p. 74 and Sheu and Wacker (2001), p. 902 and Petroni (2002), p. 331.
[37] See Hamid et al. (1991), p. 74 and Petroni (2002), p. 338.
[38] See Hamid et al. (1991), p. 74 and Petroni (2002), p. 338.
[39] See Sheu and Wacker (2001), p. 902.
[40] See Manthou, Vlachopoulou, and Theodorou (1996), p. 191.
[41] See Hamid et al. (1991), p. 77.
[42] See Hamid et al. (1991), p. 77.
[43] See Hamid et al. (1991), p. 74 and Spencer and Cox (1995), p. 1884.
[44] See Hamid et al. (1991), p. 74 and Petroni (2002), p. 331.

changes in demand, losses due to scrap, inventory losses and changes in the management set parameters are difficult for the system to handle.[45]

In the literature, it was often found that MRP is used in combination with other methods, such as just-in-time (JIT). Just-In-Time is a management strategy that aligns raw-material orders from suppliers directly with production schedules and is often used as part of MRP, but there are no general methods to include JIT in MRP.[46] When JIT first was invented, the academics involved predicted that it would replace MRP.[47] Just-in-time has the advantage of tracking and adapting to changes in lead times.[48] Still, MRP has better planning capabilities, as often lead times are used, that remain static and are sometimes even inflated to prevents stockouts.[49] However, JIT better handles the shop floor control, which is respectively the most significant weakness and greatest strength.[50]

An additive method for MRP is lean manufacturing, which developed from JIT. Lean manufacturing is primarily focussed on waste reduction; the difference with JIT is the point of view from which the waste is reduced, namely the consumers.[51] The lean initiative is an excellent enhancement for MRP, as it helps to adapt to the changing market and customer conditions, with a particular stress on customer demand changes.[52] Nasution, Siregar, Nasution, Syahputri, and Tarigan (2018) made an implementation plan for lean manufacturing by using value-stream-mapping. With the help of value stream mapping the supply chain's most wasteful actions can be analysed and improved.[53]

Another popular addition for material planning which arose in the literature is the re-order point calculation. It was discovered that most of the users of the re-order point method use a based-on-experience fixed quantity rather than the lead time plus safety stock calculation. When using MRP, safety times are a more accurate calculation variable, but in practice, the safety stock method is used more often. With the re-order point method, the order quantities

[45] See Manthou et al. (1996), p. 191 and Buzacott (1997), p. 71.
[46] See Nagendra and Das (1999), p. 208 and Erkayman (2019), p. 5473 and Spencer and Larsen (1998), p. 316.
[47] See Spencer and Larsen (1998), p. 312.
[48] See Nagendra and Das (1999), p. 211 and Flapper et al. (1991), p. 338.
[49] See Nagendra and Das (1999), p. 211
[50] See Nagendra and Das (1999), p. 208.
[51] See Singh, Kaur, and Singh (2018), p. 16.
[52] See Hong and Leffakis (2017), p. 1067.
[53] See Nasution et al. (2018), p. 1.

are reviewed more often than the safety stocks. It was proven that accurate safety stocks create more positive performance impact.[54]

Looking at these three different enhancing methods it seems that JIT is another aspect of Company X difficulty to manage what they already have properly. The technique would help Company X managing their inventory, however when analysing the current material plan JIT is what they are doing for all the materials needed in the production of bread. An improvement for Company X could come from the lean manufacturing, which is similar to JIT. Especially when using a value stream map for their supply chain, which could give Company X insight in where logistics can be improved. The re-order point method is difficult to apply to Company X as they almost have no room to keep a safety stock. If the inventory room is elaborated, this could have a positive impact.

Small- and medium-sized enterprises are necessary for a diverse and broad supply of the market and are thus crucial for the economy.[55] However, it is also well-known that, in contrast with large corporations, SMEs typically do not have the capacities and resources to afford expensive software systems for material planning. Many large corporations choose to implement material planning in the MRP method using a software system; however, due to the limited sizes and possibilities of SMEs, they consider investments in expensive software unappealing. Still, for SMEs to enhance their procedure, an external intervention, such as software programmes, simplifies implementation.

No specific numbers were found regarding how many SMEs use MRP to its full potential. A study of lean management, which is an addition to MRP and has an equal workload, in the UK in 2019 found out that 80 percent implemented lean manufacturing, but only 20 percent applied it to their entire value chain.[56] Furthermore, in a different study, it was confirmed that most of the SMEs do material planning using a spreadsheet.[57] As more substantial corporations use sophisticated software packages, this does not often occur in SMEs. The foremost reason is because it is too expensive. In addition, the software does not comply with the individualistic requirements of a production planner in an SME.[58]

---

[54] See Jonsson and Mattsson (2006), p. 992.
[55] See Assarlind (2015), p. 1107
[56] See Alkhoraif, McLaughlin, and Rashid (2019), p. 6.
[57] See Kanet and Stößlein (2010), p. 298.
[58] See Kanet and Stößlein (2010), p. 291.

Material planning influences companies, especially SMEs, in the form of three questions: 'What is needed? How much is needed? and When is it needed?' [59] To answer these questions, the material planner requires four pieces of information: the master production schedule, bill of materials, product cycle times and material needs at each stage of the production cycle, and supplier lead time.[60] Many factors that are important in research on large companies, such as the emphasis on size lose their relevance in the SMEs sector.[61] In several studies concerning ERP, SMEs have been included in the sample with larger corporations to explore the pre-conditions, project behaviours and choice.[62] While SMEs do not have the same resources as large companies or holdings, the same benefits of ERP are found in SMEs. However, to achieve these benefits, more effort must be made—especially a detailed implementation achieved by change management. This is confirmed in other studies, such as a study on lean management in SMEs, in which the results revealed that managers must first consider the organisational culture and how the new or enhanced process will fit into that culture. It is greatly important that all the managers are supportive and on the same side prior to initiating the implementation. Assessing critical success factors in MRP for SMEs reveals that MRP is also beneficial for SMEs on the presumption that this is appropriately introduced. Small- and medium-sized enterprises that implemented a successful MRP demonstrated improved customer service, better production scheduling and reduced manufacturing costs.[63] It is essential to mention that these benefits were primarily achieved due to the high level of integration of company employees and managers in addition to the high levels of data accuracy. In general, it was seen that the implementation success rate was rather low, as most SME did not comply with the specified conditions.[64] The implementation can be seen as successful when it is implemented as a total system; it is impossible only to implement a part of MRP[65]. The study by Petroni (2002) concluded that management support, level of integration and data accuracy are variables that are necessary for successful implementation.

Material requirement planning can be implemented in two ways: using a software system or manually. The most important factor with the implementation is the inclusion of the entire

---

[59] See Shenoy (2015), p. 1.
[60] See Shenoy (2015), p 1.
[61] See Federici (2009), p. 86.
[62] See Federici (2009), p. 86.
[63] See Petroni (2002), p. 345.
[64] See Petroni (2002), p. 345.
[65] See Petroni (2002), p. 331.

company, as it has a strategic impact on all departments.[66] When initiating the implementation of MRP, three basic design principles form the primary process. First, the operations must be defined; then, the good flow control items and production phases must be identified; and finally, the production units must be established.[67] Most MRP implementations require a software package, which has the advantage that, when implemented correctly, the system takes over the cancellation of batches, the insertion of new orders and the count of overtime and acquisition of new resources.[68] As Company X already uses an ERP system from the firm AFAS, this should be enhanced to use the new material plan.

It was proven that the implementation of a detailed MRP was reported to be most successful when managers from all departments were included in the design and implementation, including the departments that do not directly work with the system. A different viewpoint, it will add to an improved continuity and prevent unforeseen problems, such as a shift of employees due to transfers and resignations.[69] With a detailed change management plan, there are higher chances of a successful implementation.

Concluding this literature review of MRP and applying the gained knowledge to Company X the following applications were found. MRP I is applicable for Company X asked for a simple material plan, which is not too broad. MRP II is too broad for this business case. Currently, Company X already dispose most of the elements described as components of MRP in their material plan, such as the master production schedule which is now the basis for the material plan. It seems as if Company X is using all the steps, but not to their fullest reliable potential. The material plan for Company X can be improved on forecast, inventory lists, and especially reports. There are efforts to come up with decent reports, but these are complicated to set up and to read. Looking at the three different enhancing methods it seems that JIT is another aspect of Company X difficulty to manage what they already have properly. The technique would help Company X managing their inventory, however when analysing the current material plan JIT is what they are doing for all the materials needed in the production of bread. An improvement for Company X could come from the lean manufacturing, which is similar to JIT. Especially when using a value stream map for their

---

[66] See Manthou et al. (1996), p. 192.
[67] See Petroni (2002), p. 330-331 and Bertrand and Muntslag (1993), p. 13.
[68] See Manthou et al. (1996), p. 187.
[69] See Manthou et al. (1996), p. 192 and Kumar, Sharma, and Agarwal (2015), p. 243.

supply chain, which could give Company X insight in where logistics can be improved. The re-order point method is difficult to apply to Company X as they almost have no room to keep a safety stock. If the inventory room is elaborated, this could have a positive impact. Software systems have made MRP accessible to many companies, especially in large corporations, in which it was revealed to be a beneficial process enhancer. Still, in SMEs, MRP can be highly valuable, provided that it is implemented correctly. In a company such as Company X, an MRP software is particularly difficult, as Company X handles a stochastic environment due to their dependence on the weather. Nevertheless, it should be implemented when Company X wishes to improve. Aforementioned studies already discuss the benefits of change management when implementing new processes into a small- or medium-sized company, which is how Company X sees themselves. As Company X already uses an ERP system from the firm AFAS, this should be enhanced to use the new material plan. The study by Petroni (2002) concluded that management support, level of integration and data accuracy are variables that are necessary for successful implementation. With a detailed change management plan, there are higher chances of a successful implementation.

3.3. Change management: Adapting the people to the new environment.

As demonstrated in the study by Federici (2009), SMEs require more attention to detail than do large corporations when implementing an ERP system, which can also be translated to MRP systems. Thus, a further literature review has been conducted on change management.

Change management is a structured process in which, through behaviour change, human factors are instantly associated with planning and implementing a new process, leading to the benefit of a higher success rate after the implementation.[70] When implementing a new method, proper change management must be applied accordingly; otherwise, the success of the new process is likely to be negative, as employees find it too difficult and believe that instead of working more efficiently, the new process is slowing them down. The adverse effects of a new process can occur if the implementation process of MRP is not communicated with the people who must work with it, leading to misunderstandings and incomprehensible goals of the MRP.[71] To overcome the critical stage of implementation, this must be managed appropriately. Moran and Brightman (2001, p. 111) define change

[70] See Kumar et al. (2015), p. 253 and Ben Arfi, Enstrom, Sahut, and Hikkerova (2019), p. 14.
[71] See Petroni (2002), p. 345.

management as 'the process of continually renewing an organisation's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers.'[72]

To achieve a lasting change in the organisation, a change in culture is needed, as Company X has been used to working in the current process for 25 years. Wiesner et al. (2018) said that 'cultural change can be used to bring about change in systems, implement corrective and preventive actions or influence management for business improvement'. To achieve this, a detailed change management plan is necessary. It is essential to have a majority of advocates in the company where the change is needed.[73]

When considering change management in SMEs, a different approach is needed than that used for large organisations.[74] The different approach is needed as SMEs, due to limited resources, require simplification, transparency and target orientation. Managers of SMEs must determine ways to continuously challenge the status quo, either through people from within or with help from external change agents. However, SMEs implementing change is still tricky, as they do not have the advantage of many examples found by other researchers that they can follow. Thus, they must often be the driver of change for the entire industry by implementing initiatives and identifying leverage points where a small, focussed action can cause a positive change. Perhaps the most crucial step of all is that an SME must believe in what they are doing to achieve success.[75] These mentioned steps by Wiesner et al. (2018) were adapted into an implementation plan.

Different challenges were found when implementing a new process with the help of change management. Kumar et al. (2015) argue that the change will most certainly fail if the top managers lose interest halfway through the process.[76] In a study by Kumar et al. (2015) on lean management, it is explained that lean management is introduced with 5S stages: sort, set in order, shine, standardise and sustain. Furthermore, it is mentioned that one firm neglected the stage of standardisation, and thus the entire process became futile, primarily due to the loss of interest at the top manager level, which translated even more negatively in the workforce.[77]

---

[72] See Wiesner, Chadee, and Best (2018), p. 2 -3.
[73] See Basu and Bhola (2016), p. 16.
[74] See Vedenik and Leber (2015), p. 592 and Wiesner et al. (2018), p. 3.
[75] See Wiesner et al. (2018), p. 3.
[76] See Kumar et al. (2015), p. 254.
[77] See Kumar et al. (2015), p. 253.

For a successful change, it is important to develop a supportive culture for change with the help of learning and knowledge sharing.[78] With process change, the transition can be hindered by behaviour pattern problems.[79] A change manager, in some instances, is likely to be convenient for setting an example, which would ensure that the change is managed in a workable range. The change agent can also be someone external, such as a consultant. Consultants possess the hard and soft skills needed to initiate a new project. In addition, from experience, they know where the bottlenecks from process implementing are, something that an in-house person could miss. External people also have the benefit of not being emotionally involved. Employees do not know the external person beforehand, and that adds to the goodwill factor. A consultant is thus a great communicator.[80] However, the external change agent should not be present throughout the entire process. It is advised that the change agent leaves the implementation process gradually throughout the final stages.[81]

How change occurs in a company can be visualised with the Kubler-Ross curve.[82] The Kubler-Ross curve is a well-known graph known also as the five stages of grief and can be applied in several situations. The graph can help to prepare managers and the workforce for what to expect when introducing a new process to the company. Kumar (2015) adapted the Kubler-Ross curve to be suitable for a change in a company. Thus, not only the five stages introduced by Kubler-Ross— denial, anger, bargaining, depression and acceptance—are mentioned. Instead, they have been complemented with the additional stages shock at the beginning and integration and disillusionment at the end. In Figure 7, a graph with descriptions at every stage can be found. It can be disturbing to find that disillusionment occurs at the end of the graph. Change

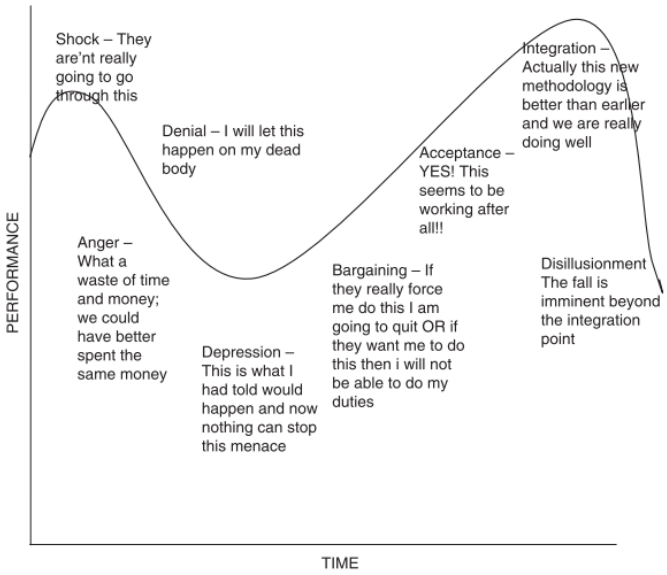

Figure 7—Kubler-Ross curve on change management

[78] See Kettinger and Grover (1995), p. 9.
[79] See Vedenik and Leber (2015), p. 587
[80] See Assarlind (2015), p. 1108.
[81] See Assarlind (2015), p. 1113.
[82] See Kumar et al. (2015), p. 254.

management is meant to help users overcome obstacles and guide them to an efficient process in a challenging environment. When working in a supply chain department, employees must be naturally flexible in their work, as adaptation to the everchanging, uncertain environment is essential.[83] Even though it seems impossible, a changed person should not return to an unchanged environment, as it is not only confusing for the employee but also instils fear that the employee might get laid off.[84]

To implement process change in a company, the three-stage process as defined by Lewin (1947) should be considered as it describes how people react and adapt to change. Lewin's theory sees change not a series of individual processes but rather one that flows from one process to the next[85]. The three stages in from the change process are unfreeze, change and refreeze, which are visually represented in Figure 8.[86] Unfreezing the process stands for overcoming the current ingrained process and to break down the current work ethos. An important part of that stage is getting over the initial defence mechanism. The change stage is commonly a transition period, that comes with disorientation and uncertainness about the future. In the final stage this is overcome, and the new mindset is accepted by the people who were involved in the change process and becomes the new standard.[87]

Figure 8—Lewin's Three stage process of change

The literature gives Company X important indicators on how to implement the new material plan with the help of change management. Change management has various ways in which it is beneficial for a company. However, while it is difficult to manage for larger companies due to the different opinions, it is easier to handle in smaller companies. Here, all relevant employees can give their say on the new subject and explain how they think it would best be implemented in the company. Still, change management should not be underestimated as

---

[83] See Gupta and Singh (2015), p. 18 and Beamon (1999), p. 276.
[84] See Kumar et al. (2015), p. 254.
[85] See Mayfield (2014), p. 70.
[86] See Mayfield (2014), p. 71.
[87] See Mayfield (2014), p. 71.

change in organisational culture has a significant impact on the daily work process of a company which has existed for several years, with the same employees. From the mentioned theories, the Kubler-Ross curve in particular stands out as necessary for Company X as even though all employees claim to need change, they still have difficulties to actually accept the change and act upon it. Another point that becomes clear, is that not all the involved employees are on the same step in the ongoing change process at the company. Other important aspects from the literature review are the importance of the full commitment to the change of all people involved, but especially the managers, and the benefit of hiring a neutral consultant to help guide the change at Company X.

4. Implementation: Improved processes are expected to be more successful when implemented with a change management plan.

The original goal of this research was to find an improved material planning process for Company X. The research has shown that although it can provide recommendations on different theories on MRP, it cannot determine a functioning material planning process for Company X, as it is expected that the employees involved will not agree with the new process. In the following it is however attempted to write an implementation plan of change management for Company X on how they can determine the new material planning process.

Looking at the outcome of the change management literature review an implementation plan can be set up with the help of Lewin's three stage process change and the stages of grief by Kubler-Ross, which was enhanced by Kumar. The adapted Kubler-Ross curve should be applied to Company X to convince all the involved people that change is the only way to continue Company X. The employees must understand, that if they continue the processes the same way in the last 25 years, Company X will not keep up with the competition and slowly go out of business. To achieve successful change management, Company X should create a project team for implementing change. This project team could consist of the six employees who were interviewed for this research. To prepare for the expected change, the Kubler-Ross curve should be inspected in detail. The Kubler-Ross is a well-known graph known also as the five stages of grief and can be applied in several situations. The graph can help to prepare managers and the workforce regarding what to expect when introducing a new process to the company. The graph used in this research is the one adapted by Kumar (2015). Thus, not only the five stages introduced by Kubler-Ross—denial, anger, bargaining, depression and acceptance—are mentioned. Instead, they have been complemented by the additional stages shock at the beginning and integration and disillusionment at the end. In Table 6 all the stages are provided with a description of what occurs at that stage.

Change Stage	**Description of occurrence at stage**
Shock	The question of why there should be change, expected to be paired with the fear of being laid off.
Denial	There is no need for change. The current has been working for quite some time.
Anger	Maybe there is a need for change, but why does this particular employee need to change.

Depression	The positive working atmosphere is nowhere to be found. The benefits of the new process cannot be seen.
Bargaining	The need to change is accepted but does this workflow need to be adapted as much as the suggestions.
Acceptance	Full acceptance of the new process, but the new process is not fully integrated.
Integration	The new process is integrated and can be evaluated regularly.
Disillusionment	The new established process will become obsolete in a few years and then the whole process needs to be done again.

Table 7—Applying the stages of Kubler-Ross to change management

The adapted Kubler-Ross curve also shows that not all the involved employees are on the same level concerning change. As the purchaser for packaging material is the only one, who spoke out that he does not want any automation of the processes, he is still in the denial phase. The purchaser special ingredients is the one, who was very outspoken against Company Y, the holding, and although he sees that change needs to be done he is not cooperative in accepting suggestions, which is why he is in the anger phase. The purchaser raw materials, purchaser cardboard and purchaser crates all already went through minor changes at the time of the data collection. However, they are all of the opinion that their process before the changes was better and have difficulties of seeing the benefit in changing. It was also clear that they were angry about the current situation where higher placed people kept telling them what to do, which places them on the depression stage. The production line manager has a special position, as he is only the controller. The line manager has spoken his opinion about needing a more static planning, but concerning material planning he is not as involved. That is why he is not placed at a particular change stage at the moment. In Figure 9 it is visually represented on what stage the employees are in the change process.

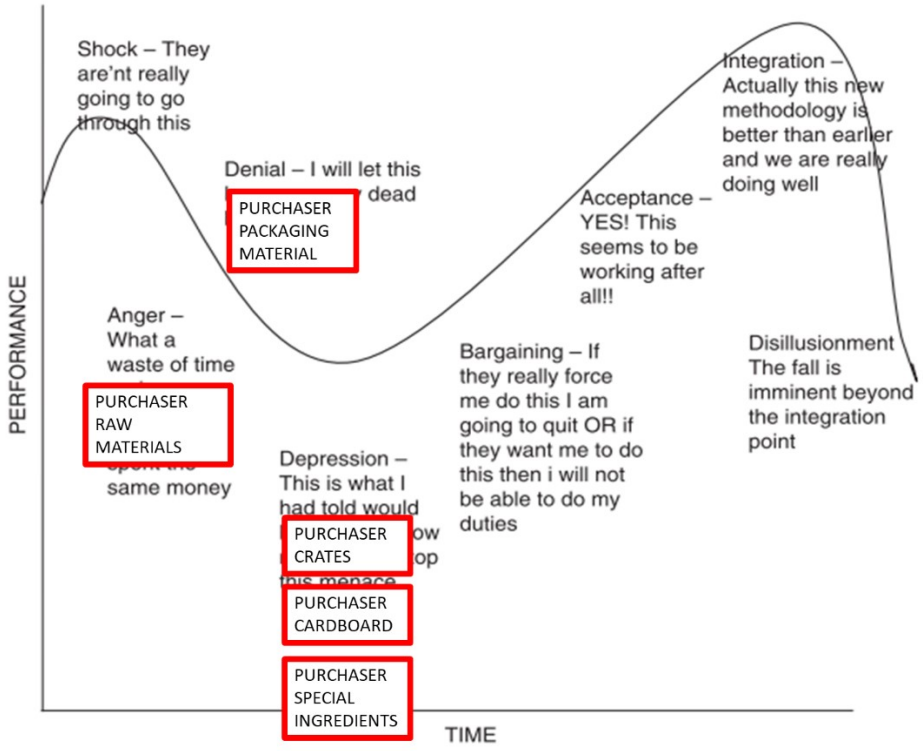

Figure 9—Position of involved employees on the change management process

To implement the change Company X first, need to unfreeze their current processes by evaluating them and pointing out bottlenecks, this is partially done in this research. In this time the project change team made up of the six involved employees concerning material planning will meet up to discuss what they believe is their process and what they believe the bottlenecks are. Then they will come up with solutions to solving these bottlenecks. The research done in this paper comes in handy there are well. They need a detailed MRP process. In this research indicators are given as the current state of BPM and MRP were already applied to Company X. In the change process the company responsible for the AFAS implementation at Company X has implemented the new process and the employees start working with it. There should be regular feedback meetings, first every two weeks and later once a month until the process is satisfactory, and bottlenecks are solved. With that happening the change is processing into its third stage and the process is refrozen again. To guide the change process, a change agent could come in conveniently. The change agents could additionally make sure, that all the involved employees, also the managers stay committed to the change. In Figure 10 the change management implementation plan is visualised.

Figure 10—Change management implementation process

As MRP is the best-known material planning method, it has been well established and evolving. Software systems have made MRP accessible to many companies. Company X already uses AFAS and has hired an external AFAS company to configure the system. To find the process that the AFAS company must configure, Company X should create a change management project team to develop the steps, including detailed descriptions, that they believe are needed in AFAS to more easily automate the process and transfer tasks.

5. Discussion: How SMEs stand tall against large corporations.

5.1. Interpretation of the results

In industries, in which SMEs have the upper hand, a need for efficient material planning was discussed by a company in this industry. In studies (Federici, 2009; Petroni, 2002), it is mentioned that broad material planning methods, such as material requirement planning (MRP), can be perceived as too elaborate for SMEs and thus must be considered from a different perspective. It was perceived that SMEs do not have the resources to implement all the applying steps that accompany MRP, as in a large organisation.[88] The mentioned problem was brought to attention by Company X a medium-sized bake-off bread supplier in the Netherlands that is also part of a holding.

For the first research sub-question *'What is the current situation for material planning at Company X?'* we reflect on the current situation in Chapter 1, Section 2. There, it is concluded that bottlenecks found in the current material process are, among others, the inaccurate forecast and the consequently changing production planning, leading to daily effort made for material planning. Furthermore, some purchasers do not agree with the approach from the parent company, which effects the working atmosphere. One of the most significant bottlenecks is the small inventory, which does not allow for extensive preparation for several days of production, and these inventories are checked only manually. According to the involved employees, three have been working at Company X since the founding and are familiar with how the company worked when there was only one production line. Even though the process appears to work currently, future risks include losing the tacit knowledge held by the involved employees. This can also be described as a bottleneck, in that there is too much tacit knowledge held by an individual employee. Furthermore, the current process takes up a great part of their weekly tasks to some even being daily tasks and the different steps take a substantial amount of time, especially for the purchasers of cardboard, crates and packaging materials. Figure 11 displays the bottlenecks again.

[88] See Petroni (2002), p. 331 and Federici (2009), p. 82.

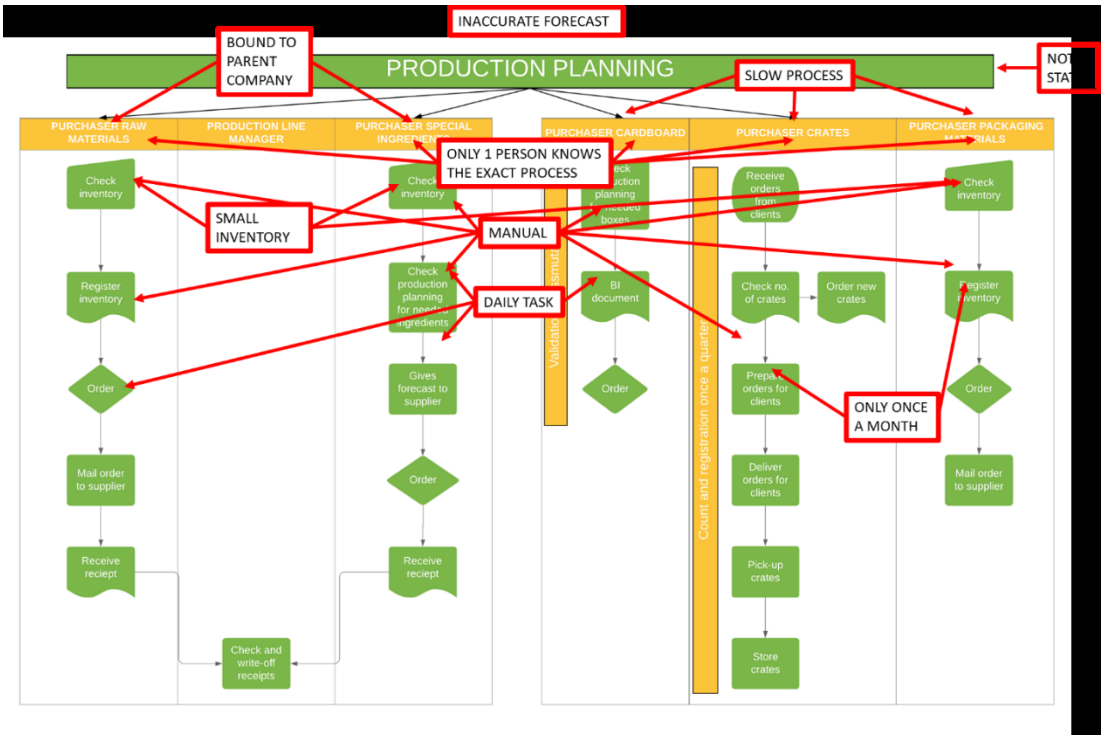

Figure 11—Current material planning process, with bottlenecks (again)

Considering the second sub-question *'What is the ideal situation for material planning at Company X?'* solutions to the mentioned bottlenecks should be found in the literature. Many studies (Kanet & Stößlein, 2010; Petroni, 2002; Shenoy, 2015), mentioned using a software, not only for the material planning but for the entire supply chain process. Material planning is implemented in many forms over several different settings. In combination with the digitalisation changes in the past years, it has become easier to work with software systems to the point that it is difficult to not work with software systems anymore. As Company X already uses AFAS as their ERP system, including an MRP would be beneficial for the workflow. Company X already uses AFAS Profit, but this could be extended with automated processes for the entire supply chain process. Machine learning will help to analyse a more accurate forecast. An additional method of using MRP, the lean manufacturing, are beneficial here as well. This will generate data that can be analysed for more accurate forecasts and will help to solve the bottleneck of small inventory, as no superfluous products are purchased. A distinct bottleneck mentioned by the employees were the many manual counts; for this, nothing specific was mentioned in the literature, but working with barcodes and tracking and tracing should automate the process. Regular manual checks are not superfluous handlings, however. When using the AFAS process module, it can be designed that employees can handle the process only step by step. The steps can be described in detail,

so when an employee is not on the job, others can quickly take over that job. Thus, the fear of losing tacit knowledge, since thus far, only one person was responsible, should be solved as well. When AFAS automates the process steps, this will not only solve the bottleneck of the problematic transfer but also speed up the process, as the employees will be less dependent on one another. In Table 5, the bottlenecks are listed, and possible solutions are mentioned.

Bottleneck	**Solution**
Inaccurate forecast	Use lean manufacturing, machine learning and improved AFAS implementation
Slow process	Improved AFAS implementation
Small inventory	Lean manufacturing
Single person responsible	Improved AFAS implementation
Daily task	Better AFAS implementation
Manual tasks	Track and trace of the products

Table 8—Bottlenecks and their solutions

For the final sub-question *'What must Company X do to achieve the ideal situation for material planning?'* an implementation plan was set up on the basis of Lewin and Kubler-Ross, adapted by Kumar.

It was investigated what the company could do to make the improvements a lasting success. When considering the solutions mentioned in the literature, it is quite vague what the ideal situation is. This is because every case is specific, especially in an SME, as mentioned in Assarlind (2015). The ideal situation is one in which all people who must work with the system can get behind the new system, and to achieve that, a company needs change management in which the expertise of the employees is used. Instead of providing a new process, it is recommended to adapt the current material planning process. To find the best fitting and working process for the current employees at Company X, they should be involved in designing the new process. As most of these employees have been working at Company X for a long time, their expertise should be helpful in establishing an automated material planning process. The subject of change management is a necessary addition here, as it was seen that employees of Company X felt left behind due to significant changes in

the recent past. To achieve successful change management, Company X should create a project team for implementing change. This project team could consist of the six employees who were interviewed for this research. The implementation plan set up with the help of the theories from Lewin and Kubler-Ross will guide the employees and help them believe that the improvements will actually have a great, positive impact on the company, and even more important a positive impact on their weekly work process. As that is the main recommendation of this paper, it cannot yet be checked whether the solution applies to the critical success factors, indicating that this research cannot yet be fully validated. However, as seen in studies by Assarlind (2015) and Federici (2009), in which SMEs change their processes with the help of change management, many successes have been celebrated.

Looking back at the conclusion of the current situation, the current situation and desired situation were put together in an overview to see what the gap of Company X is. In Table 9 the table is presented again, this time with possible solutions to close the gap.

Current situation	**Desired situation**	**Solution**
Daily process with only one person to possibly replace the responsible person.	Less workload on a single day and easy takeover by another employee in case of missing.	A detailed process implementation in AFAS.
Dependence on individual tacit knowledge	A small dependence on a single employee.	A detailed process implementation in AFAS.
Too high flexibility	Less flexibility with a static production planning.	Analyse the production planning to find the bottlenecks, which keeps changing the planning at the last minute.
Limited stockroom for all stock.	More elaborate stockroom at Company X; save transportation and storage costs.	Better use of the inventory with lean manufacturing.
External stock, which is not correctly registered.	Register external stock with a track and trace system.	Digitalise the supply chain with barcodes;

		implement a track and trace system.
Manual count of stock	Digitalise the stock numbers with a track and trace system hung up in the inventory.	Digitalise the supply chain with barcodes; implement a track and trace system.
Manual record of delivery flour.	Registration of the delivery by using the track and trace system.	Digitalise the supply chain with barcodes; implement a track and trace system.
No exact known numbers of the inventory.	Digitalise the stock numbers with a track and trace system hung up in the inventory.	Digitalise the supply chain with barcodes; implement a track and trace system.
Continuously monitor the possible changes in production planning and the consequent adjustment.	A static production planning which does not need a reschedule after every interruption.	Analyse the production planning to find the bottlenecks, which keeps changing the planning at the last minute.
Business intelligence tool for cardboard does not calculate the numbers correctly.	A static production planning based on a more reliable forecast.	Analyse the production planning to find the bottlenecks, which keeps changing the planning at the last minute.

Table 9—Current situation and desired situation with solutions

Even though this research does not provide a concrete material plan, it is helpful for the recommendations and the change project team to find the requirements presented again, as further research can verify whether the results from this research were as expected. It is believed that the new process can easily be implemented in AFAS by the external firm, and instead of spending an average of 50 to 60 percent of their workweek on the material planning, this will be reduced to 10 percent. In addition, an error log should determine the exact number of errors made to learn from these errors and reduce them to a monthly

occurrence. Machine learning will generate data that can be analysed for more accurate forecasts and will help to solve the bottleneck of small inventory, as no superfluous products will be purchased; however, adding a more extensive inventory would also be beneficial for Company X. Finally, employees should need at most one training and one week of practice to work with the new process. Reviewing the criteria set in the feedback meetings after the implementation which will make the new process a success.

5.2. Limitations of the research

One worry is that the employees will not accept the more significant usage of the software. In addition, they might believe that change management is a time-consuming method, but in a few short meetings, the process should severely impact the amount of time employees spend on, in this case, material planning. Assarlind (2015) already mentioned that the main goal is to work smarter rather than harder.

5.3. Practical and academical implications

Practical implications of this paper are recommendations on how to achieve an improved process of material planning in an SME, with a focus on how to implement the new process. Even though Company X is a specific business case, as they are a subsidiary of a larger holding but still enjoy some independence, this result might not be applicable for the general SME market. Still, it is expected that it can translate to other SMEs, as the literature in this research was written with the SME market in mind rather than the difficult-to-translate research on large companies.

This paper is academically relevant, as it combines three research topics which have not been investigated in significant amounts. Small- and medium-sized enterprises believe they cannot afford the same systems and processes that many large companies can. It was revealed in the literature that SMEs also benefit from material requirement planning (MRP), which is the most common method for material planning, but it is likely that if not correctly implemented, people will quickly revert to their old habits. It appears that the solution to this is change management. Currently, there is a deficiency of literature that focusses on the operational improvement in SMEs, which is odd considering that 99 percent of the companies in the EU are SMEs.[89]

---

[89] See Assarlind (2015), p. 1107.

5.3 Recommendations for further research

One recommendation for further research is to check after a year whether the implementation was successful. Furthermore, it could also be checked for other SMEs who are struggling with their processes whether the result from this research could be applied to more business cases.

5.4. Purpose of this study

The purpose of this study was to provide Company X recommendations on how to improve their material planning and how these improvements can be implemented. This research is essential, as it should show SMEs that they can also use methods which are beneficial for larger corporations. Furthermore, this research reveals that for an SME to grow or prepare for the subsequent generations, a detailed process is needed.

6. Conclusion: Company X must enhance the implementation of their improved material planning with change management.

6.1. Conclusion

To conclude this research, the main research question '*How can the material planning process at Company X be improved?*' is answered. To achieve process improvement, Company X should, with the help of change management, find a suitable process that they can implement in their ERP system AFAS. The current system has some flaws but is, in its core, not a poor one. It is expected that with teamwork, a better process flow can be generated, which can then be implemented by the AFAS firm. It is recommended to do so, following the implementation method with Lewin's three-stage model, combined with the Kubler-Ross curve, which was adapted by Kumar.

The bottlenecks found at Company X are undoubtedly also found in other business cases, for that it is expected that the implementation method described in this research can also be generalised towards SMEs in general.

In the literature review on material requirement planning, it was found that primarily in large corporations, MRP is a beneficial process enhancer. Still, new studies (Assarlind, 2015; Shenoy, 2015) reveal that also in SMEs, MRP can be of great value, provided that it is implemented correctly. These studies already mention the benefits of change management when implementing new processes into a small- or medium-sized company. It was interesting to see that the literature often addressed the human factor as a critical success factor for MRP, which led to the inclusion of another literature review concerning change management.

The argumentation for this result is based on several studies of SMEs in which it was revealed that SMEs can use methods intended for large corporations if they are correctly translated into their daily processes. When working together on a process through change management, it should result in a lasting process with which employees can work naturally.

Finally, this research contributes to the SME presence in the economy, describing how they can be successful among larger corporations.

6.2 Limitations

This research was held on a single business case; however, to find more profound and general conclusions, multiple cases could have been considered. Then, instead of detailed qualitative research, it would be quantitative research. In addition, Company X might not have been the ideal case for generalisability, as they have more funds at their disposal thanks to being a subsidiary of Company Y. It is also unfortunate that this research only provides recommendations; it would have been interesting to see whether the recommendations were followed and whether the results from the new implementation exhibited the expected conclusions.

One limitation of this research is that the case is particular. The researcher could be biased, as she worked along in the company. The respondents might also have withheld information if they did not trust the researcher and were afraid of losing their job. In addition, the cooperation might have been difficult, as the respondents have been working at Company X for a long time and understand how the company works and thus have their own reservations about changing anything.

References

Aguilar-Saven, R. S. (2004). Business process modelling: Review and framework. *International Journal of Production Economics, 90*(2), 129-149.

Alkhoraif, A. A., McLaughlin, P., & Rashid, H. (2019). A framework to improve lean implementation by review leveraging aspects of organisational culture: the case of Saudi Arabia. *International Journal of Agile Systems and Management, 12*(2), 124-179.

Assarlind, M. (2015). Analysis of an improvement programme for MMEs. *Journal of Manufacturing Technology Management, 26*(8), 1107-1125. doi:10.1108/JMTM-04-2013-0044

Basu, R., & Bhola, P. (2016). Impact of quality management practices on performance stimulating growth Empirical evidence from Indian IT enabled service SMEs. *International Journal of Quality & Reliability Management, 33*(8), 1179-1201. doi:10.1108/ijqrm-10-2015-0153

Beamon, B. M. (1999). Measuring supply chain performance. *International journal of operations & production management*.

Ben Arfi, W., Enstrom, R., Sahut, J. M., & Hikkerova, L. (2019). The significance of knowledge sharing platforms for open innovation success A tale of two companies in the dairy industry. *Journal of Organizational Change Management, 32*(5), 496-516. doi:10.1108/jocm-09-2018-0256

Bertrand, J. W. M., & Muntslag, D. R. (1993). Production control in engineer-to-order firms. *International Journal of Production Economics, 30-31*(C), 3-22. doi:10.1016/0925-5273(93)90077-X

Boehm, H. (2019). The Difference Between MRP I and MRP II. Retrieved from https://softwareconnect.com/manufacturing/mrp-i-vs-mrp-ii/

Bornmann, L., Thor, A., Marx, W., & Schier, H. (2016). The application of bibliometrics to research evaluation in the humanities and social sciences: An exploratory study using normalized G oogle S cholar data for the publications of a research institute. *Journal of the Association for Information Science and Technology, 67*(11), 2778-2789.

Buzacott, J. A. (1997). Continuous time distributed decentralized MRP. *Production Planning and Control, 8*(1), 62-71. doi:10.1080/095372897235578

Cheng, C. Y., Li, S. F., Chu, S. J., Yeh, C. Y., & Simmons, R. J. (2013). Application of fault tree analysis to assess inventory risk: A practical case from aerospace manufacturing. *International Journal of Production Research, 51*(21), 6499-6514. doi:10.1080/00207543.2013.825744

de Sousa Jabbour, A. B. L., Luiz, J. V. R., Luiz, O. R., Jabbour, C. J. C., Ndubisi, N. O., de Oliveira, J. H. C., & Junior, F. H. (2019). Circular economy business models and operations management. *Journal of Cleaner Production, 235*, 1525-1539.

Delic, M., Eyers, D. R., & Mikulic, J. (2019). Additive manufacturing: empirical evidence for supply chain integration and performance from the automotive industry. *Supply Chain Management: An International Journal*.

Dennis, D. R., & Meredith, J. R. (2000). Analysis of process industry production and inventory management systems. *Journal of Operations Management, 18*(6), 683-699. doi:10.1016/S0272-6963(00)00039-5

Erkayman, B. (2019). Transition to a JIT production system through ERP implementation: a case from the automotive industry. *International Journal of Production Research, 57*(17), 5467-5477. doi:10.1080/00207543.2018.1527048

European Commision. (2019). What is an SME? Retrieved from https://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_nl

FAN, F. A. N. (2007). Business process modeling.

Federici, T. (2009). Factors influencing ERP outcomes in SMEs: a post-introduction assessment. *Journal of Enterprise Information Management, 22*(1/2), 81-98.

Flapper, S. D. P., Wijngaard, J., & Miltenburg, G. J. (1991). Embedding JIT into MRP. *International Journal of Production Research, 29*(2), 329-341. doi:10.1080/00207549108930074

Fredriksson, A., Wänström, C., Johansson, M. I., & Medbo, L. (2015). A structured procedure for materials planning during production transfer. *Production Planning and Control, 26*(9), 738-752. doi:10.1080/09537287.2014.971534

Fry, T. D., Oliff, M. D., Minor, E. D., & Keong Leong, G. (1989). The effects of product structure and sequencing rule on assembly shop performance. *International Journal of Production Research, 27*(4), 671-686. doi:10.1080/00207548908942575

Gallego, G. (2001). Aggregate production planning. *Columbia University*.

Gunasekaran, A., Goyal, S. K., Martikainen, T., & Yli-Olli, P. (1993). Modelling and analysis of just-in-time manufacturing systems. *International Journal of Production Economics, 32*(1), 23-37. doi:10.1016/0925-5273(93)90005-6

Gupta, T. K., & Singh, V. (2015). A systematic approach to evaluate supply chain management environment index using graph theoretic approach. *International Journal of Logistics Systems and Management, 21*(1), 1-45. doi:10.1504/IJLSM.2015.069077

Hallam, C. R. A., Valerdi, R., & Contreras, C. (2018). Strategic lean actions for sustainable competitive advantage. *International Journal of Quality and Reliability Management, 35*(2), 481-509. doi:10.1108/IJQRM-10-2016-0177

Hamid, A. A., Agus, A., & Mat Hassan, M. E. (1991). Computerised materials requirement planning in manufacturing companies in Malaysia. *International Journal of Production Economics, 25*(1-3), 73-79. doi:10.1016/0925-5273(91)90132-D

Hammer, M., & Champy, J. (1993). Reengineering the corporation. 1993. *HaperCollins, New York*, 50.

Hong, P., & Leffakis, Z. M. (2017). Managing demand variability and operational effectiveness: case of lean improvement programmes and MRP planning integration. *Production Planning and Control, 28*(13), 1066-1080. doi:10.1080/09537287.2017.1329956

Jonsson, P., & Mattsson, S. (2006). A longitudinal study of material planning applications in manufacturing companies. *International Journal of Operations and Production Management, 26*(9), 971-995. doi:10.1108/01443570610682599

Kanet, J. J., & Stößlein, M. (2010). Integrating production planning and control: Towards a simple model for Capacitated ERP. *Production Planning and Control, 21*(3), 286-300. doi:10.1080/09537280903363209

Kettinger, W. J., & Grover, V. (1995). Toward a theory of business process change management. *Journal of Management Information Systems, 12*(1), 9-30.

Kirchmer, M. (2017a). Business process management: what is it and why do you need it? In *High Performance Through Business Process Management* (pp. 1-28): Springer.

Kirchmer, M. (2017b). *High performance through business process management*: Springer.

Ko, R. K., Lee, S. S., & Wah Lee, E. (2009). Business process management (BPM) standards: a survey. *Business Process Management Journal, 15*(5), 744-791.

Kousi, N., Koukas, S., Michalos, G., & Makris, S. (2019). Scheduling of smart intra–factory material supply operations using mobile robots. *International Journal of Production Research, 57*(3), 801-814.

Kumar, B. R. R., Sharma, M. K., & Agarwal, A. (2015). An experimental investigation of lean management in aviation Avoiding unforced errors for better supply chain. *Journal of Manufacturing Technology Management, 26*(2), 231-260. doi:10.1108/jmtm-12-2013-0174

Lewin, K. (1947). Frontiers in group dynamics: II. Channels of group life; social planning and action research. *Human relations, 1*(2), 143-153.

Lopes de Sousa Jabbour, A. B., Rojas Luiz, J. V., Rojas Luiz, O., Jabbour, C. J. C., Ndubisi, N. O., Caldeira de Oliveira, J. H., & Junior, F. H. (2019). Circular economy business models and operations management. *Journal of Cleaner Production, 235*, 1525-1539. doi:10.1016/j.jclepro.2019.06.349

Manthou, V., Vlachopoulou, M., & Theodorou, P. (1996). The implementation and use of material requirements planning system in Northern Greece: A case study. *International Journal of Production Economics, 45*(1-3), 187-193. doi:10.1016/0925-5273(95)00140-9

Marshall, C., & Rossman, G. B. (1989). Marshall, Catherine, and Gretchen B. Rossman, Designing Qualitative Research. Newbury Park, CA: Sage, 1989.

Mayfield, P. (2014). Engaging with stakeholders is critical when leading change. *Industrial and Commercial Training*.

Modi, S. B., & Mabert, V. A. (2007). Supplier development: Improving supplier performance through knowledge transfer. *Journal of Operations Management, 25*(1), 42-64.

Mohr, G. (Producer). (2018). Processes & Systems in purchasing. Retrieved from https://canvas.utwente.nl/courses/2383/files/208847?module_item_id=36363

Nagendra, P. B., & Das, S. K. (1999). MRP/sfx: A kanban-oriented shop floor extension to MRP. *Production Planning and Control, 10*(3), 207-218. doi:10.1080/095372899233172

Nasution, A. A., Siregar, I., Nasution, T. H., Syahputri, K., & Tarigan, I. R. (2018). *Lean Manufacturing Applications in the Manufacturing Industry.* Paper presented at the MATEC Web of Conferences.

Oladokun, V., & Olagunju, F. (2015). *A Framework for the Development of a Manufacturing Resources Planning System.* Paper presented at the International Journal of Engineering Research in Africa.

Özdamar, L., Yetis, N., & Atli, A. Ö. (1997). A modified hierarchical production planning system integrated with MRP: A case study. *Production Planning and Control, 8*(1), 72-87. doi:10.1080/095372897235587

Pandey, P. C., Yenradee, P., & Archariyapruek, S. (2000). A finite capacity material requirements planning system. *Production Planning and Control, 11*(2), 113-121. doi:10.1080/095372800232315

Petroni, A. (2002). Critical factors of MRP implementation in small and medium-sized firms. *International Journal of Operations and Production Management, 22*(3), 329-348. doi:10.1108/01443570210417623

Porter, M. E. (1997). Competitive strategy. *Measuring business excellence, 1*(2), 12-17.

Recker, J. C. (2006). Process modeling in the 21st century. *BPTrends*, 1-6.

Rorrer, A. S. (2016). An evaluation capacity building toolkit for principal investigators of undergraduate research experiences: A demonstration of transforming theory into practice. *Evaluation and program planning, 55*, 103-111.

Sali, M., & Giard, V. (2015). Monitoring the production of a supply chain with a revisited MRP approach. *Production Planning and Control, 26*(10), 769-785. doi:10.1080/09537287.2014.983579

Schiele, H. (Producer). (2019). Process organisation. [Powerpoint slides] Retrieved from https://canvas.utwente.nl/courses/3395/files/565365?module_item_id=67146

Shahabi, V., Emami, M., Monnavari, M., & Ghods, F. (2014). An exploration investigation on measuring the impact of information technology on bullwhip effect on supply chain management. *Uncertain Supply Chain Management, 2*(1), 33-42.

Shenoy, S. (2015). Simplifying inventory management and MRP for SMEs. Retrieved from https://www.linkedin.com/pulse/simplifying-inventory-management-mrp-smes-sunil-shenoy/

Sheu, C., & Wacker, J. G. (2001). Effectiveness of planning and control systems: An empirical study of US and Japanese firms. *International Journal of Production Research, 39*(5), 887-905. doi:10.1080/00207540010009705

Singh, C. D., Kaur, H., & Singh, R. (2018). *Impact of risk factors and techniques in lean manufacturing*: BookRix.

Sinha, A., & Swati, P. (2014). Supply Chain: Next generation issues and concerns. *Uncertain Supply Chain Management, 2*(1), 1-14.

Smith, E. A. (2001). The role of tacit and explicit knowledge in the workplace. *Journal of knowledge Management*.

Spencer, M. S., & Cox, J. F. (1995). The role of mrp in repetitive manufacturing. *International Journal of Production Research, 33*(7), 1881-1899. doi:10.1080/00207549508904787

Spencer, M. S., & Larsen. (1998). Kanban implementation between a heavy manufacturing department and foundry suppliers. *Production Planning and Control, 9*(3), 311-316. doi:10.1080/095372898234299

Statista. (2019). Bread & Bakery Products - Europe. Retrieved from https://www.statista.com/outlook/40050000/102/bread-bakery-products/europe?currency=eur

Steele, D. C., Philipoom, P. R., Malhotra, M. K., & Fry, T. D. (2005). Comparisons between drum-buffer-rope and material requirements planning: A case study. *International Journal of Production Research, 43*(15), 3181-3208. doi:10.1080/00207540500076704

Stock, G. N., Greis, N. P., & Kasarda, J. D. (2000). Enterprise logistics and supply chain structure: The role of fit. *Journal of Operations Management, 18*(5), 531-547. doi:10.1016/S0272-6963(00)00035-8

Tenhiälä, A., & Helkiö, P. (2015). Performance effects of using an ERP system for manufacturing planning and control under dynamic market requirements. *Journal of Operations Management, 36*, 147-164. doi:10.1016/j.jom.2014.05.001

Thakur, V., & Mangla, S. K. (2019). Change management for sustainability: Evaluating the role of human, operational and technological factors in leading Indian firms in home appliances sector. *Journal of Cleaner Production, 213*, 847-862. doi:10.1016/j.jclepro.2018.12.201

Ulewicz, R., Jelonek, D., & Mazur, M. (2016). Implementation of logic flow in planning and production control. *Management and production engineering review, 7*(1), 89-94.

Ünal, E., Urbinati, A., & Chiaroni, D. (2019). Managerial practices for designing circular economy business models: The case of an Italian SME in the office supply industry. *Journal of Manufacturing Technology Management, 30*(3), 561-589. doi:10.1108/JMTM-02-2018-0061

Van den Berg, J. P., & Zijm, W. H. (1999). Models for warehouse management: Classification and examples. *International Journal of Production Economics, 59*(1-3), 519-528.

Van der Aalst, W. M. (2013). Business process management: a comprehensive survey. *ISRN Software Engineering, 2013*.

Vedenik, G., & Leber, M. (2015). Change management with the aid of a generic model for restructuring business processes. *Int. J. Simul. Model, 14*(4), 584-595.

Wiesner, R., Chadee, D., & Best, P. (2018). Managing Change Toward Environmental Sustainability: A Conceptual Model in Small and Medium Enterprises. *Organization and Environment, 31*(2), 152-177. doi:10.1177/1086026616689292

Wong, T. N., Cheung, C. H., & Lau, H. (1999). Decision support system for a jewellery manufacturer. *International Journal of Production Economics, 60*, 211-219. doi:10.1016/S0925-5273(98)00142-X

Appendix 1 – Summary of the interviews

Confidential.