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IMPROVING INVENTORY MANAGEMENT IN A SMALL MANUFACTURING COMPANY: A CASE STUDY

Bachelor's Thesis

International Business Administration

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ABSTRACT

Inventory management is usually one of the neglected parts of the small business. Aggressive growth and increase in sales will inevitably lead to increase in inventory, especially in manufacturing business where the purpose of the business is to convert the materials into new ones of higher value. The study was conducted for a case company, which lacks a policy to manage its inventories and suffers occasional stockouts and overstock, which negatively affects the business.

The purpose of the study is to analyze the inventory of the case company using data of the past year to get an understanding of the current situation and to suggest a solution built upon relevant theory presented in the framework.

The study is a quantitative study. Sales and manufacturing data are gathered from the ERP system the company is using. Analysis of the data and a suggestion is presented after the theoretical part of the thesis. For a small business with limited resources and highly fluctuating demand, the lack of policy to control the inventory affects negatively to the profitability of the business. This thesis presents a suggested solution in a form ABC-XYZ analysis of the raw materials and of a min-max policy applied to A class items to improve the inventory management.

Keywords: Inventory management, Inventory Control, ABC-XYZ classification, Small Business, Reorder Policy

INTRODUCTION

Inventory management is an important part of supply chain focusing on aspects such as planning and controlling the flow of inventories within a company. In many cases, it is one of the most expensive assets of an organization and therefore managing inventories has risen to be a critical managerial issue within companies of all size. Closely tied with logistics, it considers everything related to inventory and moving it apart from the state it is in. The fundamental goal of inventory management is to deliver the right product to the right place, at the right time, in right quantity and at the right cost. To be able to deliver it, and efficient management system is necessary.

Widening the scope of inventory control through mathematical models, inventory management has become a managerial trend considering the future movements in a broader scope. Advancements in technology has enabled to integrate the warehouse to other segments of the business, sharing the information from every aspect of business. The era of internet has contributed to sharing of information not only inside the company, but between companies. This further increases the importance of proper management of inventory.

For small businesses, the first years are more or less survival and pushing their product to the market and making themselves visible. Optimizing inventory is not the top priority and therefore is often neglected. Especially in manufacturing business, a lot of resources is tied to raw materials and therefore should have emphasis on inventory management early on. In addition, small businesses rarely have the human resources to divide the tasks into small segments, or bargaining power to negotiate the best price. Still, every organization, big or small, can have policies and plan for managing their inventory. This frees time, provides structure for the management and makes possible to share responsibility more efficiently.

Case company of this thesis is a small manufacturing company producing currently 24 different chocolate products. Fluctuating demand and growth have led to occasional stock outs and overstocks and the management of inventory is very time consuming. The root cause is considered to be volatile demand and lack of control of the inventory on monthly basis. To get a reliable forecast of the demand is rather difficult for a specific period in such a situation, although the lead time for raw materials is not too long, longest being one month.

Purpose of the study is to investigate and analyze the current inventory situation and the disorganization of the inventory management within the company. The research question is how the concepts of inventory management can be applied to a small manufacturing business, providing help to control the inventory in an environment of fluctuating demand. Further, to build guidelines for managing the necessary materials related to the production through an inventory policy after examining the relevant theory.

First, theory of inventory management is studied to get a basic understanding of the concepts and techniques used in managing inventory. Second, the data of the case company is studied to reveal the applicable theories. For a manufacturing business, converting raw materials into items of higher value is the nature of the business. Not all raw materials are of same value, nor are their demand equal. Therefore, a classification analysis was chosen. Based on the results of the analysis, a relevant reorder policy is suggested.

The thesis is of quantitative nature. Data of the case company is gathered from the sales and manufacturing records of the past year. ABC-XYZ analysis is conducted and the items categorized accordingly. Further, a min-max policy is suggested from the data gathered to the A class items, considering the limited capacity and current resources of the production.

First chapter of the thesis provides the theoretical framework and methodology from which the research is conducted. Second chapter provides overview of the case company, the current situation, the operations and the empirical part of the study. Third chapter concludes the thesis.

1. INVENTORY MANAGEMENT

Inventory has many functions within an organization. In many cases, it is one of the most expensive assets of business. Especially in food service, manufacturing and retail, considered an inventory-sensitive sectors, availability of finished products is the core of the business. Inability to meet the demand when needed can be intensely harmful. On the other hand, inventory can be considered as a liability. High level of inventory carries the risk of fluctuating demand, spoilage, damage and expiration. If not sold in time, it has to be disposed of through discount sales, charity or simply exterminate. (Prater & Whitehead, 2012, Kumar, 2009, Naresh, 2005)

The need to meet the economic and financial requirements, while ensuring the optimal amount of raw materials, semi-finished products and final products on stock, gave birth to the discipline of inventory management. (Prater & Whitehead, 2012) Companies should use all techniques available, which fit their line of business, to manage its inventories. Through good management, companies can increase customer satisfaction, lower costs of inventory while increasing efficiency of production and purchasing and maximize the profit by increasing revenue. The ultimate goal of inventory management is to have right amount of inventory and ensure that neither shortages nor overstocking occurs. (Prater & Whitehead, 2012).

1.1. Objective of Inventory

Inventory is used to satisfy the demand of the customers. Generally, two different types of demand have been distinguished. Demand for items not related to other items, such as finished goods, are considered independent. Independent demand is subject to factors outside the organizations control. Items such as raw materials are dependent demand items. In manufacturing, raw materials are dependent of each other in the process of building the finished product. If any of the items are missing in the process, the product will remain unfinished. (Muller 2003, Rufe 2013)

Companies have typically three categories of inventory: (Muller, 2003).

- Raw Materials: Ingredients and materials to build or produce a saleable finished product, or semi-finished product to a certain stage.

- Finished product: Saleable product to the customer. Especially in manufacturing environment, a buffer of finished products can be made to meet the demand uncertainties and seasonal spikes in sales.
- Work-in-progress (WIP): Items in WIP are other words items in production. Usually inventory levels are small and caused by a delay in production. Work-in-progress stage is a conversion of raw materials to a saleable product.

Furthermore, the inventory is maintained in two forms (Prater & Whitehead, 2012):

- Physical inventory: All tangible materials used to make a product. This includes raw materials, work in process, spare parts and finished goods.
- Logical inventory: Software used to control inventory, information-based assets, databases, other intangible assets.
- Integration of these two inventories is essential for proper management of the company's assets.

Depending on the organizations line of business, inventory has different roles and functions within it. It is necessary to carry inventory to sustain the operations within a business. In manufacturing environment, inventory is carried for production purposes to convert the raw materials into finished goods. Furthermore, certain amount of finished goods might be stored in case of spikes in demand. In retail and distribution, the inventory is primarily for sales purposes and consists of finished goods. An empty shelf might turn into lost sales and decreased customer satisfaction. (Lancioni & Howard, 1978)

In addition, there are other important reasons to hold inventory:

Safety Stock: Buffer between the product demand and product supply. The intention of safety stock is to cover for the higher than expected demand, or the longer than expected lead time. If the demand was certain and predictable, there would be no need for a safety stock.

Purchasing discounts: Only a few suppliers are interested to negotiate a good price for a small order. It is tempting for buyer to decrease the price per unit by increasing the total order quantity. Yet, it might have a negative effect if the company is unable to sell the excess units.

Production shutdowns: Especially in manufacturing business, it is common to have a shutdown during holidays and maintenance. This applies to suppliers as well. To maintain the customer satisfaction, it is necessary to have enough stock to be able to meet the demand during the shutdown period.

Seasonality: Depending on the line of business, certain seasons of the year might increase the demand by several hundred, even thousands of percent. This requires preparations, proper planning and in many cases, inevitable increase in inventory to meet this kind of demand.

Spare Parts: For manufacturing business, the spare parts in stock ensure a continuous production. It might be expensive, but one breakdown of a critical machine might cripple the whole operation for a long time. (Richards & Gwynne 2011, Muller 2003)

Just-in-time approach has gained popularity, especially among the big companies having resources to invest in software and people for inventory management. For smaller businesses, this is hardly ever an option. The dependence of the steadiness of suppliers, without the bargaining power, may drive the small business into distress. Small businesses generally have only a few suppliers for most of their raw materials, without an alternative. If there is a delay in the supply chain, it may cause harm to the business, and affect the whole supply chain up and down. (Polito & Watson, 2006)

Lack of customer management, fluctuations in customer demand and last-minute adjustments to customer orders, without proper management, lead to unexpected overgrowth of the inventory.

Having inventory doesn't come without a cost. Generally, the costs of having inventory have been divided to three main categories: (Chunawalla 2008, Shipping College 2019)

- Holding cost: Cost associated with inventory on hand. This incurs, when inventory products have been stored for some period of time. This category includes costs of storage, handling, obsolescence, insurance, opportunity cost of capital and taxes.
- Ordering/Set-up Costs: These costs are mainly connected to the physical activities of processing an order. Receiving, issuing and processing orders, handling of goods, inspection and machine setups especially if product is manufactured, are included to this category.
- Stock-out costs: This cost occurs when an order is placed and cannot be delivered form the inventory. If the order is accepted as a delayed delivery, in other words back order, it requires extra paperwork with additional order processing and transport costs. In case the customer withdraws the order, the costs occur in form of lost profit and may have negative effect on the future sales.

1.2. Inventory Control

There are multiple models to control the inventory. Simply put, Inventory models are mathematical tools used to determine the quantity and time of the order. Due to various alternatives, businesses can choose the most suitable inventory control strategy for their specific purposes. One of the oldest models is Economic Quantity Model (EOQ). Nowadays many industries are using models like Just-in-Time (JIT), Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP). (Prater, E., & Whitehead, K., 2012) In addition to the mathematical tools, many businesses use a classification of their inventories according to the importance.

1.2.1. Economic Order Quantity Model (EOQ)

EOQ is a simple formula developed by F.W. Harris in 1915. It is used to determine the order quantity while minimizing the ordering and inventory carrying costs. The EOQ formula has been presented with the following limitations: (Farahani et al., 190, 2011), (Mueller, 127, 2006), (Onwubolu & Dube, 2006)

- The demand rate is constant, recurring and known
- The carrying cost and ordering cost are independent of the quantity ordered
- The lead time is constant and known
- Formula can handle only one type of item at a time
- Orders arrive in a single batch

1. Economic Order Quantity (EOQ) = $\sqrt{\frac{2\ x\ D\ xR}{H}}$

2. Variable cost of EOQ (VC_{EOQ}) = $\sqrt{2\ x\ D\ x\ R\ x\ H}$

3. Total cost of EOQ (TC_{EOQ}) = (U x S) + (VC_{EOQ})

U = the unit cost of the item

R = reorder cost for the item

H = holding cost of one unit of the item in stock for one period of time

Q = order quantity, which is always a fixed order size

T = cycle time, the time between two consecutive replenishments

D = demand of the item that should be supplied in a given time period

Because the strict assumptions of the EOQ formula doesn't reflect to the real world, variations to the basic formula have been developed. The abovementioned models did not consider price discounts to the equation. However, it is common to have a price discount related to the order size.

1.2.2. ABC-XYZ Classification

ABC-analysis is one of the most common technique used to classify inventory. It is still widely used due to relatively easy implementation and effectiveness. (Chen et al. 2008) Based on Pareto's principle, the technique classifies the inventory to A, B and C categories based on the annual dollar usage. According to the principle, items in A category represent 20% of the total items and account for 80% of the total dollar usage. B category items contain 30% of the items and 15% for the dollar usage and C category items contain 50% of the items and 5% of the dollar usage. (Onwubolu & Dube, 2006). The dollar usage is calculated by multiplying the annual dollar value per unit by the annual usage rate. Inventory items are arranged to the groups based on the dollar usage in a descending order. Class A items are small in number but have the greatest dollar usage. For comparison, class C items are considerable in number, but have relatively small dollar usage compared to class A. Items in between the two groups are classified as B class items. (Yu, 2011) Figure 1 presents the classical pareto curve with cumulative percentage of dollar usage and SKUs.

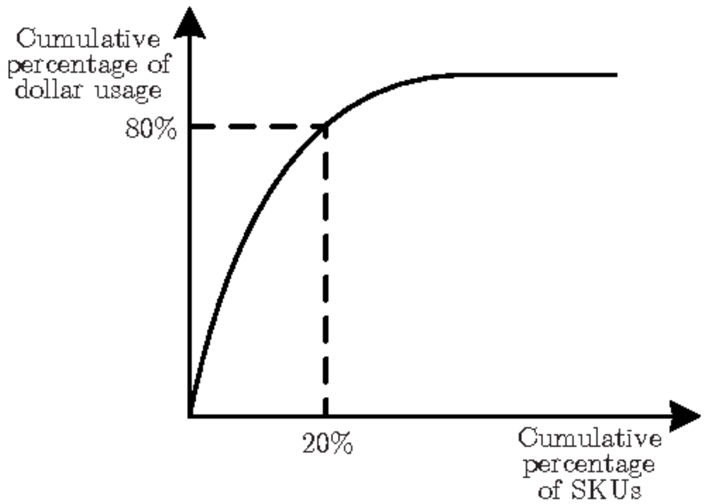

Figure 1. Classical Pareto Curve
Source: Peters & Skowron (2008, 36)

Annual dollar value being the only criteria of the ABC analysis has aroused criticism of the method. (Yu, 2011) Depending on the nature of the business, criteria such as lead-time, inventory cost, obsolence, commonality and order size might be more important factors in classifying the inventory. (Chen et al. 2008, Yu, 2011) Flores and Whybark (1986) have presented a joint criteria matrix to the classical ABC system. An additional criterion is added, widening the scope of the analysis. The objective is to reclassify the items into categories AA, BB and CC. The additional category, being lead-time, can be taken into account in the analysis. This matrix creates nine cells for the inventory, enabling the business to classify the items based on the dollar value and the lead-time of the item.

Some items might have high dollar value, but short lead time. On the other hand, low ranked item in dollar value might have longer lead time, especially if the item has to be imported abroad. This puts the high value item with short lead time to A-C category, downranking the class of the item to B category. The second item being ranked C according to the dollar value criteria, might be promoted to a B rank item due to long lead time. (Flores & Whybark, 1986) This method enables a further insight to the importance of the item, enabling review from multiple perspectives. In Figure 2, typical joint matrix ABC-analysis is presented. Before unnoticed products are spotted and therefore the overall efficiency of the inventory control is improved.

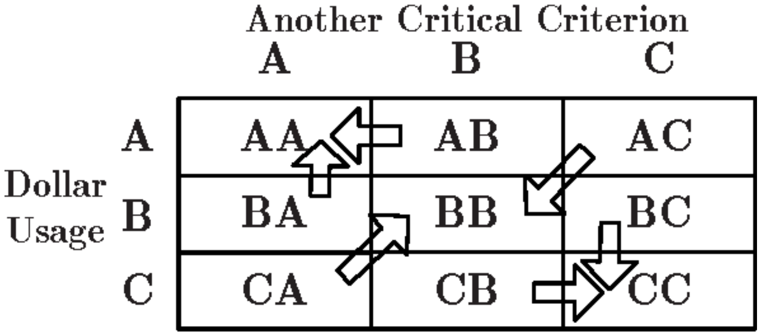

Figure 2. Joint Matrix
Source: Peters & Skowron (2008, 37)

There are various different classification methods for inventory control. One of the widely used applications is ABC-XYZ analysis for better management of stock and reduction of inventory costs. XYZ-classification is a modification of ABC analysis and classifies the items based on rate of usage, therefore evaluating the fluctuations in demand during a set time period. Coefficient of variation is calculated for each item and classified based on the ratio Typically, the items are divided into three groups, where X-category includes the relatively constant moving items which doesn’t have too much fluctuation, therefore considered as predictable. Y-category items have certain amount of fluctuation due to seasonality or other trends in item consumption and their prediction is considered medium. Items falling to Z-category are of very low or irregular use and ability to predict the movement is very low. (Bulinski et al. 2013, Pandya et al. 2016)

	A	B	C
X	High value percentage Continuous Demand High Predictive value	Average value percentage Continuous Demand High Predictive value	Low value percentage Continuous Demand High Predictive value
Y	High value percentage Fluctuating demand Average predictive value	Average value percentage Fluctuating demand Average predictive value	Low value percentage Fluctuating demand Average predictive value
Z	High value percentage Irregular demand Low predictive value	Average value percentage Irregular demand Low predictive value	Low value percentage Irregular demand Low predictive value

Figure 3. ABC-XYZ Analysis
Source: Pandya et al. (2016, 84)

The ABC analysis together with XYZ analysis divides the products into nine groups giving each item a new group. From Figure 3 can be seen the method to categorize the items in new nine categories of AX, AY, AZ, BX, BY, BZ, CX, CY and CZ. The criteria for categorization is annual usage and fluctuation in demand, providing a wider understanding of the items. (Bulinski et al. 2013, Pandya et al. 2016)

1.2.3. Just-in-Time (JIT)

Just-in-time philosophy has become famous through Toyota's achievements of implementing it successfully. It emphasizes the techniques developed by Taiichi Ohna, who worked in Toytota in 1970s. The idea of JIT is to meet the demand in terms of quantity, time and quality.

APICS define JIT as follows: "*a philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery and including all stages of conversion from raw material onward. The primary elements include having only the required inventory when needed; to improve quality to zero defects; to reduce lead time by reducing setup times, queue lengths and lot sizes; to incrementally revise the operations themselves; and to accomplish these things at minimum cost*." (APICS, Muller 2003)

Just-in-time is a managerial philosophy affecting the principles inside an organization. The concept of lean manufacturing was first used in 1990s, implementing the techniques developed by Taiichi Ohno to manufacturing world. In lean manufacturing, inventory is considered as a waste. The methods of lean target seven types of waste (Muller 2003, Farahani et al. 2011):

1. Waiting time: To improve efficiency, minimizing the time of machines, materials and people waiting
2. Processing:
3. Inventory: Having just enough materials for the planned production. All spare inventory is useless
4. Motion: Minimizing the no value adding activities to the product or service
5. Overproduction: Making more products than what is needed. Money, effort and space is wasted
6. Defects: Fixing and finding defects is a waste of time and money.
7. Transportation: Unnecessary moving of items, people and information

1.2.4. Inventory policies

To optimize inventory, policy has to be chosen depending on the situation and the nature of the product. Davis, 2016 has presented four replenishment policies:

1. SS = (s, S) policy: When the level of inventory falls to or below the reorder level, s, an order is placed to raise the inventory back to the order-up-to level, S. If current inventory position is y and y is less than s, an order of S – y is placed. This policy is also referred to as the min-max policy.
2. BS = (s,S) policy when S= s +1 (base-stock policy): When the inventory position falls to or below the reorder level, s an order is placed so as to raise the inventory position to the order-up-to level, S
3. NQ = (s, nQ) policy when you have a fixed ordering cost for each lot ordered: You incur a fixed ordering cost for each lot ordered. When the inventory position falls to or below the reorder level, s, an order is placed to bring the inventory position just above s. The size of this order is a multiple of the base lot size, Q.
4. RQ = (s, nQ) policy when you incur a single fixed ordering cost: you incur a single fixed ordering cost independent of the number of lots ordered. When the inventory position falls to or below the reorder level, s, an order is placed to bring the inventory position just above s. The size of this order is a multiple of the base lot size Q

It is necessary for any business to have a method of tracking their inventory. Two frequently discussed systems are the periodic and continuous review system, which are a way to keep track of the incoming and outgoing inventory.

In periodic system, a certain time period is set for the physical review of inventory levels. This could be a week, month or a year. In addition, predetermined maximum stock level is set to determine the size of replenishment upon review. If the stock level is below the before set amount, an order is placed. This system enables to order multiple items at one time, since the time interval is fixed, but the order quantity depends on the current stock level.

For the continuous review system, as the name states, the level of inventory is continuously monitored. When the inventory level reaches a preset minimum value, a fixed quantity replenishment order is placed. Even though the inventory is constantly monitored, physical count is still needed to verify the record in case of errors. (Naresh 2005, Vrat 2014)

1.3. Inventory Management

1.3.1 Enterprise resource planning (ERP)

Manufacturing planning and control systems have been part of manufacturing industries since the time before computers. Emerging of information technology has enabled companies to take advantage of this development in manufacturing planning. Manufacturing requirements planning (MRP) and Manufacturing resources planning (MRP-II) are the predecessors of the Enterprise resource planning system (ERP). (Rondeau & Litteral 2001, Vrat 2014)

ERP, unlike its predecessors, is a computer-based system which integrates the data of every department of an organization to be managed through one system. Due to change in business environment throughout the time to more customer oriented, combining all the departments of an organization to one database accessible to everyone is necessary to survive in today's environment. (Rondeau & Litteral 2001, Muller 2011)

The five main reasons for organization to implement ERP are (Muller, 2011):

1. Integration of financial information – all business units use the same set of metrics
2. Integration of customer order information – Customer informatin is available to all business units on a real time basis.
3. Standardization of manufacturing process – Standardization of processes leads to operating efficiencies.
4. Reduction of inventory – Excess inventory is held to a minimum.
5. Standardization of human resources information – uniformity of information and access leads to better administration.

The ERP software is divided to multiple modules for different aspects of the business. Warehousing, human resources, manufacturing, accounting and sales are differentiated inside the system, but the data for every aspect it integrated. This enables sales department to monitor the shipped orders and the items available for sale, as well as the accounting department to monitor the purchases or receipts. (Rondeau & Litteral 2001, Muller 2011)

1.3.2. Customer and Vendor managed inventory systems

Vendor-managed inventory system (VMI) is an inventory model, where supplier, instead of the customer, is responsible for the replenishment of inventory. To be able to do that, supplier has to know the inventory movement of the customer. Generally, this happens through electronic access to the customers inventory database. Supplier is responsible for monitoring the level of goods and sends goods only, when the stock is running low. Successful VMI programs can lead to reduction in inventory levels, although it requires teamwork and commitment from both parties to gain the full benefit of the system. Immediate benefits for suppliers engaging in VMI is access data on customer sales and inventory levels of the customer. (Harrison & Hoek 2008, Prater & Whitehead 2012)

Customer-managed inventory (CMI) on the other hand, gives customers the responsibility to control their inventory. In addition to customers own inventory, the visibility is extended to the inventory of the suppliers as well. The replenishment is managed by the customer from the supplier's inventory when needed. (Clear Spider, 2008) Both systems aim to integrate and simplify the supply chain by using technology applications to make the process efficient. One of the most common technologies used for sending information is electronic data interchange (EDI). This enables the exchange of demand data in a standard format and can be accessed through various internet-based applications. (Harrison & Hoek, 2008)

1.3.3. Demand planning and forecasting

Planning and forecasting the future demand are essential for every organization in today's business environment. Every organization has some level of forecasting included in its operations. Prater & Whitehead (2012) introduce four basic methodologies of forecasting:

- Qualitative: Based on personal intuition or insight of the future demand
- Causal: Specific variables are used for the forecast. If a customer is opening multiple new locations, increase in sales is assumed.

- Time series: Historical data is used to predict the future demand. Sales last year in specific month can be used as a basis for the same month's estimate in this year.
- Simulation: Combination of causal and time series method, with multiple what-if scenarios.

Further, forecasting is divided on three different time frames. Short term forecasting considers forecast up to three months from present. It is applied to individual products or services. Medium term forecasting is from three months up to two years, applied to product or service families. Long term forecasting is from two years on and applied to the total sales of the organization. Different above-mentioned methods are used depending on the length of the forecast. (Prater & Whitehead, 2012)

Technology has enabled organizations to update and follow the forecasts in real time. Such example is EDI mentioned in previous chapter. Further, technologies like Radio Frequency Identification (RFID) have started to become more common. RFID uses a computer chip and a reader to keep real-time data on the inventories. Customer and supplier both synchronously know when a certain item is running low, enabling a decrease in cycle time of orders (Prater & Whitehead, 2012)

Generally, lead time is the duration between receiving an order and delivering it to the customer. Lead times exist in every supply chain and affect the inventory levels of the organizations. Traditionally lead time has been explained as the time it takes for supplier to procure the materials, manufacture the item, ship it to the customer and for the customer to receive the item. Nowadays it measures the speed of delivering the order to the customer. (Muckstadt, A. J. and Amar S., 2010, McDonald, S. C., 2009)

Reorder point is set to certain level of inventory, which triggers the need to order more of the materials to reach the preset point of inventory. When inventory on hand and on order falls below the set limit, an order is made to replenish the stock. Basic formula for calculating the reorder point is: (Toomey, 2012)

Anticipated demand during lead time + Safety Stock = Reorder Point

Some limitations are addressed to the formula mentioned above. Demand for the items is assumed to be uniform and continuous. Unfortunately, in reality the demand for independent inventories is not continuous. Therefore, another approach is needed. (Toomey, 2012)

2. INVENTORY MANAGEMENT IN THE CASE COMPANY

2.1. Background of the case company

Case company selected for the research is a small chocolate manufacturing company established in 2015. Starting with a few products and focusing to establish a customer base in Finland and Northern Europe to support the bigger goal, the US market. Today the company has sales in 14 countries, through distributors and retail.

The Company is located in Helsinki, Finland and currently employs 19 people, one of the founders still working for the company. Annual turnover for the last two years has been around one million EUR. The product range has evolved to 4 different product categories, totaling 24 different types of chocolate products. Due to innovative nature of the company, product development is constantly work in progress and planning for new products is part of the daily business. In 2018, the company has been investing a lot of capital to machinery, employees and a new production facility. Also, two of the four product lines were released and fifth one is currently under development, planned to be launched in May 2020.

Multiple product categories increase the complexity of managing the inventory. Currently there is one person in the company responsible for the replenishment of the inventory and no policies have been implemented to support the decision making.

2.1.1. Operations and suppliers

The main operation of the company is the production of chocolate. The production department consists of nine people and two in administrative roles, totaling of 11 people. One person is responsible for the procurement, logistics and planning of the production and one is responsible for the R&D and quality. Rest are production workers. Warehousing and shipping of the finished products are currently in-house operations and done by one of the people in production. Currently the procurement is based on short-term planning and gut feeling.

In the office, there is CEO and one of the founders seeking funding to support the growth and responsible for the major operational decisions. For sales, there are two representatives in Europe and two in USA. One people is responsible for the financial management and one for the design for the products.

The production is with the emphasis of handicraft and minimal automation. Especially in the packaging phase, only the folio wrapping of the product is made with the help of a machine. The chocolate is packed to the sales display by hand and ingredient stickers are added during this phase. Due to various market locations, multiple labels are needed for the product to be acceptable in foreign markets. This further increases the complexity with the management of the inventory.
The company has multiple suppliers for the materials necessary to make a saleable product. Due to the new product launches, new suppliers have emerged to meet the demand of all the ingredients. For the ingredients to make the chocolate, total of ten suppliers are currently used. One of them provides spices, five of them provide the base materials for making chocolate, two provides berry powders for the flavor and two provides more special ingredients, such as birch leaves. For Packaging materials, there is currently six different suppliers. Stickers, foil, sales displays, cardboard boxes and envelopes for the product are coming from different sources.

2.1.2. Inventory of the case company

Current inventory level is relatively high compared to the annual sales. For the past year, the average total inventory has been 285 000€ from which raw materials averaged 136 000€, packing materials 42 500€, WIP 67 500€ and Finished goods 39 000€. Cost of goods sold for the same year was 255 752€. Inventory is counted periodically, in the end of every month, where the whole inventory of the company is calculated. Despite the physical calculation, no inventory control system has been established for monitoring the levels of inventory.

Inventory turnover for the past year, calculated with cogs, was 1,13. General broad range for inventory turnover in manufacturing business is between 1.0 and 2.0, although for manufacturers it is considered good to be closer to 2 in terms of cash flow. For days inventory outstanding, the ratio was found 291. Cash conversion cycle for the past year was found at 720. It is alarmingly high and is a sum of many. It implies that the company is not able to turn its inventory efficiently into sales. The payment period of customers is very long, and negatively affecting the cash flow of the company. Certain unwise purchases have been made, which are directly affecting increasingly to the ratios. To further reflect the problem, if hypothetically the error purchases were subtracted from the inventory value, inventory turnover would increase to 2,1 and DIO decrease to 153.

Overall, the management of the inventory has been neglected. Occasionally, multiple purchases are made for the same materials within the period of one month. The need usually occurs when one of the employees gives a notice of a low level of certain item in the inventory. Sometimes a stockout follows for late purchasing, delaying the production, which leads to late delivery to the customer. On the other hand, certain items end up having too high level of stock, enough for several months.

2.2. ABC-XYZ Inventory analysis of the raw materials

By classifying the items, the author believes that the management of the inventory becomes more efficient by focusing enough time to the right items.
According to Chunwalla (2008) and Onwubolu & Dube (2006) the procedure for making the ABC analysis are:

1. Find out the annual quantity for each item.
2. Obtain annual dollar usage for each item by multiplying the annual quantity by the cost of each item.
3. Sum the dollar usage of all items to get the total annual dollar usage
4. Divide the annual dollar usage per item by the total dollar usage to obtain the percentage of usage for each item.
5. List the items in descending order by the percentage of usage
6. Classify the items by annual usage as A, B or C

Due to similarity of the sales price of the saleable products, the ABC classification was conducted to the raw materials to get a deeper understanding of the usage rate and spending for each item annually. Usage rate of items has been chosen as a main criterion to classify the products. According to the procedures listed above, Table 1 presents the annual usage and spend for each item. The classified items are the ingredients to make the end product. It consists of the materials to make the base of the chocolate as well as ingredients to add the flavor to the product, such as berries and spices. The price range of the products also varies quite a lot, which further gives emphasis to the importance of classification.

Table 1. Annual usage and monetary value per item

Count	Item number	Annual usage per item	Cost per item	Annual value €
1	CB-1	2931	10,30 €	€ 30 189,30
2	CN-2	872	13,20 €	€ 11 510,40
3	CN-1	5444	8,40 €	€ 45 729,60
4	CPN1	295	10,00 €	€ 2 950,00
5	GM	649	6,50 €	€ 4 218,50
6	Can-1	134	12,30 €	€ 1 648,20
7	CB-3	979	6,00 €	€ 5 874,00
8	CS-1	6815	3,98 €	€ 27 123,70
9	OCM	3094	3,31 €	€ 10 241,14
10	OO!	985	2,26 €	€ 2 226,10
11	Crp-1	26,4	58,00 €	€ 1 531,20
12	Ca-1	3,36	52,96 €	€ 177,95
13	SPH-1	15,6	46,00 €	€ 717,60
14	OA	19,97	17,47 €	€ 348,88
15	OLR	16,07	16,32 €	€ 262,26
16	OGP1	22,38	22,67 €	€ 507,35
17	OMP1	26,24	15,69 €	€ 411,71
18	OCC1	5	14,74 €	€ 73,70
19	CU	24	10,20 €	€ 244,80
20	ORG-1	10	56,00 €	€ 560,00
21	OLG	10,35	8,60 €	€ 89,01
22	ORM1	4,4	28,60 €	€ 125,84
23	Tu-1	1,7	19,16 €	€ 32,57
24	BP-1	84,15	46,00 €	€ 3 870,90
TOTAL		22467,62		€ 150 664,71

Source: Author's own calculations

From table 1, the items can be listed according to the percentage of usage rate calculated and rearranged in descending order according to the percentages. Further, the items are classified as A, B and C with slightly modified percentages of pareto principle

Table 2. Ranking of the items according ABC-classification

Count	Item number	Annual usage or demand	Cost per part	Annual spend value	% of annual units used	% of annual spend value	% of items	Class
8	CS-1	6815	3,98 €	€ 27 123,70	30,33 %	18,00 %	4 %	A
3	CN-1	5444	8,40 €	€ 45 729,60	24,23 %	30,35 %	8 %	A
9	OCM	3094	3,31 €	€ 10 241,14	13,77 %	6,80 %	13 %	A
1	CB-1	2931	10,30 €	€ 30 189,30	13,05 %	20,04 %	17 %	A
	Base ingredients for most of the products manufactured			€ 113 283,74				
10	OO1	985	2,26 €	€ 2 226,10	4,38 %	1,48 %	21 %	B
7	CB-3	979	6,00 €	€ 5 874,00	4,36 %	3,90 %	25 %	B
2	CN-2	872	13,20 €	€ 11 510,40	3,88 %	7,64 %	29 %	B
5	GM	649	6,50 €	€ 4 218,50	2,89 %	2,80 %	33 %	B
4	CPN1	295	10,00 €	€ 2 950,00	1,31 %	1,96 %	38 %	B
	Similar ingredients as in Group A, though not as often used due to items limited usage depending on flavor			€ 26 779,00				
6	Can-1	134	12,30 €	€ 1 648,20	0,60 %	1,09 %	42 %	C
24	BP-1	84,15	46,00 €	€ 3 870,90	0,37 %	2,57 %	46 %	C
11	Crp-1	26,4	58,00 €	€ 1 531,20	0,12 %	1,02 %	50 %	C
17	OMP1	26,24	15,69 €	€ 411,71	0,12 %	0,27 %	54 %	C
19	CU	24	10,20 €	€ 244,80	0,11 %	0,16 %	58 %	C
16	OGP1	22,38	22,67 €	€ 507,35	0,10 %	0,34 %	63 %	C
14	OA	19,97	17,47 €	€ 348,88	0,09 %	0,23 %	67 %	C
15	OLR	16,07	16,32 €	€ 262,26	0,07 %	0,17 %	71 %	C
13	SPH-1	15,6	46,00 €	€ 717,60	0,07 %	0,48 %	75 %	C
21	OLG	10,35	8,60 €	€ 89,01	0,05 %	0,06 %	79 %	C
20	ORG-1	10	56,00 €	€ 560,00	0,04 %	0,37 %	83 %	C
18	OCC1	5	14,74 €	€ 73,70	0,02 %	0,05 %	88 %	C
22	ORM1	4,4	28,60 €	€ 125,84	0,02 %	0,08 %	92 %	C
12	Ca-1	3,36	52,96 €	€ 177,95	0,01 %	0,12 %	96 %	C
23	Tu-1	1,7	19,16 €	€ 32,57	0,01 %	0,02 %	100 %	C
TOTAL	–	22467,62	–	€ 150 664,71	–	–	–	–

Source: Author's own calculations

Pareto Chart of the classified items was constructed and is presented in the following Figure (see Figure 4) in descending order.

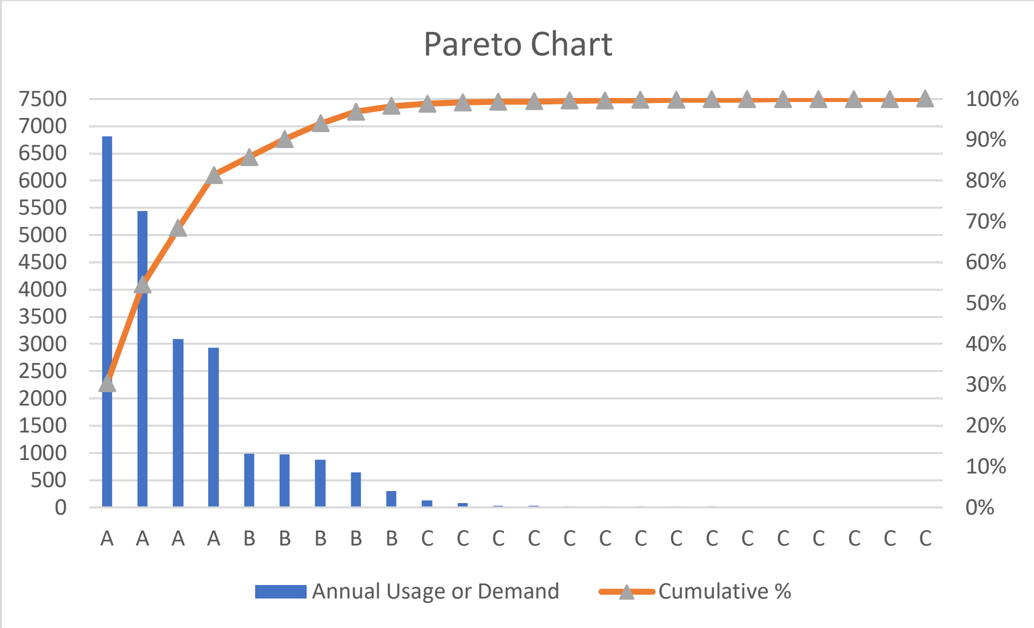

Figure 4. Pareto Chart of the classified items
Source: Author's own calculations

By conducting the ABC analysis, the items causing largest impact on the overall inventory can be identified. (Onwubolu & Dube, 2006) On Table 2 above, 17 percent of the items haven been classified as A class items, 21 percent as B class items and 62% as C class items. It can be concluded that the four highest ranked items CS-1, CN-1, OCM and CB-1 are clearly most used and therefore should have the tightest control of all inventory. The whole inventory is counted every month's end, but thus far there has been no emphasis on any of the materials upon the count. This has led to occasional stock outs of the high rank items, that has further caused a need for small replenishment orders within a review period. Sometimes, the production plan has been delayed due to absent raw materials. To avoid such occurrences, the monthly review tied to certain date is not a viable only option for replenishment. The next five items OO1, CB-3, CN-2, GM and CPN1 are medium priority items and should be constantly monitored, but not as tightly as the class A items. The last 15 items Can-1, BP-1, Crp-1, OMP1, CU, OGP1, OA, OLR, SPH-1, OLG, ORG-1, OCC1, ORM1, Ca-1 and Tu-1 are of lowest priority regarding the control but should be monitored occasionally to avoid stock outs.

A point worth mentioning is that all of the class A items are used as a basis for the end product. If one of those is missing, it may cause a total shutdown of production for a certain period. Items of class B and C are mostly used for seasoning and if one of them unintentionally runs out, it will not cause a shutdown and therefore is a slightly less harmful compared to the class A items. Although it may still cause a lost sale in certain cases, if a substitute product is not accepted.

To further understand the fluctuation in demand, XYZ-analysis was conducted in addition to the ABC-classification. Being still a relatively young company and finding the place in the market, the overall fluctuation is considerably high. In addition, the main product being chocolate, predisposes the company to seasonality, which inevitably affects usage rate of raw materials. Typical classification based on coefficient as per ratio is 20%:30%:50% for X, Y, Z respectively. (Pandya, B. et al., 2016) In calculation of the coefficient per item, average variation was 93 percent. Therefore, the coefficient ratio was modified as per ratio X<=50%, Y<=100%, Z>100% to get a more realistic analysis of the items. Table 3. Provides an overview of the coefficient variation for each item.

Table 3. Coefficient variation for each item.

Item number	Coefficient variation	XYZ-Class
CS-1	45 %	X
CB-1	49 %	X
CN-1	56 %	Y
OLR	71 %	Y
CN-2	71 %	Y
OCM	74 %	Y
Can-1	85 %	Y
BP-1	89 %	Y
Crp-1	93 %	Y
ORG-1	93 %	Y
ORM1	93 %	Y
GM	94 %	Y
CU	96 %	Y
OMP1	99 %	Y
OCC1	101 %	Z
Ca-1	101 %	Z
Tu-1	101 %	Z
OO1	105 %	Z
OA	105 %	Z
SPH-1	116 %	Z
CB-3	119 %	Z
OGP1	121 %	Z
OLG	126 %	Z
CPN1	135 %	Z

Source: Author’s own calculations

From the table can be seen, that lowest variation is 45 percent, which is considered relatively large. With typical classification, most of the items would have ranked as Z-class and only a few Y-class. The values had to be changed to obtain values relevant to the case. Table 4 shows the new nine categories, and the class respectively for each product.

Table 4. ABC-XYZ categorization of the items

Class	X	Y	Z
A	CS-1, CB-1	CN-1	-
B	-	CN-2, GM	OO1, CB-3, CPN1
C	-	OLR, CaN-1, BP-1, Crp-1, ORG-1, ORM1, CU, OMP1	OCC1, Ca-1, Tu-1, OA, SPH-1, OGP1, OLG

Source: Author's own calculations

From table can be seen, that three categories are absent products. In AX-category, there is two items, AY one item, BY two items, BZ three items, CY eight items and CZ seven items. Even after increasing the coefficient ratio for classification, only two items are considered as constant demand items. On the other hand, most of the classified items which fall to the highly fluctuating demand category, are also of lowest importance when considering usage rate.

2.3. Replenishment policy for the case company

2.3.1 Background

The company has implemented a new ERP system in the beginning of 2019, to support the maintenance of operations. The ERP-system integrates the sales, financial management, inventory management and production of the company. It has readiness to implement reorder rules and alarms for when the items are running low on stock, to support managing the inventory, but this has not yet been exploited. Every step of production is recorded, providing valuable data for analysis.

For replenishment, no policies have been implemented. Purchases are made on short notice, when a low stock of an item has been discovered by an employee or from the ERP system. This has led to multiple purchases within one review period and causes uncertainty in production. For a small manufacturing facility using rather simple equipment for production, the maximum capacity is rather easy to calculate. Two different kind of equipment are made for the production of chocolate mass, with a certain limit of capacity which is rather impossible to exceed.

First line of production is a set of eight stone grinders each of having a capacity of holding 40kg of the mass. The production time for the machines is two days, totaling in 360kg of mass three times a week. The second line is one machine with 50kg capacity, possible to run two times a day. Currently the production works in one shift and the calculations are made with the current resources in the company.

2.3.2. Reorder point

To determine the reorder point for each item, the lead time has to be studied first for each item. Lead times used in calculation are the maximum time it will take for the order to arrive, if there are no external problems. The times are confirmed from the suppliers of the case company.

The calculation of reorder point is done same way as Muller, 2011 has presented the Min-Max inventory system. Formula presented in the chapter 1.4.3. is used for the calculations. The lead times are shown as percentages of the month as follows (Muller, 2011):

1 week = 0,25 = 25%	3 weeks = 0,75 = 75%
2 weeks =0,5 = 50%	4 weeks = 1,00 = 100%

Four weeks is the longest lead time for the items used in analysis. Table 3 presents the lead times for each item.

Table 4. Lead time of the items based on current data of the suppliers.

Product code	Lead Time	Class
CB-1	0,75	A
CS-1	0,75	A
CN-1	0,5	A
OCM	0,5	A
OO1	1	B
CPN1	0,75	B
GM	0,75	B
CN-2	0,5	B
CB-3	0,5	B
CaN-1	0,5	C
CU	0,5	C
Bp-1	0,5	C
SPH-1	0,5	C
ORG-1	0,5	C
OA	0,25	C
Ca-1	0,25	C
OCC1	0,25	C
OGP1	0,25	C
OLR	0,25	C
OMP1	0,25	C
ORM1	0,25	C
Tu-1	0,25	C
OLG	0,25	C

Source: Author's own calculations

Overall, the lead times are relatively short, longest being four weeks. On the other hand, being short of the items for three weeks might cause a tremendous loss on sales and efficiency. Therefore, special emphasis is required for the class A items, these being the basis of making the end product. The monthly usage, working stock, working reserve and safety stock is presented for average demand in Table 4. Safety stock is determined to be 50 percent of working reserve in the calculations.

Table 5. Lead time, monthly usage, working stock, working reserve and safety stock of the items.

Product code	Lead Time	AVG monthly usage rate in kg	working stock in kg	working reserve in kg	Safety stock in kg	ROP in kg	Class
CB-1	0,75	362,11	90,53	271,58	135,79	407,37	A
CS-1	0,75	708,09	177,02	531,07	265,53	796,60	A
CN-1	0,5	532,74	133,19	266,37	133,19	399,56	A
OCM	0,5	258,16	64,54	129,08	64,54	193,62	A
OO1	1	88,47	22,12	88,47	44,24	132,71	B
CPN1	0,75	26,80	6,70	20,10	10,05	30,15	B
GM	0,75	148,23	37,06	111,17	55,59	166,76	B
CN-2	0,5	79,32	19,83	39,66	19,83	59,49	B
CB-3	0,5	89,01	22,25	44,51	22,25	66,76	B
CaN-1	0,5	12,18	3,05	6,09	3,05	9,14	C
CU	0,5	2,17	0,54	1,09	0,54	1,63	C
Bp-1	0,5	7,65	1,91	3,83	1,91	5,74	C
SPH-1	0,5	1,42	0,35	0,71	0,35	1,06	C
ORG-1	0,5	3,33	0,83	1,67	0,83	2,50	C
OA	0,25	1,82	0,45	0,45	0,23	0,68	C
Ca-1	0,25	0,31	0,08	0,08	0,04	0,11	C
OCC1	0,25	0,46	0,11	0,11	0,06	0,17	C
OGP1	0,25	2,03	0,51	0,51	0,25	0,76	C
OLR	0,25	1,54	0,38	0,38	0,19	0,58	C
OMP1	0,25	2,39	0,60	0,60	0,30	0,89	C
ORM1	0,25	0,40	0,10	0,10	0,05	0,15	C
Tu-1	0,25	0,15	0,04	0,04	0,02	0,06	C
OLG	0,25	0,94	0,24	0,24	0,12	0,35	C

Source: Author's own calculations

By using average demand to calculate the reorder point for each item doesn't provide a solution but offers valuable information for building a better level of control to avoid stock outs. Further, the reorder point is the minimum amount of stock which should be held in hand even in more quiet periods, enabling to start the production in full speed if situation changes rapidly.

Seasonality is a strong factor in the case company's line of business. Therefore, the calculations based on average demand are not accurate for seasonal peaks in demand. Usage rates for class A items are presented in Table 5.

Table 6. Demand and usage ratio per month for A class items.

Product Code	12	1	2	3	4	5	6	7	8	9	10	Total
CN-1	257,1	1035,0	632,3	852,5	522,6	98,4	219,3	919,7	354,1	318,5	552,2	5761,8
	4 %	18 %	11 %	15 %	9 %	2 %	4 %	16 %	6 %	6 %	10 %	
CB-1	104,4	524,1	390,2	488,5	270,4	82,4	134,6	357,7	562,7	280,7	452,9	3648,6
	3 %	14 %	11 %	13 %	7 %	2 %	4 %	10 %	15 %	8 %	12 %	
CS-1	235,9	1048,4	782,7	809,4	479,3	204,4	267,1	863,6	776,3	522,5	740,7	6730,2
	4 %	16 %	12 %	12 %	7 %	3 %	4 %	13 %	12 %	8 %	11 %	
OCM	238,1	657,2	103,9	364,1	324,3	29,1	66,4	458,2	58,3	140,2	378,3	2818,2
	8 %	23 %	4 %	13 %	12 %	1 %	2 %	16 %	2 %	5 %	13 %	

Source: Author's own calculations

Normally the demand decreases during the warmer months of the year globally. From April to the end of June are usually the quietest months for the case company. On July, the preparation for the upcoming Autumn is started to increase the response time for the high season.

From Table 5 can be seen, that there are months where the demand exceeds the working reserve and safety stock presented in Table 4. To be able to react to the fluctuation, another version of reorder point is calculated in Table 7. Chapter 2.3.1. mentioned that the current maximum capacity of the production is relatively easy to calculate due to only two different lines and limited resources. In table 6 can be seen the total amount of chocolate production per week and per month.

Table 7. Production amount per week and per month in kg.

MON	TUE	WED	THU	FRI	TOTAL PER WEEK	TOTAL PER MONTH
360		360		360	1080	4320
100	100	100	100	100	500	2000

Source: Author's own calculations

From the table above can be seen the current maximum amount of chocolate made in one week. The total amounts per week can't be combined, since it is used for different product lines. Next, the reorder point is calculated according to the maximum capacity.

Table 8. Reorder point for maximum capacity.

Product code	Lead time	Monthly usage in kg	Working stock in kg	working reserve in kg	Safety stock in kg	ROP in kg
CB-1	0,75	1170,00	292,50	877,50	438,75	1316,25
CS-1	0,75	1870,00	467,50	1402,50	701,25	2103,75
CN-1	0,50	1778,00	444,50	889,00	444,50	1333,50
OCM	0,50	302,00	75,50	151,00	75,50	226,50
OO1	1,00	473,00	118,25	473,00	236,50	709,50
GM	0,75	512,00	128,00	384,00	192,00	576,00

Source: Author's own calculations

In addition to the class A items, two other items were added to the calculation because those are necessary parts in the process of the second line of production. The column Working + safety stock can be interpreted as maximum value for the items respectively. Table 8 provides a summary for the min-max values for these six items.

Table 9. Min-Max values for the base items of production in kg.

Product code	Min	Max
CB-1	407,37	1316,25
CS-1	796,60	2103,75
CN-1	399,56	1333,50
OCM	193,62	226,50
OO1	132,71	709,50
GM	166,76	576,00

Source: Author's own calculations

These values provide a guideline for optimizing the stock levels depending on the situation in emphasis to avoid stock outs. Even in quiet months when the min value is reached, the situation should be carefully revised if replenishment order is not placed at the moment of reaching the value. On the other hand, the maximum amount of stock is known which should not be exceeded within a month, when trying to have an optimum amount of inventory for sufficient production. The above max number per item can be used as a restriction to the order amount, when replenishing stock.

The propositions made are first of kind for the case company, and the idea is to present a basis for the replenishment and control of the raw materials. Further, the idea behind the proposition is to make an easily accessible tool for the company's use which can be further developed and expanded according to the needs. The min-max values can be entered to the ERP system, which gives an alarm when an item reaches a preset level. In addition to the physical check, it adds another dimension to the monitoring of the important items and saves time of the responsible employees and frees time to further development of the inventory management.

CONCLUSION

Inventory management has become an important focus point of improvement for many companies. For small companies, it is even more important compared to the larger companies, due to lack of resources and bargaining power. Many small businesses face difficulties with their inventory management, because it is one of the easiest neglected parts of the business. Inventory management is a widely studied topic. Major part of the theory presented in the literature is easier to utilize in bigger companies. Research specifically towards small companies with rapid growth and fluctuating demand is limited. Nevertheless, the fundamental theory of inventory management applies to companies regardless of the size. Theories of different tools and models for replenishment, classification method for items and relevant concepts, have been opened for the purpose of conducting this study. To improve the inventory management with limited resources, a solution suitable for the case company's current situation was suggested.

In addition to the theory used in this thesis, tools such as EOQ were presented in the theoretical framework, although not found applicable for the case company. Just-in-time was presented as a managerial approach to inventory management. If inventory is properly managed and the control constantly developed, it will inevitably lead to result similar to such approach.

The suitable theoretical framework was constructed by applying the ABC-XYZ analysis to the raw material inventory of the case company. ABC-analysis is commonly used classification tool to find out the important few items. According to the Pareto Principle, 20% of the items account for 80% of the dollar usage. XYZ-analysis is commonly used addition to the ABC-analysis to deepen the analysis by calculating the coefficient variation of the items, to broaden the classification to nine categories, instead of three.

The case company's data was analyzed for the past year to conduct the study. Sales and the manufacturing data of the company was used to build the empirical part. The aim of the study was to build a tool for daily use within the company and to implement it into the ERP system. The need to make such a study grew relevant from the company's side as well, due to occasional stock outs and lack of proper policies to manage the inventory. By conducting the ABC-XYZ analysis, the crucial A class items were found: CN-1, CB-1, CS-1 and OCM. Of these, CB-1 and CS-1 were also X class items. According to the results of the analysis, a min-max policy was applied to the analyzed A items to support the replenishment of the stock. The policy can be used as a supportive method to check the inventory levels alongside the monthly periodic review currently used in the company. A min-max policy where the company can set limit values for all raw materials in use was created. With the help of the created policy, the case company can manage fluctuating demand and avoid stock-outs as well as overstock of items.

It was also found, that if even one of the A class items were stocking out, in worst case scenario, might cause a total stoppage of the production for a couple of weeks, which would negatively affect the profitability of the company. The tool would help to improve the management of inventory and free time of the management for further process development. The study was made for the current situation in the company. If investments to personnel or machinery are made, the policies have to be revised and amended accordingly.

Inventory management is a never-ending development process. Improvement in technology has enabled companies to more easily access relevant tools to improve the managing of inventories at a reasonable price. Internet-based ERP systems allow companies to monitor the stock levels outside the office in real time and enables better information sharing within the company. For the case company, further research should be conducted to the finished goods and work-in-process inventory, implementing similar tools as in this work. This would allow a framework for more efficient production planning, which would further increase the efficiency and profitability of the company.

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