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Measuring and optimizing inventory management processes for Restaurant X

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Abstract

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Inventory is one of the largest accounts in the balance sheet of a product-based company. Inefficiencies may occur in any process and induce high costs to the company. Ensuring that efficient processes are associated with it, is value-adding to the business.

This thesis aims to determine the cost of the inventory management processes in Restaurant X and suggest improvements on existing inefficiencies. The commissioning company is a franchisee in the restaurant industry. Only Restaurant X's processes are studied.

The research focuses on the managerial accounting perspective of the topic. Five interviews and on-the field observations are the qualitative analysis methods. A process flowchart is created. Numerical data analysis is the quantitative analysis method.

In the case company, the inventory process includes materials planning and forecasting, purchasing, receiving and storing ordered goods, picking inventory from storage and moving it into production. Inventory can become obsolete at any point. Inventory is physically counted at regular intervals. The inventory processes and their costs can be divided to ordering and holding costs.

Inventory-related financial figures for the past two years are analyzed. Total inventory-related costs are determined for both timeframes. Inventory management efficiency measurements and an analysis model are applied.

In 2018, total inventory costs for Restaurant X increased by 5% while sales grew by 9%. Inventory salaries and obsolescence represent the highest costs. The analysis model proves that, in 2018, the process efficiency increased by 8% from 2017. However, the value is below the industry average.

Keywords
Inventory process efficiency, cost, optimization, metrics, inventory management

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1 Introduction

This chapter offers an overview of the topic and purpose of the thesis, the research question and investigative questions associated with it and discusses the demarkation of the topic. The chapter also outlines the benefits for all parties involved in the thesis and the key concepts frequently mentioned throughout the research. Finally, the chapter provides information about the probable risks regarding the thesis completion and concludes with an introduction of the commissioning company.

1.1 Background

High costs can arise when inefficiencies occur. A significant source of hidden costs in the restaurant business is inventory management inefficiencies. Recognizing these inefficiencies and their impact on the costs is the first step to resolving them.

Most restaurants receive deliveries of raw materials, store them, prepare them into finished goods, and make the finished goods available for sale to the customer. The aim of the thesis is to determine what the cost of the inefficiencies resulting from these processes is for the Restaurant X and how they can be reduced. By supporting the processes with numerical data, management can interpret the phenomenon with facts and make informed decisions. However, the company prefers to be anonymous so the term “Restaurant X” is used when referring to the commissioning company in this thesis.

The restaurant in question follows a similar procedure of inventory management; deliveries arrive at the store, raw materials and finished goods are stored either at the storage area, refrigerators or freezers according to the product requirements, and they are prepared and taken to the sales market when needed. According to the Operations Manager, it is expected that the current processes amount to more than 3 500€ per week. This number is adapted to fulfil the confidentiality agreement.

Inventory management belongs to the area of Managerial Accounting, which is the career path that suits my interests. Further, the company has been my employer and this is a challenge for me to provide my resources for the company’s benefit.

1.2 Research Question

This thesis aims to first determine the cost of the inventory management processes in the restaurant and then suggest improvements on existing inefficiencies.

The research question is How can the inventory management practices be optimized in Restaurant X?

To match the company's corporate language, the terms FY17 and FY18 are used as reference points and they stand for Financial Year 2017 and 2018, respectively. A Financial Year in the company starts on September 1st and ends on August 31st.

IQ 1. What are the current implemented practices regarding inventory management in Restaurant X?
IQ 2. How are the costs of inventory management processes during FY18 compared to FY17 in Restaurant X?
IQ 3. How can Restaurant X's inventory management efficiency be analyzed?
IQ 4. How can efficiency in the inventory management of Restaurant X be improved?

Table 1, below, presents the theoretical framework and research method for each investigative question. Also, the table directs the reader to the appropriate chapters where the results of each investigative question are found from. The theoretical framework behind IQ1 includes theories of improving efficiency for each inventory management process individually. The theoretical framework behind IQ2 and IQ3 composes of theories on measuring inventory-related costs as well as monitoring efficiency with various efficiency metrics. Finally, the theories and the results are used in a supplementary manner to answer IQ4. The selected research methods and an elaborate justification is provided on chapter 4.

Table 1. Overlay matrix

Investigative question	Theoretical Framework	Research Methods	Results (chapter)
IQ 1. What are the current implemented practices regarding inventory management in Restaurant X?	Inventory management processes	Face-to-face interviews & observations	4.1 – 4.8
IQ 2. How are the costs of inventory management processes during FY18 compared to FY17 in Restaurant X?	Managerial accounting for inventory management	Internal data collection method	4.9
IQ 3. How can Restaurant X's inventory management efficiency be analyzed?	Managerial accounting for inventory management	Internal data collection method	4.10
IQ 4. How can efficiency in the inventory management of Restaurant X be improved?	Inventory management processes and accounting	Qualitative analysis	4.1 – 5

1.3 Demarkation

The thesis focuses on the processes and costs of inventory from forecasts to sales. Restaurant X has three main areas of sales; restaurant, food market, and a staff restaurant. This thesis considers all areas mentioned in addition to possible sub-areas. The focus of the thesis is on the managerial accounting aspect of inventory management and the processes' cost-efficient improvement. Restaurant X is the only restaurant of the international franchise that the research is concerned with and only its figures for the financial years 2017 and 2018 are analyzed.

Costs related to the supplier choice and opportunity costs of finished goods sold at a discounted price because of sales estimations are excluded from the calculations. Similarly, the opportunity cost calculations for insufficient stock is ignored. Figures for the restaurant's financial years 2017 and 2018 are analyzed. The thesis does not offer suggestions on product pricing based on the results nor does it focus on risks associated with inefficient inventory management practices.

1.4 International Aspect

The commissioning company is a multinational company that operates in more than 40 different countries (Restaurant X 2017, 4) and its official working language is English. Secondly, the issue of inefficiencies in the inventory management practices is not restricted within Finland. Also, I am an international student conducting a research in Finland.

1.5 Benefits

The direct benefiting party is the commissioning company. By determining the costs of inventory management, the restaurant management will be able to address the topic and take well-informed actions. Also, the restaurant can monitor inventory management efficiency in the future by using the efficiency metrics from this thesis, if not already used. Implementing appropriate actions is expected to reduce costs in the long run, thus increasing the restaurant's efficiency and profit. If proven that the inventory management is inefficient, other restaurants of the same franchise might consider evaluating their processes, too.

Efficiency can have a positive impact not only on the company's financial figures but on the employees and customers' satisfaction. Ideally, the lead time of the goods arriving to the store until they are brought to sale will be reduced. The employees would devote that

additional time to other areas, such as better customer service. The customers can also enjoy indirect benefits of a better flow of goods in the restaurant. For example, if proven that the current practices inflate the product prices, actions might be taken to correct those and possibly reduce the sales prices for the customers.

The company focuses on the development of its employees, so this project is also a way of the company supporting my career development in my field of specialization. Throughout the research, my knowledge on business management and inventory management has improved.

Finally, the university is another shareholder since this is a commissioned thesis. The thesis fulfils the requirements to be considered a research and development activity conducted on behalf of the university.

1.6 Key Concepts

Inventory management is “the process of ordering, storing and using a company's inventory” (Investopedia 2018).

Inventory control “includes the functions of inventory ordering and purchasing, receiving goods into store, storing and issuing inventory and controlling levels of inventory” (BPP Learning Material 2017).

Raw materials are goods included in the inventory of a business and have not been modified after delivery (Solution Matrix Limited 2018).

Finished Goods are goods that are produced by the company from raw materials and they are available for sale (Solution Matrix Limited 2018).

Economic Order Quantity (EOQ) is a mathematical model normally used to determine the number of units a business should order (Solution Matrix Limited 2018).

Work In Progress Inventory considers goods that are not yet finished but partially modified (Solution Matrix Limited 2018).

Cost of Goods Sold is defined as the “direct costs in producing a good or providing a service” (Corporate Finance Institute 2015).

FIFO (First In First Out) describes the flow of inventory in a company where the goods purchased first, are used first (Solution Matrix Limited 2018).

Pull model is the inventory control system where a customer order initiates production (Business Dictionary 2018).

The reorder point is the point at the inventory levels of an item that triggers the purchase of new inventory. The purpose of a reorder point is to be able to receive new inventory of an item just as its last unit is used up. (Bragg 2018, 3.)

1.7 Risks

One of the risks involved in conducting the thesis is resources. In the beginning stages of the research, there was the uncertainty of the usefulness of available resources. There was no information on what inventory systems of the company or the tools used. Therefore, it was unknown how detailed or difficult to use the tools and systems are. This risk was avoided by asking for information about the system prior to data collection.

Retrieving the figures necessary to the investigative questions is a challenge as well. The company has numerous figures, data, and reports on hand. Getting access to the system and finding the required data might be tricky. A knowledgeable person who is comfortable with the system and the figures and willing to contribute to the research is needed for this risk to be avoided. The Operations Manager has been extremely helpful on this since the start.

Another risk involves the cooperation of the commissioning company. Managers have little time to spare for interviews so arranging and participating in a meeting needs proactive planning. The risk of not being able to arrange a time with all targets exists. It can be eradicated by sending the invitations to the target interviewees well in advance. Also, alternatives to face-to-face meetings are offered, such as email exchange and phone call.

As mentioned, the figures for the last two financial years are used. Doing so enables comparison since a point of reference is used. However, this might not be enough to base conclusions on reliably. Industry information can be used to give an external perspective. Another risk associated with using industry information is the reliability of the sources. Although the information will be used, it will be done so with critical thinking.

1.8 Case Company

Restaurant X will remain anonymous throughout the thesis.

In 2017, the company in question was present in more than 300 locations in over 20 countries worldwide. For the same period, the restaurant franchise in question had more than EUR 1.5 billion turnover. (Restaurant X, 2017.)

Restaurant X has been operating for about 20 years. The restaurant offers a wide selection of goods and most of them are promptly available to the customer. The food offerings are “fast” in that sense. The restaurant’s main sales are derived from the food sales. There is usually little preparation needed after these goods arrive at the store and before they are made available to the customer. Served foods are frozen so production mainly involves heating in ovens. Another part of the sales is formed by selling sealed goods and foods. When these arrive at the store, they are already packed but employee place them on display. The other area of sales involves the staff restaurant. The food served at the staff restaurant is prepared by Restaurant X’s chefs and the menu changes daily. Food preparation is involved and the nature of goods that are ordered depend of the week’s menu, which is planned by Restaurant X’s chefs.

According to the interviewees, the range of Restaurant X consists of about 1500 different products. Restaurant X deals with 4 vendors who supply the company’s entire selection. The restaurant employees about 50 people.

2 Inventory processes behind a restaurant's counters

This chapter aims at exploring theories and exemplars of cost-efficient inventory management processes as well as methods to measure efficiency. Initially, two common classification tools are presented followed by an introduction on the costs associated with inventory management processes. Later, the Economic Order Quantity Model is explained and a variation for perishable goods is introduced. The core of the theoretical framework consists of a description and analysis of each of the inventory-related processes from a cost-efficient point of view. Finally, inventory management efficiency measurement methods and an analysis model are examined.

Prior to exploring the topic in depth, figure 1 shows the accounting terms "raw materials", "work in progress", and "finished goods" that are used in accounts in the double-entry bookkeeping. The raw materials inventory refers to all materials that are stored until needed, the work in progress inventory includes all products that are being worked on, and the finished goods inventory shows all finished goods available for sale. (Braun 2015, 124.) Figure 1 introduces some inventory-related concepts, which are explained more in the following subchapters.

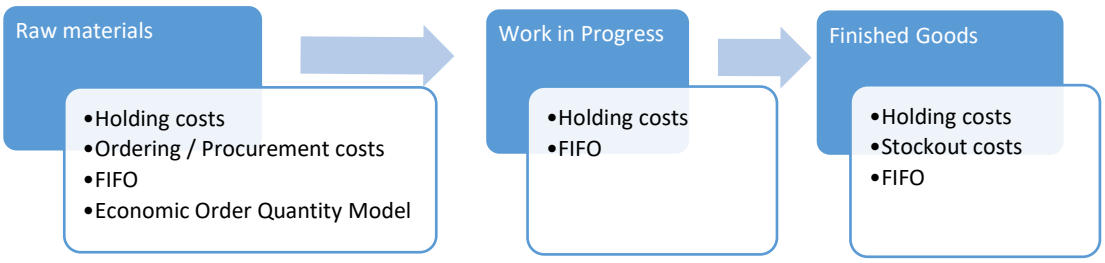


Figure 1: Illustration of the inventory process and associated concepts

A simplified version of inventory steps includes the purchase requisition, purchase order, reception of goods, storage of raw materials, and inventory count (stocktake). The purchase requisition is a document issued by the department which needs further inventory and sent to the purchasing department to perform the purchase order. The purchase order is sent to the supplier by the purchasing department. The carrier delivers the goods and the store receives them. During this step, a delivery note and a goods received note are involved; the first one is signed by the storekeeper for the carrier and the latter is prepared by the storekeeper and sent to administration. The raw materials are

stored until moved to work in progress or directly to finished goods. The inventory levels are checked at a certain day on a regular basis depending on the company's needs, by doing a physical inventory count. (BPP Learning Media 2017, 100-123.)

Inventory management in the restaurant business is highly dependent on the expiration date of the raw materials and the finished goods. The FIFO system (First In First Out) is an inventory management system applicable to the food industry (Braun 2015, 124) and thus to Restaurant X. Therefore, since the FIFO method is an inseparable part of the inventory management for Restaurant X, it is considered throughout the thesis.

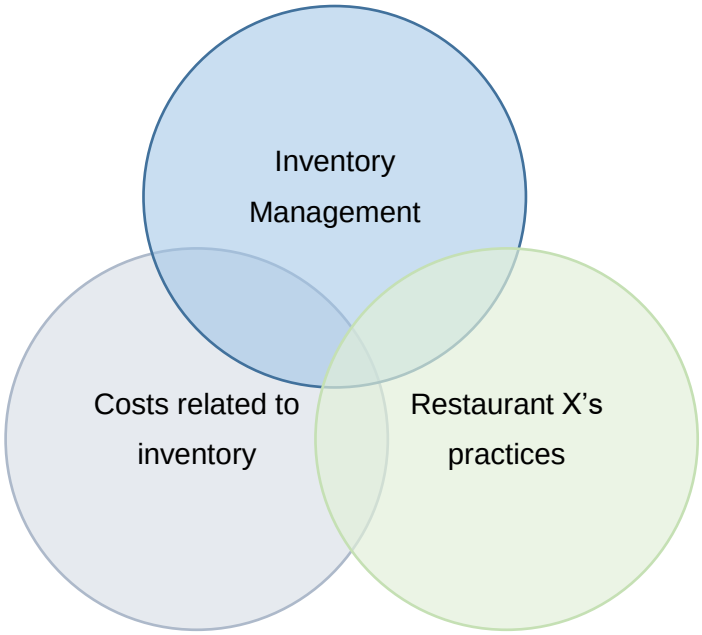


Figure 2. Theoretical framework of the thesis

Figure 2, depicts the interrelation of the main topics which are related to the topic. Inventory management theory and models are important to understand before starting the research. Secondly, a good understanding of the costs that are included in the area of inventory is required (for example holding costs, ordering costs, stockout costs). Lastly, practices applied to Restaurant X should be considered, for example the FIFO method.

2.1 Inventory classification tools

Inventory can account for a humongous portion of the expenses of a product-based business. The meaning of the size of the inventory is not restricted to financial terms; a goods-selling company can possess large amounts of physical inventory, which comprise of countless different products. Managers and analysts might face difficulties analyzing profitability and inventory efficiency for each product in the company's selection.

Therefore, classification methods are useful. Two widely used analysis methods are the ABC and the FSN analysis.

The ABC tool segregates the stock materials into three groups, A, B, and C, according to the proportion of expenditure and transactions. For this model, the relation between the usage rate and cost attached to the inventory is considered. This means that if items which represent a small portion of the inventory are responsible for a large proportion of value of inventory, they will belong to category A. Inversely, items which represent a great part of inventory but a small portion of value, they belong to category C. The company can apply this method and determine the percentages to satisfy its business structure. Preferably, this method is implemented using projected transactions rather than historical data. (Bragg 2018, 188.) An example of the percentages is shown on table 1.

Table 1. ABC classification example

Category	% inventory value / expenditure	% transactions
A	5	75
B	25	20
C	70	5

The FSN analysis classifies the goods of a company based on their sales speed and is an acronym for Fast-moving, Slow-moving, and Non-moving inventory. This tool can prove useful for companies that have a vast number of resources and spare parts with evidently different usage rates. The company can decide the upper and lower limits for each category to fit its needs. In general, the fast-moving category will consist of items that are frequently picked for sales or production. Goods with lower usage rates will belong to the slow-moving group and the non-moving category should expose the items that have not been used at all during the period of study. This classification method can assist in controlling the levels of inactive components in the warehouse. (Westford University College 2016.)

The analysis tools can be used both for financial analysis and as a base for warehouse layout planning. For example, slow-moving goods should be placed farther in the back on the warehouse, giving space to fast-moving goods (Westford University College 2016). This should save labor time and costs. Similarly, goods which are given the A classification should be placed at an easy reach (Bragg 2018, 188).

2.2 Cost groups in inventory processes

Both ordering and holding inventory induce costs to the company. The costs related to ordering inventory are clerical and administrative costs, transport, and production run costs. Clerical and administrative can be the costs of creating the purchase orders, receiving the goods and accounting for them. Transport costs are inbound freight costs typically agreed upon with a logistics carrier. Production run costs appear when inventory of an item is produced inhouse and all production costs are included in this category. (BPP Learning Media 2017, 109.)

Holding costs, as mentioned, are costly for a company. Considering that this activity is done inhouse, the costs related to holding and storing inventory can be classified as one of the cost categories listed here. There are described below and defined as fixed or variable costs, depending on their relation to the increase of inventory held. According to BPP Learning Media (2017,109) and Bragg (2018, 178-179), the cost of storing inventory can be simplified into the following categories:

- Storage costs
- Cost of funds
- Insurance costs
- Risk of obsolescence

Storage costs cover costs of the warehouse and its maintenance. Such costs can be rent, building depreciation, heating, electricity, utilities and their depreciation. An important part of this cost category is expenses to insure the premises. These are mainly fixed costs since they do not increase with the number of stored goods. (Bragg 2018, 178.)

Purchasing inventory requires cash or cash equivalents. When this inventory is held, the cash is still tied to the inventory. With cash and cash equivalents comes the interest in borrowing and saving. By holding inventory and, consequently, the cash tied with it, the company has fewer funds to pay off the dept and the interest charged with it. On the other hand, if the company does not have a loan to repay, the funds sitting with the inventory could have been deposited to the bank, thus, carrying interest income. This is also known as the opportunity cost of purchasing safety stock, meaning giving up the benefits of one alternative to choose another (Business Dictionary 2018). The costs of funds will be greater, the more inventory is held, thus it is a variable cost. (Bragg 2018, 178.)

The first category (storage costs) covers insurance expenses for the building. However, inventory can be also insured. Further costs include risk management systems against fire, burglary, and other unexpected disasters. Insurance costs are mainly fixed costs, too. (Bragg 2018, 178.)

Risk of obsolescence means that the quality of the inventory might deteriorate over time or it might be less relevant (Bragg 2018,179). Companies choose not to sell inventory that does not reach the appropriate standards for legal and marketing reasons. In the restaurant business, health reasons are also involved since most of the goods are perishable.

Holding and ordering costs should be tracked and analyzed when determining the costs of inventory. Those are indirect costs that can inflate the total inventory costs without management being aware of it. It is important to investigate these costs on a regular basis to ensure they remain within the acceptable levels.

2.3 Economic Order Quantity Model

Inventory demand for a good can be expressed in two ways; as dependent and independent demand. The first one refers to a good whose demand is dependent on another good's inventory levels and the latter is independent of other items as the customers define its demand. Demand planning would be different in each case. (Bragg 2018, 2.)

When and how much to order is a challenging question for companies with inventory. To find out the reorder point for an item, its average daily usage rate should be multiplied by the lead time for replenishment in days. According to the definitions "independent inventory demand" and "the reorder point" given, the reorder point can be used for items whose inventory demand is defined as "independent". (Bragg 2018, 3.)

Another important issue with using the reorder point formula is that the average daily usage rate will vary from the actual rate. For this reason, another factor, the "safety stock", is added to the equation. (Bragg 2018, 4.) Safety stock is the predetermined amount of on-hand inventory held by the company in case demand exceeds the average levels (Bragg 2018, 3).

As long ago as 1913, in Chicago, Ford Whitman Harris published the EOQ model and formula in a paper in Factory, The Magazine of Management (Erlenkotter 1990, 937). The Economic Order Quantity (EOQ) is a traditional inventory model which determines how many units of inventory to be ordered bringing the lowest possible inventory-related cost to the buyer. The model considers two types of costs; ordering and holding costs. Ordering larger quantities of inventory, reduces the cost of ordering. However, placing larger orders increases the holding costs because, for example, a bigger storage area is required. The purpose of the EOQ model is to define the quantity of inventory units for which inventory costs are the lowest possible. (Mowen, Hansen & Heitger 2015, 354-356.)

For calculating the EOQ, the ordering cost, the holding cost and the average number of units in inventory are needed. The model involves two cost areas; the ordering and carrying costs. The ordering cost is calculated by multiplying the number of orders per year by the cost of placing one order. The cost of placing one order should include all relevant costs discussed in chapter 2.2. It is important to clarify that the cost of inventory should not be included. Those would be inventory expenses and are not related to the ordering costs. (Mowen & al. 2015, 354.)

The holding cost can be found by multiplying the average number of units in inventory by the cost of carrying one unit of inventory. The average number of units in inventory is defined as half the number of units that there is in one order. This is because the model assumes that there is no safety stock in the inventory calculations. (Mowen & al. 2015, 354.) The formulas are summarized in Figure 3, which is adapted from Mowen & al. 2015.

$$Total\ Inventory\text{-}Related\ Cost = Ordering\ Cost + Carrying\ Cost$$

$$Ordering\ Cost = Number\ of\ Orders\ per\ Year * Cost\ of\ Placing\ an\ Order$$

$$Average\ Number\ of\ Units\ in\ Inventory = \frac{Units\ in\ Order}{2}$$

$$Carrying\ Cost = Average\ Number\ of\ Units\ in\ Inventory * Cost\ of\ Carrying\ One\ Unit\ in\ Inventory$$

Figure 3. The formulas required for determining the EOQ (adapted from Mowen & al. 2015)

The Economic Order Quantity in a scenario can be calculated by using the formula seen in Figure 4.

$$\mathrm{EOQ} = \sqrt{\frac{2\,C_O D}{C_H}},$$

where C_O = Cost of Ordering Inventory,

D = Expected Demand for a product over the period in question

C_H = Cost of Holding Inventory

Figure 4: Equation for determining the EOQ (adapted from BPP Learning Media 2017)

The values of the equation's radicands in Figure 4 can be found by using the equations in Figure 3. The radicand *D* is estimated by the company according to expectations which are often based on past years (Mowen & al. 2015, 354). The result of the equation is expressed in units and it represents the number of inventory units with the cheapest ordering and holding costs (BPP Learning Media 2017, 113).

The same result can be found by using a table for different order quantity scenarios but it involves more manual work. The same factors are taken into account but the table helps to see the bigger picture of how the inventory costs fluctuate with order quantity. The BPP Learning Media (2017,112) offers a good example of the use of a table for determining the EOQ. The example is adapted by changing the numbers and it is presented in table 2, below.

Table 2. Example of calculating the EOQ using a table with different order quantity units (adapted from BPP Learning Media 2017, 112)

Order quantity (units)	10	20	50	70	100	150	200	250
Average inventory (units)	5	10	25	35	50	75	100	125
Number of orders	500	250	100	71	50	33	25	20
Annual holding cost (€)	125	250	625	875	1 250	1 875	2 500	3 125
Annual order cost (€)	15 000	7 500	3 000	2 143	1 500	1 000	750	600
Total relevant cost (€)	15 125	7 750	3 625	3 018	2 750	2 875	3 250	3 725

Annual demand	5 000
Holding cost/unit (€)	25
Ordering cost/unit (€)	30

All items in table 2, except for “number of orders”, can be calculated given the formulas from figure 3. The number of orders is equal to the number of units of annual demand divided by the number of units per each order (BPP Learning Media 2017, 112).

The example in table 2 examines different scenarios of ordering quantities, ranging from 10 to 250 units carried per order. The average inventory changes according to the quantity ordered, thus ranging from 5 to 125 units. The annual demand for the units in question was estimated to be equal to 5000 units. In order to meet the annual demand, the first case would need 500 orders with 10 units on each of them. Similarily, the final scenario in the example would need 20 orders of 250 units in each order.

Earlier, it was mentioned that the more frequent the orders are, the more expensive the ordering costs will be. On the other hand, the less frequent the orders are and, as a result, the more inventory is held, the higher the holding costs will be. This trend can be seen in table 2, where the annual holding costs increase with an increase in ordering units and the annual order costs decrease with an increase in order quantity.

The economic order quantity in this example would be 100 units per order. According to this model, ordering each time 100 units will bring the least amount of inventory-related costs compared to the options given as order quantity. Using the formula given in figure 4, the EOQ for this case is 110 units. The table method gives the best option out of the ones that were defined as order quantity but not necessarily the correct answer.

2.4 Economic Order Quantity Model for perishables

The Economic Order Quantity Model explained in chapter 2.3 restricts its use in the business life because it takes into account only a few parameters. There have been many attempts to improve that model and develop one that depicts the inventory conditions in a real market. One of the topics of interest has been EOQ for perishable items.

According to the Financial Times Lexicon (2018), perishable goods are “Goods such as food products that must be used within a short period of time”. Generally, these goods have a restricted life cycle so demand for them changes with time. However, the basic model assumes a constant demand for the goods in question. This thesis is looking at the inventory of a restaurant, where most of the goods are perishable, therefore it is important to offer an appropriate approach.

During the Fifth International Workshop on Computational Intelligence & Applications in Hiroshima University in 2009, Ibraheem Abdul and Atsuo Murata presented their variation of the EOQ model. However, various researches and mathematical models have preceded Abdul and Murata's Conference Paper. The development of an EOQ model adapted to perishables was initiated by Ghare and Schrader in 1963 with a static demand. Later, the first model recognizing demand as dynamic was developed by Dave and Patel. The model was gradually modified by other researchers, each time narrowing the gap between theory and real life. There have been many attempts to reflect the demand fluctuations of perishable goods into the EOQ model, with most of them assuming two stages of demand; the growing and stable one. (Ibraheem & Murata 2009, 158.)

However, in most inventory situations demand for perishable goods increases in the beginning of their life cycle, stabilizes in the middle and declines at the end of their cycle (Ibraheem & Murata 2009, 159). Take cinnamon buns as an example. In general, the demand for cinnamon buns, ceteris paribus, is at its peak when they are freshly baked, after which demand settles at a more stable rate. After a few hours and towards the end of their life cycle, the cinnamon buns have become hard and they do not reach the customers' expectations anymore causing the demand to drop. This is a simple example showing that there might be more than 2 stages in the demand patterns.

Abdul and Murata's Conference Paper offers one of the EOQ variations with a 3-stage demand. In the model, different replenishment periods are allowed and equations for four demand patterns are created. The first demand pattern equation is meant for a constant demand. The second one is suitable to situations where demand changes from increasing to constant. The third pattern can be used when a constant demand starts declining. Last but not least, the fourth pattern combines the constant and declined demand during the same replenishment period. The formulas and instructions using a solution algorithm are also provided in Abdul and Murata's paper. (Ibraheem & Murata 2009, 159-160.) However, the equations are highly scientific and they exceed the scope of the thesis.

2.5 Materials planning and forecasting

Materials planning is based on product sales forecasts by the sales department. These forecasts are developed based on previous sales data and expectations of customer behaviors. A situation where the sales data match exactly the budgeted data is extraordinary. This implies that the planning of the materials does not equal demand but it either exceeds it or does not fulfil it. Therefore, the company will either have excess inventory or lost revenue from missed sales. (Bragg 2018, 22.)

In other words, the company faces both financial and opportunity costs. Ending up with excess inventory is especially risky for companies in the restaurant business because of the limited life cycle of the goods. If production is involved in the in-house inventory process, overestimating demand will result in higher work-in-process (WiP) inventory. Investing a large amount of goods in the work-in-process state complicates the processes and a list of risks are involved. It translates to an amount being locked up as working capital. Work-in-process inventory occupies working space that can be used for goods that are in demand. Also, there is a higher risk for the goods to get damaged or for their quality to get deteriorated. Another difficulty with having extra WiP could be inventory tracking. (Bragg 2018, 32.) This can happen if a component-specific monitoring system of the production line is not available. In the restaurant industry, work-in-process inventory ought not to be sold if the goods, stored in a refrigerator, are processed in room temperature for more hours than laid down by the Department of Food Hygiene and Environmental Health. Inventory becomes obsolete and the company is making a loss (Bragg 2018, 37). A more extended discussion on the advantages of controlled WiP levels will be held in chapter 2.9.3.

Work-in-process inventory can be reduced by controlling the number of jobs in the production. This is because increasing the number of simultaneously occurring jobs, increases the amount of raw materials used and, consequently, the risk of them becoming obsolete, leading to higher inventory costs. Another way in which the materials planning process can get more cost-efficient is by improving its forecasts. Forecasting sales in the near future is more reliable than doing so for sales much later. The more accurate the forecasts are, the more cost-efficient the materials planning process will be. (Bragg 2018, 38.)

For accurate materials planning, the Bill of Material (BOM), a list of contents put into a final product, is carefully used so that all materials, both dependent and independent are included in the forecasts. The purpose of this step is to ensure that there are no bottlenecks in the production. Furthermore, production can be negatively affected by lengthy lead times for components and suppliers. The lead times should be included in the materials planning process as well. These can be obtained by asking the suppliers about either lead times or estimated time of arrival (ETA) for products with sourcing difficulties. Another factor to be considered when forecasting is supplier agreements for volume discounts. Utilizing such agreements should be planned to decrease cost of goods sold and increase profitability. In addition to the lot-size agreements, any buffering policies should be included in the materials planning procedure. Peak periods should be

identified and distinguished in the plan. (Heisig 2012, 8.) Recognizing these reduces the element of surprise and increases the inventory control levels.

To sum up, materials planning and forecasting can be a daunting task which will not exactly match actual figures. Although this is true, it does not equal that the task is unnecessary. On the contrary, materials planning and forecasting is the core of production and should be completed with caution. The results will not be useful unless the task is completed in detail and is considering multiple plausible parameters. Businesses should dedicate a reasonable amount of resources to this task because the costs of unpreparedness can end up being higher.

2.6 Purchasing activities

In a departmental organization, a manual purchasing process starts by filling out a purchase requisition which goes through the purchasing department for approval where the details and pricing are checked and then a purchasing order is issued. Even though this description is simplified, it involves the collaboration of different departments which slows down the purchasing process. (Bragg 2018, 42.)

Time equals money in inventory management, so companies strive to expedite the process by automating some tasks. For example, the purchasing requisition can be substituted by an automated alert for when inventory levels of an item are below a certain amount. In addition, the purchase ordering task can be faster by sending automated purchase orders to the suppliers when the on-hand inventory reaches a level. A material requirements planning (MRP) can be built on a software that combines inventory-related information for all of the company's products. For the most efficient use of an MRP software in terms of inventory, information about the supplier lead times should be entered to be taken into account before sending the purchase order through the software. (Bragg 2018, 42.)

One of the purchasing department's tasks is to evaluate the suppliers. Some evaluation key indicators are the unit price quoted by the supplier, the quality of the goods, and the lead times and punctuality of the provided Estimated Time of Arrival (ETA), just to name a few (Bragg 2018, 51). From a financial point of view, the unit price is not the sole indicator of the supplier cost. Freight costs and customs, in case of imports, contribute highly on the total cost of the unit and they must be included in the indirect costs of the product. Freight costs and customs duties are charged per order so that cost should be divided by

the number of units in the order. (Bragg 2018, 39.) Customs duties should be followed up because they can change according to political and economic country relationships.

Furthermore, suppliers might charge the cost of stencil purchases that are used for a specific product of their customer. These costs should be included in the calculations and amortized over the estimated production units. Among the other costs that should be included in the supplier cost calculations are hedging and holding costs. Hedging costs concern companies that have transactions with at least one foreign currency. (Bragg 2018, 39.)

Hedging is a way of managing currency risks, which are risks that affect revenues and expenses and are initiated by adverse exchange rate fluctuations. A company purchasing inventory in a different currency undergoes the risk of paying more because of a change in the exchange rates. Adopting hedging strategies can be expensive and their effectiveness depend on the case. (Laing 2018.) If the business has evaluated that hedging is beneficial, the hedging costs must be included in the supplier cost determination. The costs that arise when storing excess inventory, as explained in chapter 2.2, are part of the supplier costs. A company might choose to store more inventory to minimize the freight costs and to take advantage of volume purchase discounts. From this point of view, the purchasing department will aim at narrowing the supply chain to maximize the amount of purchase discounts. (Bragg 2018, 46.)

In general, a tight supply chain is preferred because the company can exploit volume discounts and achieve greater control over the suppliers. Shifting away from the traditional purchasing activities by automating several parts of the process can increase purchasing efficiency. Purchasing efficiency can be increased by automating the processes of sending purchase orders when stock reaches a certain level acknowledging the lead times for the deliveries. Other examples include automation of delivery notifications, invoicing and paying. Evaluating suppliers, their costs, and adherence to contracts should be done regularly to identify possible mishandlings and to fix them. Another way to increase purchasing efficiency could be by implementing vendor-managed inventory (VMI), which allows the supplier to monitor and place orders, following an agreement. (Hugos 2018.)

2.7 Inventory receiving

The inventory receiving process involves receiving ordered goods at the premises, removing the goods from the receiving area, and updating the inventory levels in the

company's system. Inefficiencies can appear in any of those steps and increase the total cost of inventory management processes. A well-organized system is needed for this process to be performed in the most cost-effective way. (Bragg 2018, 53.)

One of the steps that increases the cost of the process substantially, is the number of inventory touches. The ideal process minimizes the number of received inventory handling and avoids temporary storage until the goods are moved to the location where they are eventually picked and used. Unnecessary inventory touches waste the time of the respective employees and increases the risk of inventory obsolescence. In addition, incorrect or non-existent prioritizing can create unnecessary inventory touches or even shortages. (Bragg 2018, 53.)

The information that needs to be input in the company's system, such as the name, quantity, weight and date of the delivered goods, should be mentioned on the labels of the arriving goods. This needs to be done as soon as the goods arrive so sales can occur with up-to-date inventory levels. The importance of the data recording is reflected on the process of the receipts inspection. Inspecting inventory is important to assure that the correct quantities are being delivered and to control the quality of the goods. Inspecting all the goods at the receiving area can cause bottlenecks. It is generally uncommon to receive different amounts, so companies decide to undertake the inspections in a different manner; setting the inspection priority for the suppliers with the largest number of delivered items in the company and reviewing historical data of returns to those suppliers. This method fits best suppliers high in the company's supply chain. (Bragg 2018, 57.)

Having a well-planned receiving process starts with efficient space planning that enables smooth routing of the delivered goods. Also, being prepared for when big shipments arrive is helpful. This can be done by arranging the delivery of an advance shipping notice (ASN) which is sent from the supplier when the goods are headed to the company. Other areas where inventory costs can be reduced considerably involve assigning the dock door with the shortest distance to the destination of the received goods and planning the time of the deliveries with consideration of the unloading times. (Bragg 2018, 55.)

A highly important factor to increase efficiency in receiving, putaway, and picking, is warehouse housekeeping. Although it sounds rather simple, employees tend to forget or ignore the concept. Toyota developed the 5-S approach to improve housekeeping and cleanliness on the production floor. The concept can be applied to any system to improve organization. The 5-S approach is a continuous process which includes five steps; sort, straighten, shine, standardize, and sustain. Sorting inventory by analysis categories, like

the ABC or FSN methods explained, is one step. It also suggests handling inventory obsolescence as soon as it appears. The next step is straightening inventory and data. Keeping the warehouse neat and organized by straightening the pallets and boxes can have a greater effect than expected. Educating employees to keep the goods organized should teach discipline to handle inventory with care. The third step, shine, refers to cleanliness. Raising the standards for cleanliness is the first step to achieving this. The next S refers to standardization, which reflects the importance of having the same level of organization everywhere because following the 5-S process is easier for the employees. The last S stands for sustainability. The improvement processes need to be maintained once implemented. Appropriate training and implementation of the 5-S method can result in a highly efficient inventory management process. (Sheldon 2008, 14 – 20.)

The key take-away from this subchapter is that efficiency can be increased if the number of inventory touches is reduced. The risk for obsolescence increases with every touch. Managers and employees should question what value each touch adds to the final product. Answering this question together with proactive planning should seed the mindset of moving efficiently around the warehouse. (Goldsby & Martichenko 2005 ,52.) The other take-away is that great focus and caution should be given to the warehouse housekeeping when aiming at increasing inventory management efficiency.

2.8 Putaways and picking

A great portion of warehouse costs comes from putaway and picking tasks. Putaway tasks involve moving the inventory, once received, into the warehouse. (Bragg 2018, 68.) Picking is the act of picking the inventory from the warehouse and moving it to the next location, possibly either the production or the shipping area (Bragg 2018, 70). The level of efficiency with which these tasks are undertaken has a significant impact on the costs of inventory processes (Bragg 2018, 83).

The main costs associated with these tasks are labor, equipment, and storage-related costs (Bragg 2018, 62). Time is a factor for an increase in the labor costs. Using the appropriate equipment for moving inventory improves the workflow by saving time, utilizing purchased warehouse equipment, and ensuring operational safety. Warehouse costs depend on the size of the area and how the warehouse layout plan contributes to the staff time.

There is a wide range of warehouse equipment in the market with broad-spectrum functions and a variety of prices. The equipment can be non-motorized, semi-automated

and fully automated. The turn to automation is a growing trend because companies realize the long-term benefits of such an investment. One of the many applications of warehouse automation is known as automated storage and retrieval system (ASRS). (Bragg 2018, 65.) According to the IBM knowledge center, the term ASRS describes a materials handling system which is programmed to move, store, and retrieve inventory as designated (IBM Knowledge Center 2013). Automating the putaway and picking functions leads to a lower need for employees, reducing labor costs. As mentioned in chapter 2.7, the smaller the number of inventory touches, the lower the risk for damages. Since automation reduces the inventory touch count, it can reduce waste from accidents. (Bragg 2018, 65.)

Applying automated systems and appropriate equipment can contribute to utilizing warehouse space with efficacy. The system can store inventory physically higher than a person would, thus leading to more economical inventory deposits. (Bragg 2018, 65.) Victor Coronado (13 November 2015), current Director of Supply Chain and Operations at The Onyx Company, writes on one of his LinkedIn articles that maximizing the use of the storage space should be a primary objective for increasing efficiency. He also adds flexibility in the warehouse plan to the list of objectives because purchased materials and priorities change according to the business's needs. (Coronado 13 November 2015.)

It is common that the needs of a business follow the demand patterns defined by the customers and the market. That being said, it is reasonable to plan the warehouse activities according to the demand patterns. Some goods are demanded more often than others meaning that they have to be picked up from the storage more frequently than the others. To speed up the picking process, the putaway method needs prior planning fulfilling the picking requirements. A common putaway method is by usage frequency. This method suggests that goods that need to be accessed most frequently will be placed at the front of the warehouse, whereas goods used and demanded rarely are moved to the back of the space. Such an orientation can save staff time allocated to picking tasks. (Bragg 2018, 68.) However, frequent changes in the placement of the goods without proper information flow might cause confusion to the staff.

Coronado (13 November 2015), in his article on warehouse efficiency, suggests classifying inventory based on movement velocity, from A, for fastest, to C, for slowest. Then, the frequency-based putaway method can be based on this classification. However, this requires an in-depth analysis of all inventory items based on current inventory levels, as well as historical and future sales by item. (Coronado 13 November 2015.) Bragg (2018, 70) notices how the ideal putaway and picking methods differ from case to case. If

the company follows a pull model, picking inventory can be done by order, zones or even experience levels, just to name a few.

All the aforementioned methods can be criticized for their efficiency. However, they can be used combined with other methods. Picking inventory by order is not ideal for orders that contain only one item. In this case, all orders holding one item can be collected and fulfilled in one go. (Bragg 2018, 71.) Picking by zones is done by electronically merging all orders into a master one and separating it into zones based on the physical location. Those items are picked, moved to a different location to be assigned to their orders and then shipped. This method is particularly efficient on large scales but not otherwise. (Bragg 2018, 73.) Finally, assigning putaway and picking tasks to the most experienced employees has been proven more efficient than doing so for newer ones (Bragg 2018, 75). However, this means that the business relies on the most experienced employees, which can be harmful in the long term unless new ones are sufficiently trained.

These questions can be considered by a warehouse management system (WMS) which advises the staff what the best location to store received inventory is. The purpose of WMS is to maximize warehouse space utilization. Packaging dimensions and an accurate inventory record are prerequisites for this dynamic putaway method to succeed. (Bragg 2018, 68.)

Investing in automated solutions, such as the automated storage and the dynamic warehouse system, requires large capital for acquisition, maintenance and staff training. In small volume businesses, the costs of adopting automated systems might surpass the benefits. Once the capital has been invested and the automated system is operating it is difficult to return to traditional ways, since the costs would be massive. (Bragg 2018, 65.)

A conjoint part of putaway and picking is the replenishment strategy. This step exists when there are more than one storage areas for each item, for example the main storage and the quick-access one. If a production step is involved, a quick-access storage is usually located close to the production area. There are different ways in which the replenishment task can be completed. The simplest and least efficient way is to fill the quick-access stocks when they are empty. This is inconvenient because it results to unpleasant surprises and delays. Some companies choose to replenish the smaller storages at pre-decided intervals. Reserving specific time slots for replenishments is not ideal because this does not take into account inventory levels. Another method is refilling the smaller storage when the inventory level of an item is critically low. This is based on human judgement and it requires an employee to realize the need and take action.

Finally, another method is automated; a system which sends a notification to the staff that the inventory level of a certain item is low. Although the last method is the most reliable one, it requires perfect inventory record accuracy and might not be applicable to all inventory types. (Bragg 2018, 81.)

All in all, automation can have a positive effect on the putaway and picking process by increasing efficiency and reducing costs. Planning putaway methods in a way that satisfies inventory flow requires detailed product analysis and it is a method to improve efficacy. In general, the picking and putaway methods should be determined per case as there are various factors affecting the outcome.

2.9 Production and Inventory

If any of the received inventory items must undergo a modification or manufacturing process before it can be sold, production takes place and costs are induced. The production strategy can help define the process strategies described previously. Designing an efficient production process can have the side-effect of lower stock requirements and a smaller warehouse, reducing the costs associated with them. On the other hand, producing with no planning can result in high amounts of factory overstock and higher obsolescence risk, eventually increasing stock and warehouse costs. (Bragg 2018, 84.)

The two common production systems are the pull and push systems. These two concepts are important when studying inventory management processes. The difference is that the push model is driven by forecasts, whereas the pull system is order-driven. (Bragg 2018, 85.) This subchapter attempts to distinguish the push from the pull system and discusses the effects of WiP cap, which is implemented in a pull system.

2.9.1 Push system

In a push system, units are produced to match forecasts. That being said, the probability of the number of units produced exactly matching the number of units demanded by customers is extremely low. Therefore, one of the inevitable effects of using the push model is the higher risk of obsolete inventory. (Bragg 2018, 85.)

Since a production process is the process of turning raw materials into finished goods, producing based on estimations will have an impact on the quantity and quality of raw materials. Overestimating demand will push the purchasing department to acquire more

stock, invest capital, warehouse space and personnel, which result in increases in costs and the risk of having obsolete raw materials. In accounting and supply chain management, the term work-in-process inventory is used to refer to the intermediate state of the goods in a production line (see subchapter 2.5). A production line consists of several jobs, each of them adding value to the final product. Since producing according to forecasts enables the uncertainty of facing demand, the production line remains active to avoid lost sales. This means that a number of jobs are already initiated while a finished good is produced, which can result in WiP inventory queueing up at each work station. The disadvantages of having large amounts of WiP inventory were discussed in chapter 2.5. In short, the longer the production line is, the higher the WiP inventory volume will be. (Bragg 2018, 85.)

2.9.2 Pull system

The pull system states that production is initiated only after an order is placed. Bragg (2018, 85) describes the pull model as produce-to-order model. The ultimate version of the pull system is the just-in-time (JIT) inventory system where the raw materials needed for the production line arrive on the exact moment they are demanded. The JIT and pull systems strive to keep the on-hand inventory levels low. However, a JIT system requires a massive investment and a complete alteration of the production system, where production starts only after an order is made. Bragg clarifies that using this system might result in bottlenecks in the production line during high demand times. Therefore, he continues, it is more practical to maintain a smooth production flow to create a buffer of finished goods. A purely pull system is extremely challenging to be configured and it is not common to exist. (Bragg 2018, 85.)

Bragg (2018, 86) describes a manufacturing process where WiP inventory is minimized to enable flexibility of orders. Production cells that consist of people and equipment handle the manufacturing of related products, which move from cell to cell to get modified. For a smooth transition, there needs to be minimal changeover time to avoid equipment and personnel downtime. An important factor in this issue is when goods arrive at the production cells. A Kanban can be used for this purpose. A Kanban is a system which does not allow the release of raw materials until the WiP levels are below the assigned limit. (Bragg 2018, 86.) Setting a cap in the number of goods in the work-in-process state has multiple advantages. Some of them are outlined in chapter 2.9.3, below.

On the contrary, Hopp and Spearman (2004, 133) warn their audience not to confuse the terms “pull”, “produce-to-order”, and “Kanban”. According to their definition, the pull

system is about maintaining a WiP cap on the production site. The authors conducted a literature research and found out that the misunderstanding comes from industry practitioners who attempted to explain the pull system in high-level terms. This resulted in associating the pull system with Kanban, which is only a specific practice of the system. Also, the attempt to offer a simple explanation of pull resulted in describing it as produce-to-order. According to Hopp and Spearman, the push/pull decision is a separate one from the produce-to-order/produce-to-forecast/produce-to-stock decision. Throughout the years, these terms have been used almost synonymously. To truly recognize the benefits of the pull system, it is important to realize the difference and to always define the pull system in terms of the WiP cap. (Hopp & Spearman 2004, 143.)

2.9.3 Discussion on WiP cap benefits

Some disadvantages of maintaining high levels of work-in-process goods were outlined in chapter 2.5. A more specific approach is taken in this chapter.

Some of the benefits of setting a WiP cap include reducing the average WiP level. (Hopp & Spearman 2004, 138.) According to Little's Law, "under steady state conditions, the average number of items in a queuing system equals the average rate at which items arrive multiplied by the average time that an item spends in the system" (Little & Graves 2008, 82). Thus, the average WiP levels should reduce the average time an item spends in the system, making the production cycle shorter, which can eventually lower production costs. (Hopp & Spearman 2004, 137).

Hopp and Spearman (2004, 137) support that by setting a WiP cap, the managers can achieve greater control over the production flow and the output levels. A smooth production process does not require high manufacturing overhead costs and saves employees and managers from unpleasant bottlenecks in production.

An orderly production line with quantity and time limits puts pressure for a zero-error production line because a mistake would cause a costly clog. Thus, there is an increased need for a detailed plan of the production flow. Also, as mentioned earlier, low WiP levels shorten the production cycle, thus, flaws can become visible at an earlier stage. In other words, costs stemming from errors occurring during production can be minimized. (Hopp & Spearman 2004, 137.)

Realistically, reducing the WiP level is not an easy task to implement. Problems will appear throughout the design process and possibly during the manufacturing process.

These problems, when solved, will contribute to a more efficient production flow with lower WiP and reduced costs. (Hopp & Spearman 2004, 137.)

The production model needs to be outlined and examined for inefficiencies. Although the pull system is more effective than the push system, it is difficult to be implemented. Companies may implement characteristics of the pull model to make some part of the process efficient. To absorb the most out of the pull system, it needs to be defined in terms of the WiP cap. Inventory management efficiency can be improved when a WiP cap is set. This method can be particularly useful for companies whose production process involves multiple serial jobs.

2.10 Obsolete inventory

Another topic, which is often an inseparable and inevitable part of the inventory process, is obsolete inventory. When talking about obsolete inventory, three topics should be considered; identification, disposal, prevention. (Bragg 2018, 111.)

Obsolete inventory is any item or product family that is no longer active or is active but will have zero demand in the future (Russell 2016). The identification of obsolete inventory should be done regularly to give room to usable supplies in the warehouse. Bragg (2018, 111). Some reasons for obsolescence are damage, demand overestimation, discontinued products, replacements, market changes, just to name a few (Russell 2016).

2.10.1 Identifying obsolete inventory

A common process to identify the obsolete inventory starts with assigning the task to the Materials Review Board (MRB), which has people from every inventory-related department; the warehouse, purchasing, engineering, production, and accounting departments. This coordination is suggested because the expertise of each department is needed to determine the best product-specific disposal method. For example, the purchasing manager knows that holding on to some inactive good is best because sourcing that item is particularly difficult and might be needed in the future. The engineering manager can decide to use those items for a product which is under development. The production manager can decide to use the inactive items as replacements if it will not make a critical difference to the final product. The accounting manager or business controller should be able to quantify the item cost. (Bragg 2018, 111.) In addition to quantifying the cost, the accountant or controller can immediately write

off the goods to avoid discrepancies with the stock balances (BPP Learning Media 2017, 108).

After deciding on the group, the rate of the reviews should be determined. Bragg (2018, 111) suggests the reviews take place at least once every three months and the MRB team sticks with the plan by including the event in the corporate calendar.

There are several ways to investigate the on-hand stock depending on the inventory control systems used. The best way requires a material requirements planning (MRP) system that can create a “where used” report. The report should list the spare parts and identify the final product they are included in. If the system does not identify a final product, then the spare parts should be evaluated for obsolescence. The system uses the Bill of Materials (BOM) so the BOM must always reflect reality. Another method is by the “last used” tactic. This can be a report of all items, their quantities and the dates they have been used. If it has been a long time since the last usage date, the item might be considered obsolete. However, it is important that the person evaluating supplies knows about sales plans because some items not used in a while might be needed for a later date. (Bragg 2018, 112.) This is common with seasonal products as companies utilize volume discounts and secure the goods long before they are sent to the market.

The two previous methods imply that an accurate inventory record is in place. Although this is not the case for all companies, it does not mean that only the companies with such records are able to and should investigate their inventories. A traditional method is the use of count tags. The count tags with a date can be attached to the products in the warehouse every time an inventory count occurs. If many months go by and the items are not being used, the count tag should still be on and that item can be investigated further. However, this involves more manual work and it is not reliable because the tags can be accidentally removed. In the case of neither software records nor inventory counts, the delivery dates on the boxes might shed some light to the investigation. (Bragg 2018, 112.)

Considering the restaurant industry, it has been mentioned that the FIFO method is required to be used. An indicator for the employees to store the goods, apart from the order of goods arrival, is the expiration date. It is possible, although rare, that even though a box of goods arrived later, they have an earlier expiration date. Thus, the putaway employees are required to take the expiration date into consideration and prioritize accordingly. Therefore, another practical way of investigating inventories in the restaurant business is by walking around the warehouse and looking at the expiration day of the first

item of each product group. Not only can you recognize the already-obsolete goods, but this method pushes for action for soon-to-be obsolete goods.

When the obsolete goods have been identified, a list summary with the warehouse locations, quantities on hand, descriptions of the goods, and total cost of the item's current stock should be produced. Management can sort this data by the item's total cost prioritizing the elimination of obsolescence of the most expensive goods. These reports will be used for determining disposal alternatives (see chapter 2.10.2). Finally, the decisions and the final report are sent to all MRB members to formalize the process. (Bragg 2018, 112.)

2.10.2 Disposing of obsolete inventory

Throwing away goods is one way to dispose of obsolete supplies. However, this might not be the only alternative available. There might be ways to still get a positive return on the investment unless the product and none of its parts can be used any more.

If customers order spare parts often, it is good to save some of the inventory as spare parts. In this way, the goods can be repaired without ordering few components. Another alternative is to sell it from a different location. The prerequisites for this method are that, firstly, the company operates in another location that transporting the goods does not threaten the profit margins, and secondly, that there is a higher demand for that product in that location. A different approach, which is familiar to consumers, is to include such items in a marketing campaign. Setting a lower market price, a discount, is a method to attract customers. (Bragg 2018, 113.) This method is widely used but it leaves the fate of the obsolete good on the consumers' hands, whereas the two previous ones are active.

In chapter 2.10.1, the importance of having representatives from all inventory-related departments in the recognition phase is important. This is reflected in the following method of disposition alternatives; product alteration. The engineer or R&D specialist might find value in the obsolete product. Some examples are utilizing existent resources for designing and prototyping, or the approval of that item's use in the production of an active product. Another, less common, way of disposing of inventory is returning it to the suppliers. This can be accepted by the suppliers if they apply a fee to the returned goods. The immediate effect of this action is that warehouse space is freed for storing active goods and no more assets are being allocated to inactive items. (Bragg 2018, 113.)

Another method involves trading with a third party. This usually happens by selling with large discounts. The third party functions as a reseller and buys large volumes so it is important to be cautious because similar product sales might be affected. There is another method which can be used if management has not succeeded in any of the previous methods or it fits the business idea; donations. Apart from the humanitarian and societal benefit this action has, the company can record the donations as a tax credit. The company needs to find a relevant non-profit organization, many of which accept foodstuffs, in the case of a restaurant business. (Bragg 2018, 113.)

There is some risk along with third-party transactions which can depend on the industry. For example, involving an unreliable third party while being in the electronics industry is risky because of copyrighting issues. A knowledgeable external party might investigate the product, alter it and resell it as a new one in an unregulated market. This is one of the reasons why some companies consider scraping or destroying their products. For scraping, the value of the metal is a big motif (Bragg 2018, 114). For destroying, branding can play a role. Companies that rely heavily on the power of their brand, cannot afford their brand to be resold at a price lower than the Manufacturer's Suggested Retail Price (MSRP). Last year, Burberry, a high-class fashion brand, destroyed obsolete products worth over € 30 million to "make its brand exclusive again" (BBC 2018).

It seems fair to say that all disposal methods mentioned have one thing in common; they aim at maximizing profit with the shortest holding times (Jones 2008, 160). This supports the theory of previous chapters on the holding costs. Management should give an end to the debate of holding on to obsolete inventory or disposing of it in a way that profit and holding time are considered.

2.10.3 Preventing inventory obsolescence

None of the methods described in chapter 2.10.2 are better than not needing to deal with obsolete supplies. Companies can plan how to treat obsolete inventories. This chapter is about how companies can prevent inventory from reaching the obsolete stage.

Proactiveness is the key action and it can take many forms. If there are products that undergo engineering modifications, for example to create a new, more-featured version, the stock of the components of the older version should be planned to finish before the new release. Also, as mentioned in chapter 2.10.2, it is safe to save some components as buffer for spares and production mistakes. Therefore, the new version should be released to the market when the supplies meant for the older version are used and a small amount

of spare parts are saved for possible future repairs. (Bragg 2018, 114.) However, this method can only be applied when the engineering modifications are planned but not when they are emergency changes.

Similarly, proactive planning can significantly reduce inventory obsolescence when a product is discontinued. If there is some demand for the product, the company can produce a last batch of goods to match the demand. In that case, the on-hand inventory of all necessary components should be allocated to a finished product, including some buffer. If the company realizes that there is no demand, it might be better not to push production because a finished good is more difficult to be disposed of. On the contrary, the engineer or production manager should evaluate the stock and pinpoint the product-specific components and consider ways of disposal with the Materials Review Board before the product is discontinued. (Bragg 2018, 114.)

Another way to prevent obsolescence is by tracking shelf life. It has been mentioned that product life is crucial for the restaurant business. The FIFO method should be used to keep an order in the stock. Ideally, the expiration dates or receipt dates would be recorded in the software system and an alert would be issued when a product approached its expiration date. (Bragg 2018, 114.) This would shorten the time it takes for the employees to search around the warehouse for expiring goods.

To conclude, inventory obsolescence can be costly for a company. There are several methods for identifying obsolete inventory, reporting and visual inspection being the main ones. When obsolete inventory is identified, it must be handled immediately, as it was outlined by the 5-S of Toyota in subchapter 2.7. There are many ways to dispose of inventory and still get a positive return, apart from throwing it away. Those need to be determined per case. In addition to this, planning prevention strategies is suggested so that managers and employees are aware of them.

2.11 Inventory tracking accuracy, counting and reconciliation

Most of the previous inventory processes entail accurate and reliable inventory records. It is important that management improves inventory recording in all inventory-related steps of the process. Low to no inventory accuracy can result in inefficiencies in purchasing, picking, production, and accounting, which can harm the overall performance of the business. (Bragg 2018, 129.)

2.11.1 Record accuracy

The importance of stock precision is reflected both in financial and operational terms. In a product business, inventory is a massive asset in the balance sheet. As long as shareholders are involved, the asset value of the inventory should be accurate because it is included in many financial key indicators of business performance. Also, inventory is often used as collateral so accurate records are necessary. Finally, taxation also depends on inventory records since the beginning and ending inventory values affect the Cost of Goods Sold, which in turn affects the amount of accounting and taxable profit. From an operational point of view, the purchasing department cannot order the correct amount of supplies, there can be production delays because of missing parts or high holding costs if too much inventory is acquired. In an inefficiently planned warehouse, employees can waste time looking for missing parts during production or during stocktake. (Quarterman 2006, 8.) All these can induce high inventory costs to the company.

Unfortunately, there is a surprising number of places in the process where something can get recorded wrongly and, thus, interfere with the level of accuracy. As with most controling processes, problem recognition is the first step. Inventory record errors can happen at any point of the inventory flow so the best way to recognize the risk areas is by looking at each step of the process separately. Therefore, record errors can occur during receiving inventory, putaway and picking, production and waste tracking, physical inventory counts, and even ordering and purchasing. Other factors increasing error possibilities are the capacity and speed of operations, employee professionalism and warehouse environment. (Bragg 2018, 129.)

When inventory is received, the quantity of the goods might be recorded insufficiently, wrongly, or not recorded at all. A solution to this problem is to engage all receiving employees to check the received items or pallets against the delivery note. Some companies, especially when dealing with liquid products, weigh the deliveries when they are received into the warehouse. Other times, for low volume deliveries, a visual inspection might be enough. Moving on to the next stage, putaway, the goods might be placed to a different location than usual because a new employee does not have the knowledge, or the designated area is already full. If the location is not recorded, the picking staff will waste time looking for those items. If the putaway employee records the location manually, the risk of recording it wrongly exists, especially if the warehouse coding is not planned in a logical manner. A solution for this issue is to develop an organized way of storing deliveries and, if possible, correctly record the locations. To check the accuracy of the recorded locations, it is suggested to check records and actual

locations daily. Also, if an inventory tracking software is implemented, a report of empty locations can be created with the purpose of checking its correctness. (Bragg 2018, 140.)

Regarding picking activities, the picked items might not be recorded for similar reasons or recorded incorrectly. If the procedures are recorded manually, the accuracy of future transactions is highly dependent on the employee's own accuracy and motivation. Therefore, the importance of inventory accuracy must be made clear to all inventory handlers. Ideally, no inaccuracies in this area should come from employee irresponsibility. A solution to handle such errors is to record transactions by employee. Similarly, production and waste recordings are procedures that are prone to stock record inaccuracies. If recorded manually, the same employee-related risks are involved. Waste should be recorded as soon as it occurs, and records should include the information explained in chapter 2.10.1. Otherwise, there is a high chance of on-hand supplies not representing stock reports, thus resulting in unexplained missing inventory and losses. Subsequently, if records are inaccurate and the on-hand supplies are less than reported, the number of purchased units will be far from the number of needed ones, leading to shortages and lost sales. (Bragg 2018, 140.)

Both Bragg (2018, 130) and Quarterman (2006, 13) agree that the bigger the volume of transactions is, the greater the inaccuracy risks will be. Bragg takes this statement further by correlating error risk with low storage capacity. A high number of transactions will require a large storage area that can result in difficulties to pick items from the warehouse as it reaches full capacity. When processes get more complicated than usual, there is a tendency for errors. Bragg suggests that a sudden increase in errors may be used as an indication of a full warehouse.

Speed is another factor that Bragg (2018, 130) considers impactful for accuracies. A flow that goes from point A to B and is recorded at both points without intermediate stops will be more accurate than a process flow where goods are picked, stored temporarily, moved from one order to another, and later reaching point B. Quarterman (2006, 13), while elaborating on the reasons for inaccuracy, he mentions that inaccuracy risks come with every step of the process. This explanation is similar in content to Bragg's, but it is more unambiguous.

It would be naïve not to include the warehouse environment in the list of factors affecting inventory record inaccuracy. There are several factors that go under this category but the greatest one is warehouse housekeeping. Not only does an organized and strategically planned warehouse increase efficiency but also can reduce record inaccuracies. A messy

warehouse creates confusion and demotivates employees to be organized, thus storing the same item in several different locations making it difficult to keep track of all of them. Also, items can get lost more easily or even wrong items be picked up. The steps to creating an organized working area were outlined in subchapter 2.7. If a company is recording stock and transactions manually, and not though a software, paper reports can get lost. Some other factors that can negatively affect precision are poor lighting, direct sunlight, and high temperatures. If the lighting is dim, it is more difficult for workers to read product codes and if the lighting is too bright, fork lift workers might not be able to read the location codes. Direct sunlight on the barcodes can affect scanner readability. Abnormal temperatures might affect computer device performance as well as employee performance. The effect of these factors can be eliminated if they are considered when designing or redesigning the warehouse. (Bragg 2018, 131.)

It has been shown that there is a solution to each accuracy problem arising. The common solution involves a big investment in labor to control the processes. In general terms, the processes should be improved by making necessary changes. The number of transactions should be reduced by implementing lean practices, such as Kanban. A periodic inventory count for all inventories or a daily cycle counting for a small portion of the stock are methods to correct existing errors but the former two are methods used to prevent errors from happening in the future. (Quarterman 2006, 14.) Subchapter 2.11.2 discusses more on the inventory count methods.

The metric used to calculate accuracy is called Inventory Record Accuracy (IRA) and is the percentage of the number of correct records over the number of records checked (figure 5). The formula is useful as it can be applied for both cycle counting and inventory counting. The higher the percentage, the more accurate the records. (Quarterman 2006, 12.) Bragg (2018), in his podcast, claims that he has managed to push four inventory systems to 98% accuracy. Although this is a high percentage, it does not reach 100%, which brings doubts that a flawless system can exist.

$$\text{IRA}\ (\%) = \frac{\text{Number of correct records}}{\text{Number of records checked}} * 100$$

Figure 5. Formula for calculating inventory record accuracy (adapted from Quarterman 2006)

It is important that when corrections in inventory are made, the issues are investigated so that they do not occur again. Unfortunately, many companies simply correct the non-matching records and move on. To conclude this topic and to show the magnitude of the

error probability, Bragg investigated the number of causes of errors in record accuracy in a food processing company. He found out that there were 65 different ways in which an error in inventory records can arise. This is an impressively big number so management should focus on the biggest errors first. (Bragg 2018, 144.) Changes take time. In fact, Bragg on his podcast (2018) recommends companies to budget 6 months for implementing changes involving software, warehouse, and inventory counts.

2.11.2 Inventory counting

In the previous subchapter, 2.11.1, the terms inventory and cycle counting were introduced. Their use depends on the inventory system used. There exist two types of inventory systems, the periodic and the perpetual system. (Bragg 2018, 145.)

The difference between the two systems is the time when the inventory accounting balance is updated. In the periodic system, the balance is only updated after a physical stock count is undertaken (Bragg 2018, 145). In the perpetual inventory system, the records and the balances are continuously updated after each receipt and issue of inventory. In theory, under a perpetual system, the inventory levels are readily accessible at any point and they reflect the actual levels. (BPP Learning Media 2017, 108.) In practice, the recorded balance might gradually differ from on-hand inventory, so cycle counting can be used to confirm if the accounts match (Bragg 2018, 146).

The frequency of the inventory counts depends on the number of units in the warehouse. Companies with a high-volume warehouse might consider conducting counts monthly, whereas once a year might be enough for companies with slow-moving stock. Under the periodic system, the accounting balance remains the same as it was recorded on the last count. This means that there is no inventory-related information in the periods between the counts. Not having access to up-to-date information affects the accounting work because the ending inventory balances and Cost of Goods Sold (COGS) are unknown in the interim periods. Also, adjustments for obsolete supplies cannot be made until the next count. (Bragg 2018, 146.) Under the periodic system, the COGS is calculated based on the beginning and ending inventories as shown in figure 6, below.

$$\text{Beginning Inventory} + \text{Purchases} - \text{Ending Inventory} = \text{Cost of Goods Sold}$$

Figure 6. Formula for calculating COGS (adapted from Bragg 2018)

Under the perpetual inventory system, there is updated information on the inventory levels, thus requiring less frequent physical counts. With this system, a journal entry is created every time a transaction takes place. The most common transactions for which a journal entry is created are purchases, sales, and stock adjustments due to obsolescence. For example, when a purchase is made the inventory account, which is an asset, is debited by the value of the inventories while accounts payable, a liability, is credited by the same amount. When an inventory item is sold, the accounts receivable, an asset, is debited by the amount of sales, while revenue is credited. The difference between the perpetual and periodic system is that under the perpetual system COGS is recorded at the moment of the sale. Consequently, the last journal entry is accompanied by the journal entry for COGS and inventory. Cost of goods sold is debited by the purchase cost of those goods and the inventory account is credited, so reduced. table 3, below, summarizes how the accounts are recorded under a perpetual system with amounts X for purchasing price and 2X for selling price. (Bragg 2018, 146.)

Table 3. Double-entry accounting under a perpetual inventory system (adapted from Bragg 2018)

Account name	Debit	Credit
Inventory	X	
Accounts Payable		X
Accounts Receivable	2X	
Revenue		2X
Cost of goods sold	X	
Inventory		X

Regardless of which system is used to record inventory, an occasional or regular count will be necessary. For a physical inventory count and for a high-volume warehouse, a set of steps is recommended to be taken before the actual count. A highly-efficient counting process should be planned, otherwise labor costs could rise substantially. According to Bragg (2018, 148), purchasing or creating durable count tags is the first one. The tags should be two-parted and numbered. They should include fields for name and item date, number, location, unit of measure, quantity counted, and names or initials of counter and verifier. Part numbers should be well comprehended by the counting team and the warehouse staff should ensure legibility of all numbers on the warehouse items. If part numbers are not used, they should be enacted immediately by experienced employees. In some cases, counting before the assigned time might be possible. If so, the opportunity should be taken, and a tag should be attached on the set of items to indicate the task's completion. This could be possible if a certain group of products is known that will not be

used until the physical count and this can also be true for stored seasonal products. Prior to the count, management should arrange specified areas for returning the count reports and tags. All items that are not or should not be on the warehouse must be taken care of prior to the count. Such items are goods that are placed on a different location than the warehouse and items that will not be counted, respectively. Also, a big delivery which arrives close to the date of the count can be left packed with the delivery note attached to it to reduce the time of the count. (Bragg 2018, 149.)

When the counting time arrives, the teams are instructed and assigned the tags and a location to count. The names of the employees of each assignment are recorded for safety purposes. Each group should include two people, one who counts the items and another one who supervises and fills in the tags. One copy of the tag is attached on the items counted and another one will be returned as the managers instructed. One person is responsible for verifying that all numbered tags have been returned. Experienced employees can speed up the counting process because of their expertise on the items. The quantities are entered into a database and summarized by item number if some items can be found in more than one location. If a perpetual system is used, the information on the system can be checked against the counted quantities. The inventory items that show variances should be recounted.

This process could be expedited with the use of barcodes and scanners. The process described above can become more efficient if the data is entered directly into an interface instead of tags. (Bragg 2018, 151.) Although, the purpose of the physical counts is to discover, correct and prevent stock discrepancies, their effectiveness can be debated. Apart from the allocation of many hours on this task, field experts believe that the same amount of corrected errors are created. Generally, a system where regular physical counts are not necessary is preferred. Instead, cycle counting can be used to gradually increase the accuracy percentage (Jones 2008, 180.)

One of the most important requirements for successfully conducting cycle counts is the utilization of experienced and well-trained staff. Knowledgeable employees are familiar with all inventory locations, part numbers and processes. If possible, cycle counts of a group of items should be conducted when its stock levels are low to reduce counting time. Here, the item classification is useful. The count occurrences of items marked as slow-moving can have larger intervals. There are four main methods that can be used for daily cycle counting. Cycle counting can be executed by location, usage rate, criticality, and

valuation. If the location method is used, the responsible employees move on to the next location once all items on the current one are counted. When the usage rate method is selected, the focus is shifted to the items that are used most frequently. With the criticality method, the count is prioritized by necessity levels so crucial components are prioritized. If the inventory includes items with a wide range of pricing values, the accounting department can decide to apply the valuation method. (Bragg 2018, 153.) Items of high value, like diamonds, should be counted first and recurrently as opposed to other items, like plastic strap watches. In fact, those items with an extremely high value to the company should be monitored closely and counted at exceptionally short intervals, even daily (Bragg 2018, 156).

Once the method is selected and suited to the business needs, the daily cycle counts can take place. The team should verify that all past transactions have been recorded and saved in the system. Then the counting team should count and compare the inventory selected. When variances are detected, they should be investigated and corrected. Since the counts are being made manually, the human error is present. Recounting the mismatching inventory is, sometimes, necessary. The team should delve into the results to define prevention strategies. The cycle counting method does not require all transactions to freeze, like the physical count does, but it is more product-specific so transactions regarding one item should be paused until counted. Cycle counts are recommended to be conducted in the beginning of the team's shifts to avoid other delays from affecting this process. Cycle counting can get complicated if the company is continuously operating. In that case, the focus should be on items that are susceptible to errors and a count plan based on activity volumes and shift changes should be developed. (Bragg 2018, 155.)

Both physical and cycle counts might be dreadful for staff. To prevent this from having an adverse effect on the quality of the results, a regular audit of the stock should be carried out. The IRA (%) from each cycle count can be shared with the staff and bonus can be given to the teams with consecutive accurate results and realistic improvement ideas. (Bragg 2018, 154.)

To conclude, the processes described earlier are manual, to the greatest extent. It is highly recommended for the benefit of the company to invest on a software interface that stores inventory levels by location and updates balances immediately (Bragg 2018). A

system of strategic locations and names should be built. A useful system which could fit this situation is the ABC classification.

2.11.3 Inventory reconciliation

The process of inventory reconciliation is significant because it can slightly increase Return on Assets (Jones 2008, 180). In the inventory reconciliation step, the processes of comparing, investigating, analyzing and correcting balances are included. Unfortunately, some employees rush to adjust the amounts on the records. Although this is a quick solution, it does not yield any benefits except for temporarily saving time. The difference might come from miscounts, a missing tag, a wrong part number, or wrong measurement units. Other possible areas of error can be found in the transaction history, such as a transfer to a different location. Production waste reports can provide answers to the divergence. Especially, in situations where waste is estimated and not precisely measured, the reported waste can be underestimated by employees. (Bragg 2018, 158.)

The next level of investigation is followed when variance trends exist. Errors might start from the entry of transactions, either accidentally or purposefully. If there is a negative trend for a product, the Bill of Materials should be checked as there might be a quantitative mistake in there. Canceled transactions should be identified because there is a possibility that the transaction later occurred but never changed status. Investigating the production site might yield positive results because supplies might have been moved to the production site but not recorded as a transaction. Also, it is possible that several semi-finished or finished goods are set aside to be quality tested. Temporary storing goods in different locations might be one reason for the variances. Additionally, invoices from suppliers can be checked and compared to the amount recorded by the warehouse staff. If there is a difference between those, it will reflect on the inventory balance. If the amount missing is close to the previous counting adjustment, there might have been an error in the procedure. (Bragg 2018, 159.) For example, if the account was adjusted for items in a temporary storage not counted during the last cycle count, there will be a surplus during this count, given that these items have not been used.

All in all, inventory record accuracy is a factor of determining efficiency of inventory processes. Since there are so many places were an inaccuracy can occur, investigating, fixing and preventing those mistakes can benefit the company. Using the IRA%, the record accuracy can be tracked and analyzed with time. Independently of the inventory system, physical counts are conducted. An example of an efficient and thoughtful physical

count was offered. When differences are found, investigating those items is suggested. Doing so for all products might be quite time-consuming, therefore concentrating on the top products is often preferred.

2.12 Inventory management efficiency measurements

In marketing, the infamous concept of SMART plan is used to implement ideas and projects. When improving the efficiency in inventory management processes, the SMART concept should be considered. SMART is an acronym for Specific, Measurable, Achievable, Realistic, and Time-Bounded (Swallow 2013, 82). All of them are necessary characteristics of an effective plan with success potential. This shows that quantitative analysis should be a fundamental part of a plan. Consequently, business controllers and managers feel the urge to use metrics to record performance and drive progress.

There are several ratios that are commonly used to analyze inventory management performance. Those are the Gross Margin Ratio (GM), Inventory Turnover Ratio, and the Days of Inventory on Hand ratio (Robinson, Henry, Pirie & Broihahn 2012). Other useful metrics include the Carrying Cost of inventory, the Inventory Record Accuracy Percentage, just to name a few (Bragg 2018, 229). Although there are many other measurement techniques, only the main ones will be discussed further to fit the scope of the thesis.

The Gross Margin Ratio (GM), also known as Gross Profit Margin Ratio, is a financial metric indicating the percentage of revenue allocated to the cost of sales, as expressed in figure 7, below. (Bhimani, Horngren, Datar & Foster 2008, 255.)

$$\text{Gross Margin Ratio} = \frac{\text{Revenue} - \text{Cost of Goods Sold}}{\text{Revenue}}$$

Figure 7. Formula for determining Gross Margin Ratio (adapted from Bhimani & al. 2008)

The formula includes Cost of Goods Sold, which can be derived as shown in figure 6, so having access to the beginning and ending inventory as well as the purchases is a good start. This is often used to evaluate the company's overall performance because it compares two large amounts of the Income Statement, sales and COGS. The ratio is useful when compared to historical ratios or benchmarked against industry ratios. (Gibson 2008, 307.) For example, companies in a highly competitive market will have lower margins than companies in a less competitive industry (Robinson & al. 2012).

The next important ratio is the Inventory Turnover Ratio, which expresses the rate at which the company turns inventory into sales during a measurement period (Bragg 2018, 224).

$$\text{Inventory Turnover Ratio} = \frac{\text{Cost of Goods Sold}}{\text{Inventory}}$$

Figure 8. Formula for determining Inventory Turnover Ratio (adapted from Bragg 2018)

In figure 8, the denominator is “Inventory”. There is controversy on which inventory value to use. According to Bragg (2018, 225), the value to be used is the ending inventory of the period of measurement. Other respected authors, like Rich and Jones (2017, 669) and Gibson (2008, 217), use the term “Average Inventory” for this equation. Average inventory is easy to compute (see figure 9). Bragg suggests using average inventory if the ending inventory data is not representative so critical thinking is required (Bragg 2018, 225).

$$\text{Average Inventory} = \frac{\text{Beginning Inventory} + \text{Ending Inventory}}{2}$$

Figure 9. Formula for determining Average Inventory (adapted from Rich & Jones 2017)

The Inventory Turnover Ratio indicates the efficiency of inventory usage in a company. A high turnover ratio shows that the company has sold its goods more times and the investment on supplies is smaller. This could mean that there might be an inefficient amount of supplies risking future sales. A low turnover ratio can mean that a lot of capital is being invested into inventories. This could indicate an abnormal amount of inventory balance adjustments due to obsolescence or inaccuracies. Slow-moving items can, also, lower turnover ratios. (Robinson & al. 2012.)

From the efficiency perspective, a high ratio reflects fast-moving inventory that come and go, without increasing holding expenses or decreasing in value. Therefore, a company with a high inventory turnover ratio is more efficient compared to another with a low one. (Bragg 2018, 224.) In the case of a low turnover ratio, inventories are sitting in the warehouse for longer periods. (Rich & Jones 2017, 669.) In both cases, the turnover ratios should be compared either to historical data or to industry information (Robinson & al. 2012).

The Inventory Turnover Ratio can be subdivided to turnover for raw materials, WiP, and finished goods for more detailed analysis. This indicator is useful because it can provide information on the average time inventory sits in the warehouse. This can be done by simply dividing the number of days or weeks of the period used as a measurement by the result of the calculation, as in figure 10. (Bragg 2018, 225.) This is a great indicator that can be used when the goal is to reduce holding costs or when product aging is costly.

$$\text{Days (or weeks) of Inventory on Hand} = \frac{365 \text{ (or 52 weeks)}}{\text{Inventory Turnover Ratio (annual)}}$$

Figure 10. Formula for determining the holding period of inventory (adapted from Bragg 2018)

A different indicator is the carrying cost of inventory. This is a value which combines all costs that have been mentioned in subchapters 2.1 to 2.11. This metric can be built and used to track and analyze comparably.

Overall, the similarity between the described efficiency measurement tools is that they are used to indicate when a company's inventory levels are too high, and not when they are too low. Focusing on that side of the inventory management is a result of the perception that inventory acts more as a liability rather than an asset. The main reason for this is liquidity difficulties of inventories. (Bragg 2018, 222.)

2.13 Analysis Model for Inventory Management

In 2010, the article titled "Analysis Model for Inventory Management" written by Vasile Burja and Camelia Burja, Professor and Associate Professor, respectively, of the "1 Decembrie 1918" University of Alba Iulia in Romania was published in the Annals of the University of Petroşani. The article introduces the importance of an efficient and accurate inventory management system, outlines the characteristics of an analysis-friendly system, and highlights the significance of structure and rotation. (Burja & Burja 2010, 43.)

The article explains the importance of a good system for the purchasing managers, production and demand fulfilment, allocation of capital expenditure, and, potentially, the company's competitiveness. According to the Professors, an analysis-friendly inventory system should be able to offer juxtaposition of past and current indicators, and to expand the items comprising the inventory, thus simplifying the search for inactive and slow-moving inventory. Slow-moving inventory freezes capital so the need for inventory rotation

speed is evident in highly competitive companies. Fast good rotation unfreezes the assets tied to holding inventories, and releases profits. (Burja & Burja 2010, 45.)

The model uses an alteration of the formulas for Inventory Turnover and Days of Inventory on Hand, which were introduced in subchapter 2.12 (figures 9 & 10). Instead of using the Cost of Goods Sold, the Professors are using the enterprise's turnover. (Burja & Burja 2010, 45.) Using the turnover will give a higher number for the ratio and it will give a more direct comparison to the sales than using COGS.

Also, the Professors choose to use Average Inventory instead of the ending inventory and Days instead of weeks for the analysis. The model is itemizing the inventory records to raw materials, work-in-process, and finished goods and using the total sum for the calculations of the ratios. Data of an enterprise is collected for financial years 2008 and 2009 of a company and the calculations are compared for the same periods. The result of the Inventory Turnover is also compared against industrial information to increase reliability. (Burja & Burja 2010, 47.)

In addition to the aforementioned indicators, the Professors are applying two additional ones. Those are the average sales per day and the released or inactive inventory levels. The former one can be calculated by dividing the sales by 365. The latter can be derived by multiplying the difference of the Days of Inventory on Hand between two periods with the quotient of the current period's turnover and 365, or the selected period, as presented in table 4. If the quotient is a positive number, it means that there is immobility of resources, thus a higher portion of financing is spent on inventory. If the quotient is a negative number, it indicates the value of inventory released, thus releasing capital to the company. The results should complement the changes in production and sales and analyzed accordingly. In other words, the result shows the necessary change, release or inactivity, for the inventory to match the average number of sales per day. (Burja & Burja 2010, 47.)

The article proves and analyzes the correlation between size of inventory and sales. Offering insight on the factors impacting the efficiency of inventory management, the research supports faster item rotations and shorter holding periods, while increasing turnover. (Burja & Burja 2010, 49.) The formulas are summarized on table 4, below.

Table 4. Summary of formulas used for the inventory analysis model built by Burja & Burja 2010

Indicator	Formula
Turnover	Sum of sales
Average Inventory	$\frac{\text{Beginning Inventory} + \text{Ending Inventory}}{2}$
Inventory Turnover Ratio	$\frac{\text{Turnover}}{\text{Inventory}}$
Days of Inventory on Hand	$\frac{365}{\text{Inventory Turnover Ratio}}$
Average Sales/day	$\frac{\text{Turnover}}{365}$
Released/Inactive inventory	$(\text{Days of inventory on hand}_1 - \text{Days of inventory on hand}_0) * \frac{\text{Turnover}_1}{365}$

2.14 Summary of theoretical framework

This chapter has elaborated on the various ways of improving the efficiency of the inventory system in a company. It has offered insight on methods for stock classification and for measuring efficiency based on financial figures.

The inventory classification tools suggested are the ABC and FSN methods. The classification methods are useful for both analyzing and storing goods. The ABC tool is useful if the usage rates and the value of inventory are not proportional. The FSN analysis tool is useful for stock which can be easily differentiated to three levels of speed; fast-, slow-, and non-moving. This method is especially helpful for companies that suspect that their inventory is not moving. Both are great tools to classify inventory, but the first one requires a larger amount of analysis prior to application. The method selection is company-specific so it should be adapted to the company's needs.

The chapter researched efficient ways of handling inventory processes. This was made possible by focusing on each process individually and utilizing multiple sources. Prior to researching the processes, key concepts of the inventory management and inventory-related costs were described. Their clarification is important so that the rest of the thesis is easy to read.

The materials planning and forecasting is an important part of the process because production can be based on the forecasts. Although it is uncommon for the actual sales or production to equal the forecasts, they can be rather close. It is important that a company has a purchasing plan otherwise lost sales can happen. The theory suggests that the

projections can be more accurate if the gap between forecasts is short. The amount of time depends on the volume of transactions and the available resources.

Purchasing of goods must be done carefully to include all goods with dependent and independent demand. To increase cost efficiency, purchasing should be done in a way that volume discounts are maximized whereas freight costs are minimized. However, one might question how this can be found. The Economic Order Quantity model is a simple way of finding out the most economic quantity in terms of holding and storing goods. A variation of the model for perishable goods has also been developed by mathematicians and industry practitioners. This is a quite manual task so the purchasing process would benefit from an investment on automation.

To increase efficiency in the inventory receiving process, the number of inventory touches should be eradicated. This requires careful planning of the process so that employees do not transfer goods unnecessarily. Another finding is that the premises must be highly organized. This can be achieved by applying an inventory classification method to sort stock logically. Also, excellent housekeeping habits are suggested.

Similarly, for the putaway and picking procedures, excellent housekeeping levels should be maintained. Various picking strategies are considered and they should be used critically because their effectiveness may depend on the type of the ordering system. In general, putaway, picking and replenishment strategies or instructions should be in place so that their flow does not solely depend on the employees' criticism. Automation can have a massively positive effect on these processes.

To improve efficiency in production, the inventory system should be built on a pull model. The main reason for this is that the Work in Process inventory levels are controlled and minimized. High WiP levels can substantially increase costs and setting a limit for the processed inventory is suggested. As mentioned during the discussion about the receiving process, efficiency can be increased by decreasing the number of touches. This is true for the production process as well.

In every product-based business, obsolete inventory will be found. Goods obsolescence can increase costs so it is important to control and minimize this event. The theories suggest that companies should identify waste, investigate the reasons for it and develop prevention strategies. One important lesson is for the companies to treat obsolescence so

that holding costs are minimized and profits increased, given that safety requirements are followed.

Inventory tracking is a topic which interests companies. High-volume companies might deem reasonable to organize monthly physical counts. The theories suggest that the frequency of the physical counts depends on the inventory system in place. For example, a periodic system updates inventory levels only when a physical count is completed. On the other hand, the inventory levels are available at any given point with the perpetual system. Therefore, physical counts might not be used as frequently. Ways to increase inventory count efficiency, monitor inventory record accuracy, and reconcile the missing stock were described.

At the end of the chapter, a few inventory management efficiency ratios were suggested and an analysis model for inventory management was presented. The model suggests that efficiency can be increased by speeding item rotation and holding inventory for shorter periods. Also, increasing sales can benefit the management efficiency.

3 Research Design

This chapter elaborates on the research methods, data collection methods, and data analysis methods, in respective subchapters. A reminder of the research question and investigative questions follows for better comprehension of this chapter and its contents.

The Research Question is How can the inventory management practices be optimized in Restaurant X?

IQ 1. What are the current practices regarding inventory management in Restaurant X?
IQ 2. What is the cost of the inventory management in Restaurant X?
IQ 3. How can Restaurant X's inventory management efficiency be analyzed?
IQ 4. How can efficiency in the inventory management of Restaurant X be improved?

3.1 Research methods

Since the ultimate purpose of the research is to offer suggestions for improving inventory management efficiency, there needs to be a thorough understanding of the current practices and an indication of cost efficiency in the restaurant's inventory management.

For understanding the current inventory-related processes practiced by the restaurant, interviews and on-the-field observations are conducted. Additionally, for quantifying the costs and determining the efficiency of inventory management, internal company numerical information is used. The interviews and on-the-field observations are used as data collection tools to the first IQ, whereas IQ2 and IQ3 are answered with the utilization of internal numerical data. The first three investigative questions will collectively assist to answer the final investigative question (figure 11).

The interviews are chosen as a research method because it suits the narrative approach of the first investigative question. The targets of the interviews are the restaurant managers and employees with a specific role to a process of the inventory management. The restaurant is divided into three departments, Department 1, Department 2, and Department 3. Each department has its manager. Two out of the three department managers and Restaurant X's manager are interviewed. The managers are chosen as the interviewees because they combine the expertise of all processes, as opposed to an employee with restricted knowledge to one process. The managers actively participate in the daily tasks. This helps them see how things work in practice, as opposed to how they think they work. Therefore, they can add criticism because they are able to recognize

inefficiencies. Also, they are responsible for improving their department's performance, which will, hopefully, motivate them to take part in the interviews and provide useful information. The higher the quality of the interviews, the more relevant the improvement suggestions will be.

The restaurant does not handle the administrative work. That is outsourced from the franchiser. The restaurant managers might not be familiar with that end of the inventory process, so it is for the research's benefit to get a description of the tasks from the person handling them. During the interview, the responsibilities of the administrator were described in detail and further questions were asked.

Apart from the managers, the Operations Manager (OM) is interviewed because of the expertise and access to the numerical information needed. The OM suggested to find out the costs of the inventory-related processes in the restaurant after expressing my interests in the accounting field. Recognizing inefficiencies and potential areas of improvement are part of the OM's mindset. Also, similar projects are included in the OM's experience.

Since the company name is confidential, the interviewees will remain anonymous, too. The departmental managers will be referred to as Department Manager 1 and Department Manager 2 (DM1, DM2, respectively). The restaurant manager will be referred to as Restaurant X's Manager (RXM), the Operations Manager as OM, and the administrator as Restaurant Administrator (RA). This guide can be used to avoid confusion and misunderstandings.

Face-to-face interviews are preferred to ensure that the processes are described in a detailed and completed manner. During a face-to-face interview, the interviewer can control the direction of the discussion. In addition to the face-to-face meetings, email discussions were sent. Attending multiple face-to-face meetings is not convenient for interviewees so the email exchange was deemed the best option. Therefore, giving them the option to read through the tailored interview questions and answer at their own pace was judged to be the best option available.

Semi-structured, one-hour-long interviews were used. The questions could not be identical because the interviewees are responsible for different departments. Most of the questions were open-ended with a few exceptions of closed-ended questions. Open-ended questions generate reflective and detailed responses from the respondents, which

provide more information to be qualitatively analyzed (Rubin & Rubin 2012, 177). All questions were built on an interview guide prepared before the interviews and customized according to the interviewees' responsibilities. The interview guide (see Appendix 3) uses topics discussed in the theoretical framework and filters the discussion into inventory management processes.

The preferred interview methods for each interviewee are as follows, in order of occurrence:

- RA is interviewed during a face-to-face meeting and follow-up email
- OM is interviewed on a face-to-face meeting
- RM is interviewed on a pair face-to-face meeting with the PM
- PM is interviewed on a pair face-to-face meeting with the RM
- RXM is briefly interviewed face-to-face and follow-up emails

The field observations were selected as a method to give a holistic picture of the processes without management biases. This is a preventive action which generates valuable information for the research because the processes are followed in real situations. The thesis author has been employed by the company for an extended period participating in various inventory processes so familiarity with most processes has been achieved.

The numerical information was entrusted to me. Due to the sensitive information they include, all numerical information is multiplied by the same random factor. This ensures the protection of the data and enables comparisons since the relationship between the numbers does not change. The data that is requested from OM is selected after finalizing the theoretical framework and creating a list with all relevant costs. All the possible costs, direct and indirect, generated during the inventory processes were sent via emails by the OM and RXM.

All research methods used are aimed at complementing each other rather than comparing because the specialization of the interviewees differs in nature and depth. A process familiar to one might be unknown to another interviewee or the author, thus producing the full picture of the inventory management processes.

3.2 Data analysis methods

A mixed-method approach is used for this research thesis. This means that both qualitative and quantitative analysis is conducted. Interviewing management regarding the inventory-related processes makes the approach qualitative. Also, on-the-field

observations of these processes over the period of employment are analyzed qualitatively. This method is chosen because of the nature of the data to be obtained and the majority of research tools used, the open-ended questions. A qualitative analysis is beneficial for providing fruitful insight for the final investigative question. The results of the qualitative analysis are presented with the use of flowcharts because visually presenting information can be easier for the reader. Most chapters include a flowchart in the text and the entire flowchart can be found from appendix 2. Appendix 1 explains what the symbols in a flowchart mean.

On the other hand, deriving the costs related to the inventory management and calculating efficiency indicators using the internal data collection method makes the thesis quantitative. Quantifying the costs of the described processes to estimate efficiency can help to evaluate efficiency using concrete facts.

The content of the chapter is summarized in figure 11, where the links between the different phases and the IQs are depicted. Phase one consists of desktop research with the purpose of discovering appropriate theories. The outcome will be used comparatively to the commissioning company's processes, aiming at finding ways to improve efficiency in the inventory management.

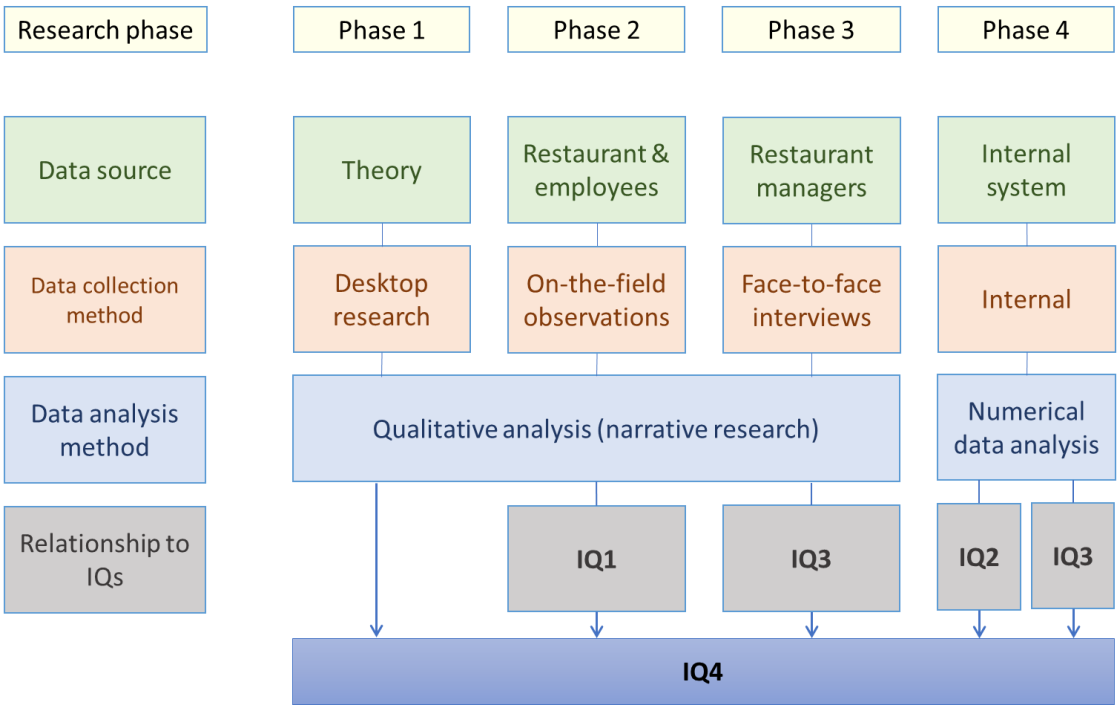


Figure 11. Visualization of research and data analysis methods

Phase two involves the interviews, both face-to-face and via emails. Also, on-the-field observations are used.

Phases three and four will use the numerical data analysis method with information given by the restaurant managers and system relating to the costs of the inventory processes. The results obtained from this phase will be used to answer investigative questions 2 and 3, and question 4, eventually.

Some of the data that will be needed for this research are costs of deliveries and ordering, inventory count costs, cost of the personnel performing the inventory-specific tasks, storing expenses, equipment and machinery costs used for this purpose. (Braun 2015, 76).

3.3 Numerical data analysis process

Combining the information from the theoretical framework and the processes as described by the interviewees, inventory-related costs are listed in an Excel file which is sent to the Operations Manager and Restaurant X's Manager. Except for the costs mentioned in subchapter 3.2, financial figures such as sales, COGS, utilities, ending inventory values, and waste values, just to name a few. Financial figures for the last 2 financial years, FY17 and FY18 are requested. The reason for this request is to enable comparison and analysis. The costs retrieved are shown in subchapter 4.9. Except for determining the inventory-related costs, the thesis also attempts to measure the inventory management efficiency. Therefore, the figures mentioned in the theoretical framework are added to the data request.

Most of the data asked are available in the restaurant's Profit and Loss statement. Since those costs do not entirely represent the inventory ones, they are allocated to the appropriate portion of the inventory. The method of allocation depends on the costs handled. For example, utility expenses related to storing costs are allocated using the portion of the restaurant area dedicated to storage. On the other hand, salaries are allocated using the total hours worked, total salary expenses, and estimations for each inventory-related process. The estimations were created with the Restaurant Manager and, later, verified by the Restaurant X's Manager.

The data is multiplied by a random constant, known to the author and the commissioning company, and the analysis is conducted. The data is categorized to two major cost groups; ordering and holding. The cost groups are determined based on the theory in

subchapter 2.2. In addition to the analysis measurements described at the end of chapter 2, other logical comparisons are made.

4 Description of inventory processes in Restaurant X

The restaurant generates revenue from three main sources; restaurant sales, food market sales and the staff-restaurant sales. This chapter aims at narrating the inventory-related processes, evaluating and comparing them to the theoretical framework. A similar structure of that in chapter 2 will be followed.

4.1 Materials planning and purchasing

During the face-to-face interview with Restaurant X's manager, the materials planning procedure was briefly discussed. Top management prepares the annual budget which is sent to the RXM. The restaurant manager is responsible for breaking down the budget and applying it to the restaurant's plans. The methods used by top management for creating the budget are not specified. Comparing the given information to the theoretical framework, one could state that the budgeted period, which purchasing is based on, is relatively long. Recalling from chapter 2.5, forecasting sales for the near future can reflect reality with higher accuracy.

After interviewing the production and restaurant managers, information on the ordering and purchasing system was clarified. There are in total 8 – 10 managers and employees who have the rights to perform purchases for all departments of Restaurant X. Purchasing is done based on the budget and human logic. The reorder point depends on each product. For the most frequently used products, orders are made frequently and in large amounts to create buffer. Underestimating demand for these items is not an option. For other items, the reorder point can be lower because their usage rate is not as high. In both cases, the managers check the budget for the items, check the current stock levels of the items by inspecting the storage areas, and subtract the current stock from the budget. The result is the quantity needed to meet demand. However, creating buffer stock is preferred so the purchaser adds a logical buffer amount. Before placing the order, the purchaser checks the backorders or contents of the upcoming deliveries so that duplicate orders are avoided.

The PM says that all orders are placed electronically through each supplier's web portal. The business account for those web portals restricts the order selection to Restaurant X's product range. This is a control mechanism which does not allow the purchaser to acquire goods that do not belong to the restaurant's range. Additionally, this mechanism can save time in administration because there are no unknown products in the invoices and delivery notes. However, the PM continues that this is not the case for one of the suppliers. This

Finnish supplier offers goods that are not included in Restaurant X's official lists. When items like that are purchased, it is impossible for the restaurant administrator to enter the data in the inventory control system, as it is explained later in subchapter 4.4. Since they cannot be properly entered in the system, tracking them is difficult and waste of such goods accounts for unexplained residuals. This creates a significant inefficiency in the inventory system, both procedural and record-related.

The process, as described above, seems prone to human error. Either intentional or unintentional errors can easily occur. Some examples of situations where mistakes on estimating ordering quantities can happen are hectic environments, lack of motivation, unexperienced employees, tiredness, and inventory system failures. These situations need to be identified, investigated, and fixed because inaccurate ordering can generate high inefficiencies in the inventory management, as it has been highlighted in the theoretical part of the thesis.

Interestingly, each location of the chain has its own production tool. However, the tool is not used for purchasing purposes because it does not fully meet the purchasing needs. This depicts that top management has realized the need for a purchasing tool, attempted to implemented it, with limited success. No information about the features of the tool was given but automating the ordering decision-making process would be beneficial for the company, as seen in subchapter 2.6.

Materials planning and purchasing as handled by Restaurant X, appear similar to the theories mentioned. However, deciding the order quantities for the restaurant is done subjectively. If the inventory system or processes are not reliable, human logic is preferred over blindly following the incorrect system. Unfortunately, it is not an efficient way of ordering. The inventory system should be reliable enough and the budget should be specific enough for the ordering process to be efficient. Ideally, the ordering process can be automated and a production tool implemented with greater success.

4.2 Receiving

The restaurant maintains a tight supply chain, which comprises of four suppliers, performing deliveries on a specific day of the week and on a total of three days. The benefit of having a few suppliers were outlined in subchapter 2.6. This was initially revealed during the interview with the RA. This agreement allows the restaurant managers to plan working shifts and prepare the receiving area for the deliveries. In Subchapter 2.7, the benefits of having an ASN (Advance Shipping Notice) were

described. Although an ASN is not used, pre-scheduled deliveries, assuming they are timely, can achieve the benefits of an ASN.

The deliveries are always scheduled for the morning, before the restaurant's opening hours. The shift managers are planning the shifts of the receiving personnel in advance in a way that at least three people are present, one of which should have a managerial position. The other two employees are assigned the putaway task.

When the deliveries arrive at the premises, the drivers know which entrance to approach. They start unloading the delivered goods and they hand in the delivery note to the responsible manager. At least one of the managers is present to sign the delivery note, which is used as a confirmation for both the supplier and the company. Some of the information that the delivery note includes are the date of shipment, the names and product codes of the good and the quantity of each row. After visually inspecting the goods, the manager signs the delivery note.

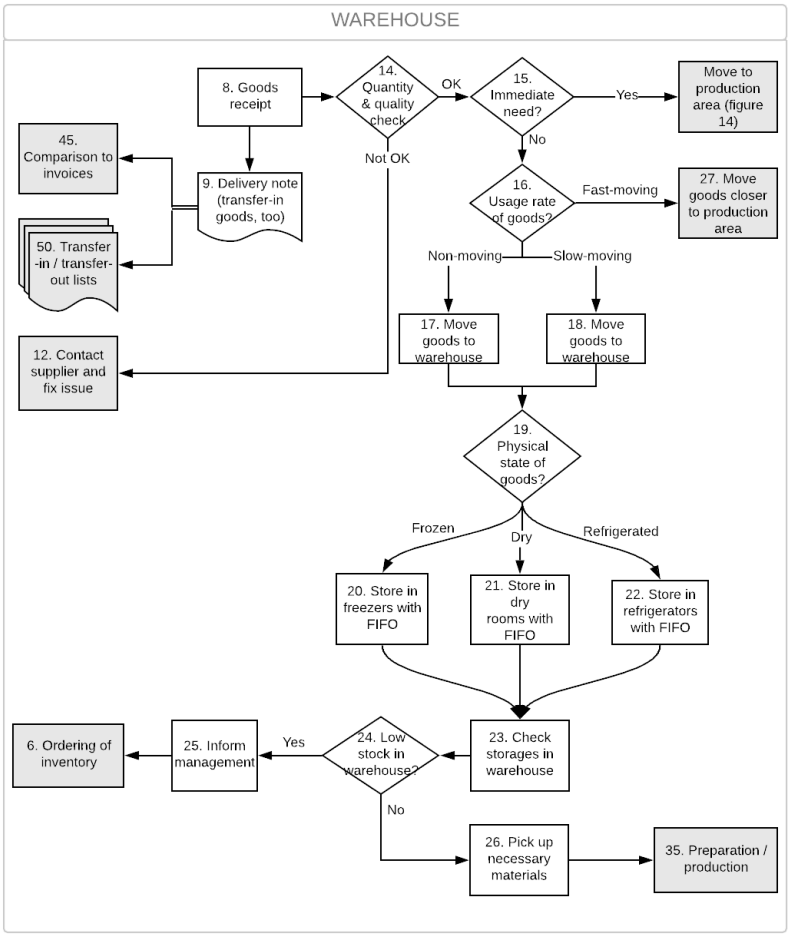


Figure 12. Inventory management process for receiving and putaway

Figure 12 visualizes the receiving and putaway process, which is narrated in the next subchapter, as they occur in the warehouse. The grey-colored blocks represent steps that do not occur in the warehouse or by the warehouse employees, but they are closely associated to the figure's processes. The key takeaways from the receiving process are that a visual check of the deliveries is done for safety reasons, and a delivery note is handed to the receiver. The putaway process is described next.

4.3 Putaway process

According to the interviews, the people assigned to handle the putaway task arrive at the premises half an hour to one hour earlier before the scheduled delivery. This enables the employees to navigate themselves around the warehouse and arrange the receiving area to allow for easier access. An important task to be done prior to the delivery is a check of all items on display and near production with low stock. These items will be the first ones to be taken from the inventory, following the FIFO method. Proactiveness, as explained in the theoretical framework, can increase efficiency. Preparing the receiving area is an example of proactiveness in real life. However, the way the area is prepared depends on what goods and how many goods are currently placed in the area. For example, during peak periods the receiving area can get crowded so the rearranging methods are adapted to the higher volumes. In large, the putaway method depends on the employee's own criticism, which might not always be reliable for several reasons, such as fatigue, lack of motivation, or little experience.

The putaway process is facilitated using tags which indicate what products or group of products should be placed in the area which the tag refers to. The managers have tried to place the tags as conveniently as possible. In the largest freezer, the tags are attached to the top of the walls of the freezer and the product names intended to be stored there are written with bold letters and a big font. This makes it easier for the employees to recognize where to go as soon as they enter the freezer so that they do not wander around the frozen area. Product name tags can be also found on shelves in most storing areas. However, based on the author's observations, not all storage areas have directive tags. This can happen for 2-sided roll cages with one type of product because it is relatively easy for the employees to see the goods. Also, the storage rooms near the production area have separate purposes, for example one is for dry goods, another one for dairy products and another one for vegetables. Tags with the category name are attached on the outer side of the doors.

Based on the observations, the names of the items with low stock available on displays are written on a piece of paper so that the correct products are taken from the storage. If some of the needed goods are already in stock, they are placed aside on a trolley or a roll cage, which is later filled with the rest of the listed delivered goods. There are no rules on how the putaway process should be done in Restaurant X, as long as the food safety requirements are met. Since each delivery trip carries two or more pallets, it is recommended that products with immediate need are moved away from the receiving area by one of the putaway employees to allow easier and more fluent movement for the other. The first one, refills the displays and shelves before the opening hours when a different task is undertaken. This transfer of responsibility from one employee to another reduces significantly the number of inventory touches. Otherwise, the inventory would be handled twice; first when a person puts away the goods to the storages and later when someone picks up the goods for replenishment. This step is represented by block 15 in figure 12.

The next question a putaway employee normally thinks about relates to the usage rate of the goods. Earlier in the theoretical framework, the FSN model was explained. The most experienced employees of Restaurant X separate the fast-moving from the slow-moving goods on receipt (blocks 16, 17, 18, 27). They tend to move the fast-moving goods closer to the production area because they are expected to be sold at faster rates.

The other employee has the main responsibility of the putaway task. The shift is scheduled to last for four hours. After some of the goods leave the receiving area, the employee separates the goods and places them to the correct storage space based on the tags. The physical state of the goods is taken into consideration, as shown in blocks 19, 20, 21, and 22. Priority is given to frozen or refrigerated goods. If there is a possibility to replenish short-term storages, those goods are set aside or handled first. Since there are multiple storage areas, the employee needs to know exactly where a good is supposed to be stored.

During the interviews and the field observations it was noted that the shift managers tend to assign the putaway shifts to experienced employees. This way of planning is in line with the theory suggested by Bragg and Coronado in subchapter 2.8. If the task is new to the employee, an experienced person is scheduled for the same shift to train the novice. This prevents misplacements from happening, which could confuse the pickers and increase the picking costs.

For most goods, the replenishment strategy is bulk-based, meaning that when employees refill the proximal storage areas and displays, they pick as many goods as they can possible store. Picking one item, rarely happens. This might be one of the reasons why some goods in the warehouse are temporarily stored in roll cages as they will be moved soon altogether. This reduces significantly the number of touches, as explained earlier in subchapters 2.7 and 2.8. It was observed that most of the roll cages which are used for short-term storage are placed near the receiving area. This may indicate that the storage capacity is not sufficient for the volume of holding goods. On the other hand, the receiving area would be unnecessarily large if it were empty. Thus, utilizing this excess space, increases storage space efficiency, and reduces the holding cost per product.

Processing the visual observations of the storage area layouts lead to the realization that, in a few cases, the goods with the highest demand are placed next to the entrance of each storage area. If the storage area is small, the fast-moving goods are placed at the end of the room, opposite of the door entrance. This could speed up the processes, given that the area between the door and the fast-moving goods is empty. However, this is not the case for all storage areas and as it appeared during the interview with the production and restaurant manager, such an arrangement was not done on purpose. Human logic prevailed when planning the area. The production manager shared that the large freezer was organized so that there is an imaginary line separating the freezer diagonally, creating two “L”-shaped areas. Each half of the area or each “L” is dedicated to one department, the restaurant and the market place. Organizing the big space in this way, the average distance from the entrance of the freezer is the same for both departments. Although no product classification theories are followed step-by-step, the human logic gets rather close to the theory cornerstones.

On the other hand, some goods are placed wherever free space exists. In some storage rooms, goods are placed in the middle of the room’s hallway, restricting walking space. Again, the restaurant seems to be scoring high in storage space efficiency. However, this is not the best way to store goods according to the theories described in subchapters 2.7 and 2.8 because workers cannot move comfortably. Unfortunately, this was observed in the storage area for dry goods.

As expressed by the two-sided arrows between blocks 23 and 20, 21, 22 altogether, there is a continuous supervision of the warehouse inventory levels by the staff. When the stock levels of an item get surprisingly low, the staff informs management (block 25) who orders more stock (block 6), if needed. This check happens every time an employee gets to the warehouse to pick up goods (block 24). If the inventory levels of the picked goods seem

fine to the employee, then the goods are picked (block 26) and transported to the production area (block 35). However, this system cannot be a reliable reordering method because it depends on the employees' criticism and motivation.

4.4 Administration

The delivery note is handed to the administration. The restaurant is outsourcing the administrative tasks related to the inventory. Although the service is outsourced, the administrators are located in the same building. The transfer of physical documents from the receiving area to the administrative area can take a minute, so it is a quick task. Figure 13 depicts the inventory processes handled by the administrator. The first row of blocks in the administrator's inventory process flow refers to actions that belong to a different department. For example, block 39 is completed in the production area or kitchen. These three grey-colored blocks (9, 41, 39) are exceptionally added to the administrator's lane because they justify the RA's following blocks.

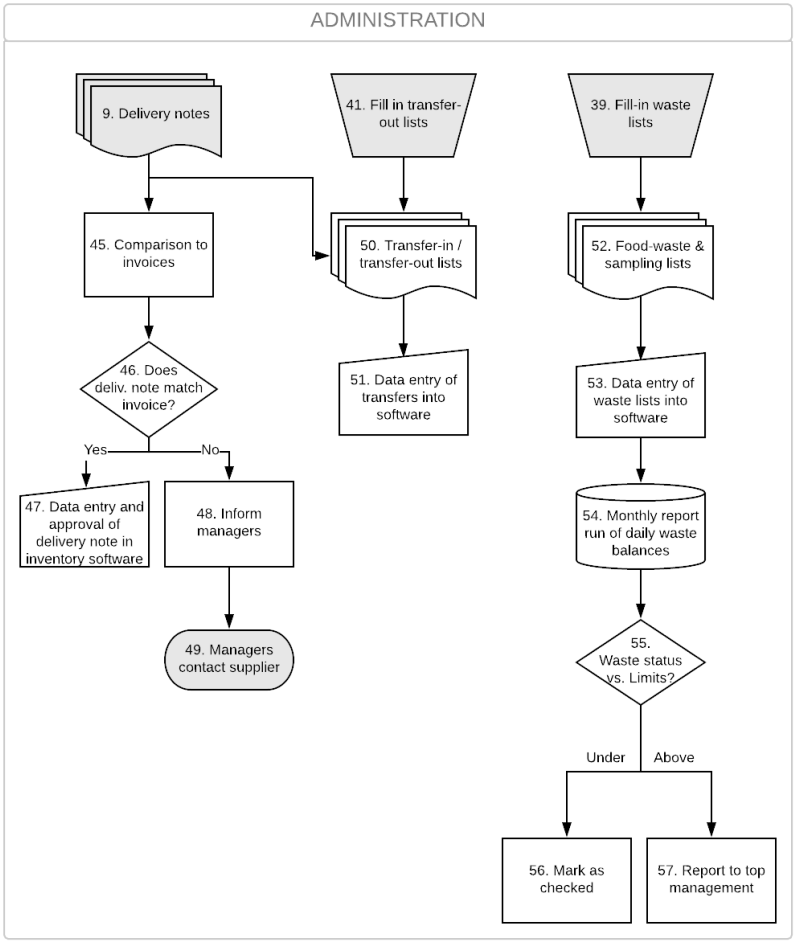


Figure 13. Inventory process flowchart for administration

The administrator has access to the inventory management system, which was presented to the interviewer during the meeting. The system stores information about all products purchased from suppliers. Each product has certain information attached to it. For example, the item number, unit weight, unit price, currency, product ingredients, and supplier cost are some of the information visible through the system. However, this information is not editable by the RA. Only the franchiser can edit or update such item information. After the interview with the RA, an email with follow-up questions was sent. There, the RA shared that the updates can take a long time until they become visible to all restaurants. If some of the information on the system, such as the unit weight and unit price, is different from the delivery note, the RA makes sure that the amount received is reflected in the system. In such situations, an item which already exists in the inventory system with the default unit weight and price is approved in the system so that the weight and value matches the delivery note.

After the receiving manager has confirmed the correctness of the delivery note and the administrator receives it, as shown in block 9, it is checked against the invoices (block 45). From the email exchange, it was explained that invoices are received through an electronic invoicing software. Most of the invoices sent by the suppliers are automatically charged as contract numbers and the same product names are used. However, the invoices are sent to the RA to be checked against the delivered goods. If the information matches, the administrator approves the delivery note and updates the inventory levels of each item in the system, as in block 47. If differences in terms of products or quantities between the invoice and the delivery note are found, the RA informs the manager about the difference. The manager, in turn, creates a claim to the supplier and, soon, a credit note should be issued (blocks 48, 49). If the restaurant receives invoices from an irregular supplier, the RA contacts the managers to confirm the truthfulness of the invoice.

The RA tries to monitor purchases from other than the common suppliers by recording the purchased goods separately. The information is saved on an Excel file which keeps track of waste values and an estimation of the good’s current stock. Since the RA does not have the rights to add products, this personal Excel file is one way to follow up on purchases outside the main suppliers. However, it is highly manual and does not update when sales occur. Therefore, the stock of the items is updated after each monthly count, which makes the inventory system for these items periodic.

The restaurant recognizes that writing off is not the only way to treat obsolete goods. If the goods cannot be sold anymore but they are still consumable, the “transfer-out” method is used. By the term “transfer-out”, the company refers to the act of moving inventory from

one department to another. As explained by the RA, transfer-out happens when money is not moving but inventory is.

Inventory transfer-out examples, as explained by the RA, are finished goods that are moved to the staff restaurant and are either sold at a cheaper price or offered free of charge. Another example is restaurant portions sold to the staff outside the working hours of the staff restaurant. Transfer-out lists can be found in specified spots in the departments and they are collected and sent to administrator daily, as block 52 describes. A transfer of inventory to a restaurant of the franchise at a different location is also included in the transfer-out category. Reversely, transfer-in is used for transferring goods from a restaurant of the same franchise to Restaurant X. Proof of the transaction is also handed in to the administrator (block 50). Finally, transfer-out is used when something about a product has changed. Examples include changing from an old item to a new one or changes regarding ingredients and allergens. When a new item is replacing an old one, all items from the old article are transferred-out and transferred-in to the new article. If the weight of the new article has changed, it is taken into account so that the correct amount is transferred. Block 51 represents the RA's responsibility of updating the inventory level records in the inventory control software.

The next responsibility of the restaurant administrator is recording waste for each restaurant department separately. During the interview, the RA mentioned that stock adjustments are made when goods become obsolete or they are used as samples. Restaurant X is using six different reason codes for waste. Tracking waste and its causes is made easier when the waste is segregated to, for example, "sampling" and "prepared expired". Employees from all three departments are required to record what items and how much is wasted. As mentioned in subchapter 2.10, having many moving lists might lead to lost lists and, consequently, discrepancies in the inventory balances. Each department should collect the waste lists of the previous day and hand them in to the administrator, who enters the data in the system, as shown by blocks 52 and 53. According to the RA, only a few employees remember to give the lists every day. This can make the administrator's work more complicated and can increase the risk of losing the lists.

During the meeting, the RA mentioned that the top-management monitors the waste levels weekly. The weekly checks are a good way of following the obsolescence of goods because surprising action can be detected within that week. If the interim period between checks and investigations is short, it can be faster to discover the source of the issue because the employees might better remember situations closer to when they occurred.

The RA is required to produce formal reports when important information of an item is outdated because the RA's rights are not sufficient. Another occasion where the RA needs to report to top management is if the waste value exceeds the assigned limit, like blocks 54-57 describe. Those values have been set by the franchiser. Every month, the RA checks the waste of each day and section in EUR. For example, if found that the waste value for the restaurant for one day exceeds 200 €, the RA informs the Production Manager about the value and the waste reason, if available. When the reason is unknown to the RA, the Production Manager asks around the restaurant. This waste controling method alerts the RA and managers of the situation, which consequently raises the question of what actions are taken to prevent it.

Although the system gives a very good picture of the inventory system, it is not flawless. One of the inefficiencies of the system that the RA is facing is when marking as obsolete items purchased at a different price. If a good was purchased at a different price than the one recorded in the system, the waste value is not accepted to be anything other than the value on record. This means that the cost of the obsolete items does not always match the cost reported, thus causing discrepancies in the unrealized inventories account. However, the RA mentioned that a solution for this is currently under construction.

To sum up, the RA is responsible for three main tasks; delivery notes, transfer-in and transfer-out, and waste recordings. Monitoring the levels of all three is, also, part of the RA's job description. A great controling method of Restaurant X is the weekly and monthly balance checks. However, this is more of a reactive method rather than a proactive one.

4.5 Production

After getting familiar with the business model of Restaurant X and discussing with the operations manager, the debate about whether the restaurant uses a push or pull production system has resulted in a satisfying answer. The short answer is that the production system of the restaurant is mainly based on a push system because the food is available before the customer places the order.

The long answer is that the production system is a blended one, which is based on push with some of the processes presenting pull characteristics. The system, in its essence, uses push for ordering raw materials and preparing the food to be ready when the restaurant opens. In those situations, production is not affected by customer orders. Instead, it is based on forecasts and expectations for the day's sales. After the restaurant

has opened, the employees can roughly estimate how much to keep producing by combining expectations for the next couple of hours with the current customer demand, which is represented by a queue. Although customer orders do not directly trigger production, a queue is an indication of orders and it signals the staff to keep producing to meet upcoming demand.

The previous statement stands true for most of the goods sold in the departments of Restaurant X. However, it was observed that there are a few products that use the pull system more evidently than others. One of them can be found from Department 1, and it is prepared for the customer only after an order is placed and the payment is confirmed. This is as “pull” as it gets in Restaurant X. In this case, only a part of the process uses the pull system while the raw materials are being ordered based on forecasts. As it was explained in subchapter 2.9.3, a purely pull system is extremely difficult to implement and shifting to pull whenever possible increases inventory management efficiency.

The previous discussion is based on the prevailing perception that push and pull are associated with the decisions of produce to stock or order. However, as extensively explained by Hopp and Spearman (2004, 137), the concepts of push and pull should be defined based on the WiP cap.

If the results of the debate can be reevaluated, this time including the WiP cap in the thought process, Restaurant X shows more characteristics of a pull system than it did before. This is true only if a WiP cap can be decided along with production. By definition, the WiP cap is set to prevent raw materials from being added to a job. Based on the observations, the restaurant does not have a pre-determined WiP cap for all raw materials but the employees can regulate the amount of goods that enter production so that waste is minimized.

To conclude the push-pull debate, the author claims that Restaurant X is essentially built on a push system but pull characteristics are implemented in some parts of production. Defining pull based on the work-in-process inventory, reveals characteristics of the pull nature in the restaurant. Researchers and practitioners believe that pull is a more efficient production system than push.

The production process flow as described during the interviews and as observed is presented in figure 14, below. As mentioned in figure 12, the fast-moving goods were transported closer to the production area. Once moved there, an experienced employee

considers the physical state of the goods; frozen, refrigerated, dry goods. This process has already been defined earlier in figure 12, so it is replaced by the special icon for block 29. The frozen and refrigerated goods are stored first. If after replenishment, the temporary storages have insufficient levels of inventory, the employees check the warehouse storage and they follow the procedure described in figure 12. If the stock levels are appropriate, the necessary goods for preparation are picked. Raw materials are put into production, whereas finished goods are put on display, like blocks 35, 34, and 43 show. Apart from sales, obsolete inventory is another outcome of production.

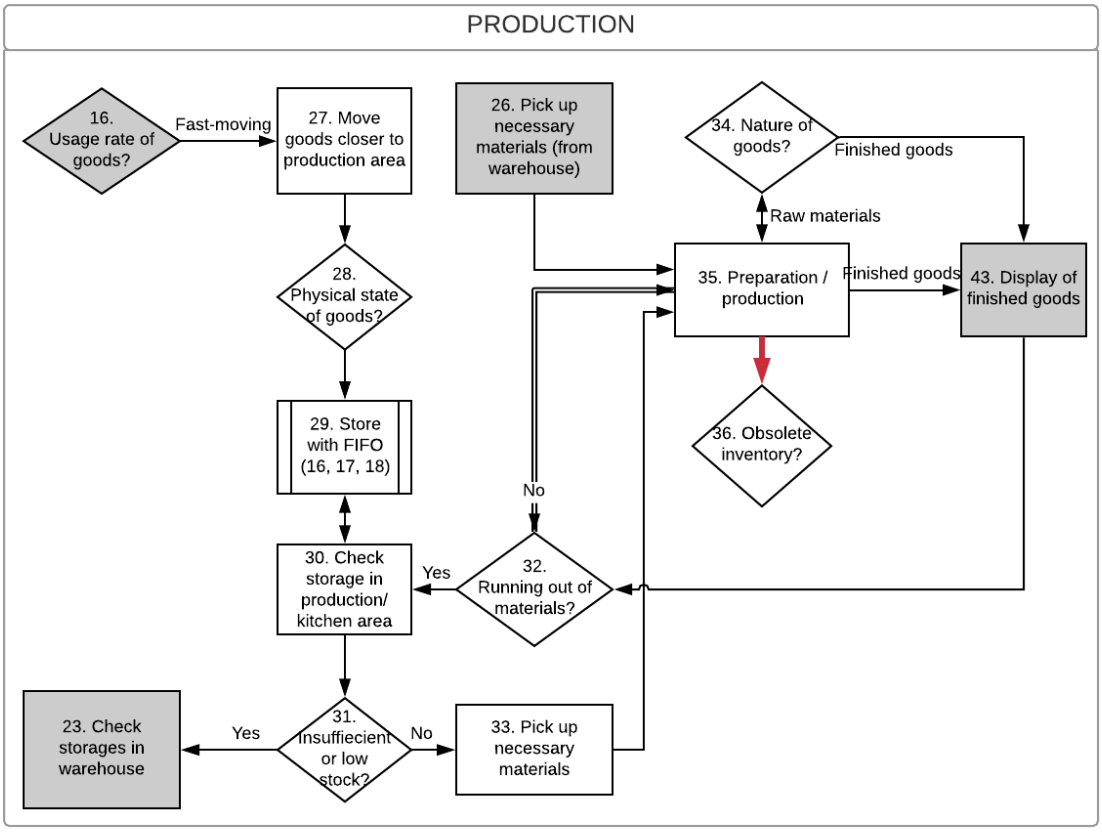


Figure 14. Inventory management process for production

4.6 Obsolete inventory

One of the reasons for pull being more efficient is the control it provides over inventory obsolescence. This is a topic of great significance to companies because it equates with lost revenues and wasted assets. This subchapter outlines the different ways in which inventory can become obsolete in Restaurant X, how it is identified and disposed of, and it concludes on how inventory obsolescence is prevented. At the end of this subchapter, figure 15 summarizes the process followed by the production employees when obsolete goods are determined.

Based on the observations, a good is deemed obsolete when at least one of the following situations is true:

- Expired goods
- Foodstuffs not meeting the food safety requirements
- Not reaching display standards
- Out of product range
- At the end of the day (for cooked food)
- Damages, etc.

Obsolescence of expired goods is a common event in restaurants where predicting demand is difficult. Based on previous discussions about FIFO, big amounts of obsolete inventory due to expiration can be an indication of inappropriate storage of goods. Expired goods are either thrown away or into a bio food waste recycling machine, depending on the good. These goods are not consumable anymore so bio recycling is the best alternative. Each major production task has its own daily waste list, which is easily accessed in most cases. Each departmental list includes the product or ingredient names and the unit of measure. When goods are thrown away, the name of the goods thrown away is matched to the product name on the list and the exact quantity of the goods is handwritten next to that name. Each list includes 15-20 items and the contents are categorized either by area or by the time of the day. For example, the main list referring to the restaurant's meals is divided into morning and evening. These lists are also used for reasons other than expired goods.

A similar situation where waste is created is food which does not meet the food safety requirements anymore. Some examples are foods whose temperature is not within the food safety limits or foodstuff that was not hygienically prepared. Just like the expired goods, these cannot be consumed so they are either thrown away or bio recycled and the exact quantities are written on the correct lists.

Since some food products are put on display, items that are not up to the visual standards are usually removed. These are identifiable by the employees if they are familiar with how the goods should look. Displaying and selling goods that are not visually correct according to the company's standards could harm the brand, so they are taken away, unless they can be fixed. These become obsolete, the exact quantities are added to the waste lists, and they get disposed of. The method of disposal is trashing.

Old products that are not included in the company's range anymore have high chances of being tagged as obsolete. Restaurant X does not have the authority to alter its product range without permission from the franchiser. Thus, if a decision to retire a product is made, Restaurant X should obey it. According to the observations, old versions of items

tend to sit in the warehouse for some time until a decision for disposal is made. This is, unfortunately, a weakness in the system because the items aimlessly occupy storage space.

At the end of the opening hours, employees throw away or bio recycle the food leftovers. These are foods that, in their current state, will be unusable the next day so, again, bio recycling is the best alternative. However, it is possible for some warm foods to be used the following day as cold if they get instantly frozen with the use of food freezing solutions. This method is implemented in the restaurant by freezing already prepared meat and fish products for the following day, if the health standards are followed. At the end of the day, the waste amounts can be considerable so using this method not only does it reduce waste, but it reduces the expenses of preparing the same cold foods the following day. However, based on the observations, there are no records of how many goods are being used in this way, although this looks like a “transfer-out” process.

Most product damages in Restaurant X happen because of employee mishandlings during putaway, picking or production. The causes for such damages are usually employees and warehouse inefficiencies. For example, during hectic periods the production and warehouse floor can get crowded with boxes, trolleys, and employees, so accidents can occur more easily. Maintaining an organized production and warehouse floor can prevent waste from accidents and reduce picking times, as discussed in subchapter 2.7. Warehouse standards, such as storage temperatures are closely monitored in Restaurant X to identify possible malfunctions and obsolete inventory.

Since there are three forms of goods: raw materials, work-in-progress, and finished goods, waste can appear in all three forms. Raw materials for Restaurant X are located in the warehouse storage and the storage areas on the production floor, like shown in blocks 23 and 30, respectively. Work-in-process is handled on the production floor (block 35) and finished goods are most likely on display (block 43). The red arrows indicate the movement of obsolete inventory. Block 38 represents an important question in the thought process of the employees, as described earlier. Depending on the answer to that question, the employees act according to blocks 39 and 41. It is important to highlight that the task of filling up the waste lists is not always done before disposing of the goods, like shown in figure 13. The lists should be filled in before disposing of the goods because the employees might get distracted and forget to add the items on the lists. The grey-colored blocks (23, 43, 52, 50) refer to actions handled in different departments. For example, block 43 belongs to the sales area but it is relevant to inventory obsolescence process description.

Figure 15, below, summarizes the movement of obsolete inventory and how it is linked to other processes of the restaurant. All in all, estimating inventory is the employees' task. It is relatively easy to be done when the goods are countable, such as individual goods. However, when the products are uncountable, the employees estimate the quantity or the weight, depending on the pre-filled lists. Recording waste based on estimations is not a reliable method to follow because it can significantly distort the balances.

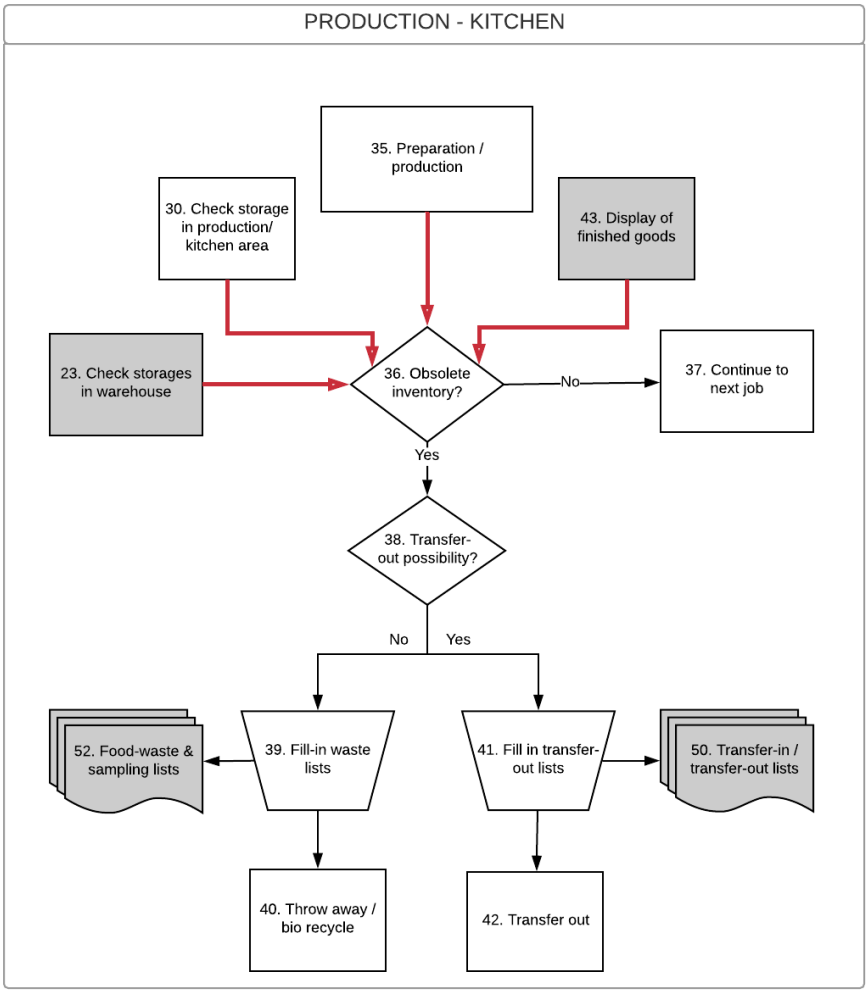


Figure 15. Inventory management process for obsolete goods

4.7 Inventory tracking and counts

During the interview with the production and restaurant managers it was explained that the inventory system that is implemented by the restaurant chain can provide a good picture of the current stock levels at any point between physical counts. Given this information from the managers, it can be said that Restaurant X performs under the perpetual inventory system, as explained in subchapter 2.11. The system is linked to the

sales software and subtracts the units of each article sold from the inventory in real time. However, Restaurant X monitors all inventory monthly and the top 5 items weekly.

Restaurant X conducts physical inventory counts at the end of each month. The inventory counts are scheduled after the closing time of the restaurant and they last for 8 hours. If all employees involved in the count are experienced, there are 6 people performing the counts. If there is at least one new employee, there might be 7 people performing the task. This happens because the new employee does not know the processes as fluently as an experienced one, thus on-the-field training is necessary. The counts take place during the night, except for special situations. In Finland, working during the night as a separate shift is compensated with a higher pay (Expat 2018). This means, that the labor costs for this task are expected to be high.

Apart from the shift arrangement, the managers prepare and print out the inventory count lists. There is a list for each physical area/department. According to the management interview, they go through the list of products and they exclude articles that are not used anymore. In addition to this, they ensure that new products are included in the lists. The lists include the product name on the first column, the product code on the second, and next, three different units of measure on alternative columns; units, packages, boxes. The columns between the ones including the unit of measure are blank to be filled by the counting pairs. Many of the inventoried products are units in packages, and those packages come in bigger boxes. Therefore, designing the lists in that way seems reasonable.

The interviews revealed that the managers try to count a part of the inventory before the scheduled physical count. When they do that, they put a note, usually written on a large carton board, in front of the goods that were counted. This ensures that none of the staff picks items from that portion of the inventory, so discrepancies in the stock balances are avoided. However, this proactive action might not always be available. Also, before the counts, the managers try to move all products with the same product number to one place. Both actions can make the counting process faster and easier for the employees.

Another proactive action, which is exercised by the restaurant managers and staff, reduces the number of goods to be counted. This is achieved by spreading the word in all departments that the physical count is approaching. The staff is advised not to fill the displays and shelves fully because these are more difficult to count. Ideally, they can be filled so that no half-opened boxes are left in storage. The count staff would have to count

only the units on display and add it to the “units” column, and then add the number of full boxes in the “boxes” column.

At the beginning of the task, the counting team gathers at the receiving area. The managers instruct the staff, assign groups of two, and an area to count for each group. Any already counted areas are mentioned so that they are not re-counted. The area count lists are given to the relative pairs, a meeting time and place is arranged and the operation begins.

The pairs move to their assigned departments and one of them counts, while the other one supervises, writes down the number and plans the next item to be counted. The last part is important. The items on the list are in alphabetical order, which is not a logical order to follow when countinghe goods in the warehouse are not placed in alphabetical order. The way in which the pairs decide to count is by taking one area at a time. An area can be a set of shelves, a roll cage, a trolley, or a pallet. The counter announces to the writer which product is being counted. When there are no more units of that product in that section, they move to the next item. Depending on the size of the goods and the type of storage, the pair can decide how to count the goods; remove from shelf and count while filling the shelf or count without moving the products. Both methods can be used but FIFO must be followed in all cases.

The process followed by the restaurant already resembles the ones discussed in subchapter 2.11.2. The similarities are that the counts are made in pairs and preferably experienced employees. Also, counting some areas in advance of the scheduled time is another similarity. The theory mentions counting by location, which is a method used in the restaurant by the employees. A significant difference is the count tags. Count tags are not used in Restaurant X’s counting process but they were suggested in the theory because they formalize the process and confirm what items have been counted. During the observations it was noted that in the teams ask each other if they have counted some items with an unclear territory marking. Since the area of the restaurant is not large, verbal communication about such topics has been enough.

The team gets together at the agreed place and time and they update the group about the status of their work. During this meeting, the pairs discuss and compare which areas they have scanned through. The restaurant can store the same product in various different areas. The groups walk through one physical area at a time and the lists include products according to where they are supposed to be. For these two reasons, the short meeting is

useful to transfer information from one team's notes to another team's count list. Then, if some groups have completed their area, they help the others to complete the count.

Surprisingly, the restaurant performs a weekly physical count of the top 5 articles. Those are scheduled on Tuesdays and they help management estimate quantities to order. Two people are assigned for this task and the same procedure of counting and reconciling is followed. A different set of lists is used for this task. The weekly count is an additional inventory control mechanism.

The process follows a smooth flow and all employees know what is to be done because of the initial instructions given. All items in the monthly counts are counted per location. When one item is counted, the counter starts counting the article next or below the previous item. The supervisor skims through the list to locate the item the counter is counting because the order of the products on the lists is not relevant to the location. Having two types of counts while a very accurate inventory system regarding sales and purchases is in place, raises the question of *why.* The information suggest that inventory obsolescence distorts the values. Some waste, as explained, is estimated by employees because there are no other convenient methods of recording it. Physical counts can be used to compare the waste recorded to the actual waste, among other things.

4.8 Inventory reconciliation

After the count, two people manually insert the values in a section of the inventory system. They check the amounts against the current stock value estimated by the system. According to the restaurant and production managers, it is not common that the values match. If the difference is small, the stock number is updated according to the amount counted. If the difference is larger, the problematic article is re-counted. According to the restaurant manager, a big difference is considered any value larger than 500 euros. If the difference is not settled after re-counting, the restaurant administrator is contacted and a further investigation occurs; the delivery notes, transfer-out lists, and waste records are checked. Finally, a variance report is prepared for top management including known explanations for the differences. If explanations for big differences are unknown, they are reported as unknown to top management.

The investigation process has common points with the processes described in the theoretical framework in subchapter 2.11. The main similarity is that the accounts are not immediately adjusted as a difference is found but investigated. Although the theory suggests that an investigation should be conducted for all differences, the restaurant

conducts it for great variances. With limited resources, even checking the biggest differences can be proven helpful. Ideally, a thorough investigation would be done but it is evident that the process would be extremely time-consuming. The return on this investment would, most likely, not be high either.

Another similarity with the theory is the methods of the investigation. Both cases use the recount method because it is understood that the human error can have a big effect on the ending value. Then, both cases support checks of the transfers and the waste. These are based on manual work so, once again, the possibility of human error is recognized.

When the production and restaurant managers were asked what ways are used to prevent inventory obsolescence, employee training, FIFO, and caution in the ordering process were the main answers. As mentioned in the theoretical framework, the employees' behavior is substantial. FIFO must be used but its application depends on the employees, again. Also, the ordering system is checked for the correctness of the quantities ordered.

4.9 Determining inventory-related costs

After all the necessary costs and figures were collected, they were manually inserted in an Excel file for analysis. An important step in this process is the allocation of the costs to Restaurant X's costs, specifically to the inventory-related costs. The costs were also allocated to each major group; ordering and holding costs, as detailed in table 5. In brief, the ordering cost group consists of forecasting, ordering, purchasing, receiving, putaway, and producing costs. On the other hand, the holding cost group includes picking, storing, physical counting, and obsolescence. Figure 16 classifies the restaurant's inventory processes to the two major cost groups. The figure separates the blocks by colors; the yellow ones belong to the ordering costs category, the green ones to the holding, and the blue is mixed.

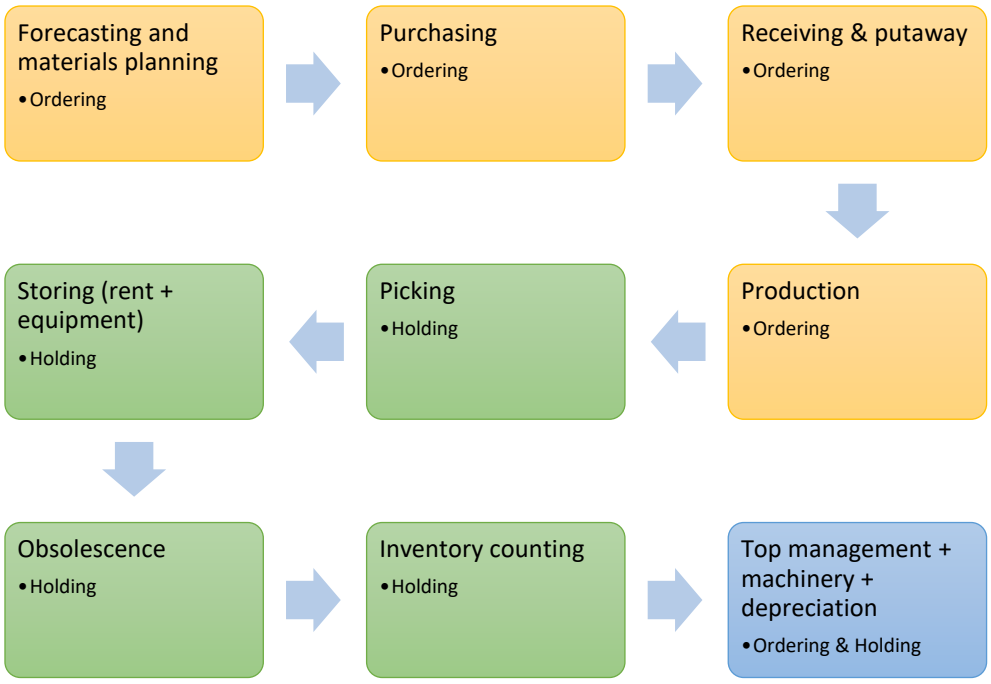


Figure 16. Cost classification based on inventory management process analysis

Table 5 outlines the cost items, their adapted figures and their allocation to the restaurant's inventory processes. As mentioned, some of the figures are retrieved from Restaurant X's Financial Statements so they might include costs dedicated to a different process, for example sales or marketing. Table 5 expresses the inventory costs as a percentage of the total cost retrieved for both financial years in question. The source of the percentages is the RXM. The top management's service, like the administration, is outsourced from the franchiser. The RXM notes that top management dedicates no more than 10% to forecasting for the restaurant and 5% for controlling obsolescence. These are estimations so they might not be reliable. Costs related to the area of production or storage are allocated using a percentage of Restaurant X's area. These were calculated by the RXM based on the square meter areas that the processes occupy. The percentage of utilities for inventory-related processes is estimated at 70% and the machinery and equipment values at 80% for production and 20% for storage. The depreciation is set at 15% for production and 25% for storage because it refers to the warehouse as well.

The value for COGS has also been given but it is removed from the public version of the thesis. The freight costs are included in the COGS, so this value is inevitably left out of the public version. Also, table 5 includes the figures for sales, hours worked, value for ending inventory and the operational gross margin. It is important to note that all of the figures in this table are adapted, even the gross margin ratio. The purpose of showing the GM% is to highlight that it is the same for both FY18 and FY17. This may indicate that there is a high level of expense control by the company.

Table 5. Cost items and allocation to inventory management processes

Financial figures	% allocated	Total		Allocated to Restaurant X	
		2018	**2017**	**2018**	**2017**
Top management (forecasting)	10%	111 050	91 963	11 105	9 196
Top management (obsolescence)	5%	111 050	91 963	5 552	4 598
Rent production	15%	222 266	221 147	33 340	33 172
Rent storage	25%	222 266	221 147	55 566	55 287
Administrative (fixed annual)	100%	57 260	57 260	57 260	57 260
Administration hours	100%	2 360	2 360	2 360	2 360
Net sales	100%	9 286 532	8 557 768	9 286 532	8 557 768
Electricity production	15%	36 830	34 726	5 525	5 209
Electricity storage	25%	36 830	34 726	9 208	8 681
Utilities *	70%	93 559	88 928	65 492	62 250
Depreciation production**	15%	348 604	272 289	52 291	40 843
Depreciation storage **	25%	348 604	272 289	87 151	68 072
Ending inventory	100%	235 833	234 516	235 833	234 516
Waste	100%	251 597	178 721	251 597	178 721
Total hours worked	100%	114 690	105 253	114 690	105 253
Salaries (specified separately)		2 786 654	2 611 403		
Machinery & equipment production	80%	80 974	65 103	64 779	52 082
Machinery & equipment storage	20%	80 974	65 103	16 195	13 021
Operational Gross Margin***		**80%**	**80%**		

* waste management, cleaning, water, heating
** warehouse + equipment
***GM is also multiplied by the constant.
Depreciation is for all machinery and equipment but their costs are only for the respective FY's

Table 5 does not specify how salaries are allocated. These are shown in tables 6 and 7, below. Salaries, as also seen from the table, is expected to be the biggest cost affecting the inventory-related costs. A deeper and more accurate allocation of these costs is necessary. As explained in the research methods, the RM and RXM were asked to estimate the duration of each inventory process, their frequency and the number of people performing the task with the same duration. Knowing the number of hours required on an annual basis for each process, the cost of conducting that process can be found by multiplying that value with the total salaries paid and dividing the product by the total number of hours worked during that financial year. Repeating the same calculation for the other financial year, the model assumes that the number of hours required for one process is constant. The results of the allocation of the hours per month and year are shown in table 6.

One thing that needs to be noted on table 6 is the weight of the base salary on each process. The inventory counting process occurs during the night so it is counted as double hours for wage employees but not for fixed-salaried employees. Thus, instead of doubling all the inventory count hours, they are multiplied by the factor 1.5. Additionally, even though the administration hours are included in table 6, they are excluded from the salary calculations on tables 7 and 8.

The production run hours are estimated to be the highest, with the receiving and administration hours following. The hours are translated into salary costs in table 7. It is expected that the salaries follow the same trend as the hours because the same salary rate is applied.

Table 6. Number of hours per inventory-related process

Inventory-related process	No. hours	Times /month	No. people	Total hours /month	*Average weight of salary*	Total hours /month	Total hours /year
Production run	21	30	7	4373	*100%*	4 373	**52 471**
Receiving	12	12	2	292	*100%*	292	**3 498**
Administration	49	4	1	197	*100%*	197	**2 360**
Inventory counting	14	1	6	83	***150%***	125	**1 499**
Picking	0.4	84	2	73	*100%*	73	**875**
Weekly inventory counting	7	4	2	56	*100%*	56	**666**
Inventory reconciliation	16	1	2	31	*100%*	31	**375**
Weekly inventory reconciliation	3	4	2	28	*100%*	28	**333**
Ordering (other suppliers)	0.9	8	2	14	*100%*	14	**167**
Ordering (one of the suppliers)	0.6	20	1	12	*100%*	12	**139**
Materials planning & forecasting (only RXM)	35	0.2	1	6	*100%*	6	**69**
TOTAL						**5 204**	**62 451**

Administration costs are fixed costs so they are not multiplied by the salary rate. The total number of hours and value of salaries presented in table 7 does not reflect Restaurant X's total working hours and salary expenses because other processes, like customer service, maintenance, trainings, and managerial tasks. For FY18, the inventory-related processes amount to 52% of the total hours or salary expenses and in FY17, they reached 57% of the entire payroll. Again, these are estimations based on the managers' experiences. These ratios are not adapted.

Recalling from the introduction, the Operations Manager estimates that the inventory-related processes amount to the adapted amount of 3 500 € weekly. However, it is unknown what items the OM's estimate includes. Even if the production-run costs are omitted from the calculation, the total salary-related cost for FY18 would be 185 164 € annually, thus 3 858 € on a weekly basis. This value already exceeds the OM's expectations even though none of the other stock-related costs have not been considered yet.

Table 7. Translation of hours into salary expenses

Inventory-related process	Total hours /year	Total FY18 expenses (€)	Total FY17 salary expenses (€)
Production run	52 471	1 274 901	1 301 849
Receiving	3 498	84 993	86 790
Administration	2 360	57 260	57 260
Inventory counting	1 499	36 426	37 196
Picking	875	21 248	21 697
Weekly inventory counting	666	16 189	16 531
Inventory reconcilliation	375	9 106	9 299
Weekly inventory reconciliation	333	8 095	8 266
Ordering (other suppliers)	167	4 047	4 133
Ordering (one of the suppliers)	139	3 373	3 444
Materials planning & forecasting (only RXM)	69	1 686	1 722
TOTAL	**62 451**	**1 517 325**	**1 548 187**
Total salaries (less: outsourced admin.)	60 092	1 460 065	1 490 927
Average monthly figures less admin.	5 008	121 672	124 244

The cost items that were retrieved from the company's internal system are adapted and shown in table 9 with the total values for the two financial years. The table shows that in the ordering costs group, the largest annual inventory-related expense is salaries for production. This is a logical result because the production process absorbs the highest number of employee hours compared to other ordering processes, like receiving and putaway, application of the budget or ordering itself. Another interesting point is that for FY18, machinery and equipment related to production rank third on the ordering cost list but forth in FY17. As mentioned, 80% of machinery and equipment costs are absorbed by the production costs. Part of the ranking difference comes from the great difference between the machinery and equipment costs between FY17 and FY18 (see table 5).

The biggest holding cost value is the obsolescence cost. Surprisingly, the rent of the storage area is the forth largest cost, after depreciation and utility expenses. Even though the salaries have a bigger weight on the counting costs because of the night shifts, they

fall right behind the storage area rent expenses. The inventory counting cost includes both the monthly count and the weekly counts. The same stands true for the inventory reconciliation costs. However, if the inventory reconciliation were included to the inventory counting costs, the total inventory count would be the second largest cost in the holding cost group.

In FY17, the total ordering costs were 3.3 times higher than the total holding costs but in FY18, the ordering costs were only 2.7 times higher than the holding ones. The difference dropped as the total ordering costs lowered for FY18 while the total holding costs for the same year increased compared to FY17. Here, it is important to note that all costs, except for the salary-related ones and the fixed administration cost, are increasing in FY18. As table 8 shows, the hourly wage is lower for FY18. Some reasons for this difference could have been a lower number of evening and Sunday shifts or an increased number of lower-wage employee hours combined with fewer managerial salaries. Given that the duration of the processes multiplied by the base salary equals salaries paid for these processes, and the duration is kept constant while the base salary decreases, the salaries for each process will decrease in FY18.

Table 8. Change in the rate of salary between FY17 and FY18

	FY18	FY17
No. hours worked	114 690	105 253
Salary expenses	2 786 654	2 611 403
Average salary rate €/h	24.30	24.81

Table 9. Cost groups, cost categories, and inventory-related costs for FY18 and FY17 (figures are adapted)

ORDERING COSTS		**FY18**	**FY17**
Salaries	Production run	1 274 901	1 301 849
Salaries	Receiving + putaway	84 993	86 790
Machinery	Machinery & equipment production	**64 779**	**52 082**
Outsourced	Administrative	**57 260**	**57 260**
Depreciation	Warehouse + equipment production	52 291	40 843
Rent	Production run rent	33 340	33 172
Outsourced	Top management charge forecasts	11 105	9 196
Salaries	Ordering	7 420	7 577
Electricity	Production area electricity	5 525	5 209
Salaries	Application of budgeting to the restaurant	1 686	1 722
ORDERING TOTAL		**1 593 300**	**1 595 700**
HOLDING COSTS		**FY18**	**FY17**

Obsolescence	All waste	251 597	178 721
Depreciation	Warehouse + equipment holding	87 151	68 072
Utilities	Waste management, cleaning services, water, heating	65 492	62 250
Rent	Holding area cost	55 566	55 287
Salaries	Inventory counting	52 615	53 727
Salaries	Picking	21 248	21 697
Salaries	Inventory reconciliation	17 201	17 565
Machinery	Machinery & equipment holding	16 195	13 021
Electricity	Storage area electricity	9 208	8 681
Outsourced	Top management charge obsolescence	5 552	4 598
HOLDING TOTAL		**581 825**	**483 619**
TOTAL INVENTORY-RELATED COSTS		2 175 126	2 079 319

Table 10, below is the final table of this subchapter and aims at simplifying and summarizing the results of the cost determination. The table combines cost categories disregarding the cost group -ordering/holding- they belong to. A percentage of the total inventory-related costs is also provided for both financial years together with an absolute and relative difference for easier analysis.

Cost category	FY18	% of FY18 total	FY17	% of FY17 total	Difference +/-	Difference %
Salaries	1 460 065	67.13%	1 490 927	71.70%	-30 861	-2.07%
Obsolescence	251 597	11.57%	178 721	8.60%	72 876	40.78%
Depreciation	139 442	6.41%	108 915	5.24%	30 526	28.03%
Rent	88 906	4.09%	88 459	4.25%	448	0.51%
Machinery	80 974	3.72%	65 103	3.13%	15 871	24.38%
Outsourced	73 917	3.40%	71 054	3.42%	2 863	4.03%
Utilities	65 492	3.01%	62 250	2.99%	3 242	5.21%
Electricity	14 732	0.68%	13 890	0.67%	842	6.06%
Grand Total	**2 175 126**	**100.00%**	**2 079 319**	**100.00%**	**95 807**	**4.61%**
Weekly cost	45 315		43 319			

Based on the results, it is notable that the obsolescence costs have grown rapidly and by the highest percentage. Such growth in obsolete inventory is negative and indicates inefficiencies. If such a rapid growth is accompanied with a slower growth in sales or even a decrease in sales, the situation is more critical. Table 11 compares the change in the total waste and the change in sales. Unfortunately, the increase in sales is only 9% whereas the increase in waste is 41% between the two years. It is unknown to the author, what the waste explanations are and why they are so high. Waste needs to be controled

more closely in the restaurant to be reduced because these rates of waste can be dangerous.

Table 10. Comparison of increases on waste values to sales

	FY18	FY17	% increase
Sales	9 286 532	8 557 768	**9%**
All waste	251 597	178 721	**41%**
% of sales	2.71%	2.09%	

Returning to table 10, the item with the second highest increase is depreciation of warehouse and machinery with a 28% difference. Right after depreciation, the machinery and equipment values are followed with a 24% increase between FY18 and FY17, which is quite similar to their depreciation change. As indicated in table 5, the values for the machinery and equipment refer to the items purchased during that year whereas the value for depreciation refers to the warehouse, and all machinery and equipment owned by the company. Therefore, there is a distortion. Interestingly, the total rent expense between the two financial years is not fixed, as it is assumed in the theoretical framework.

To conclude, the research has found that the total costs of inventory processes for FY18 for Restaurant X is 2 175 126 € and for FY17 2 079 319 €. This equals on average 44 317€ per week. This exceeds by far the OM's estimations. The majority of the inventory-related costs, around 70%, is created by the salaries for these processes. Obsolescence costs, for FY18, account for about 12% of these costs. Depreciation exceeds 6% at the end of FY18. If the total value of machinery and equipment is used, it would increase the percentage of total costs from 3.7%. Thus, the final cost could be higher if these costs are included. All in all, Restaurant X's inventory-related costs have increased from FY17 by 4.61%, with some items increasing faster than others.

On the other hand, the total costs have increased with a slower rate than the sales have, which makes the situations less critical.

4.10 Measuring efficiency for Restaurant X's inventory management

As discussed in subchapter 2.12, the gross margin ratio, the inventory turnover ratio, and days of inventory on hand were presented as good ways to measure efficiency. However, these methods require the COGS value, which has been decided to remain confidential. Thus, it is omitted from the public version but the analysis methods are explained. Instead, the analysis model for inventory management by Burja and Burja (2010, 43) is used in the public version because all the necessary data presented in table 4 can be disclosed using adapted values.

The analysis model for inventory management is applied to FY18 and FY17 to enable comparison. A comparison to industrial information from a public source is attempted. From table 5, the net sales and the ending inventory of both financial years are retrieved. Although, the model uses the average inventory in the calculations, the ending inventory will be used for Restaurant X. This is because the average inventory cannot be calculated with the available information and the two values can be used alternatively. This was clarified in the theoretical framework.

Implementing the formulas as they appear in table 4, the results shown in table 11 can be obtained. Recall that the item *Number of rotations for inventory* refers to the inventory turnover ratio calculated using sales instead of COGS. The term *rotations* is used to highlight the importance of having fast-moving inventory.

Analyzing the data, it is deduced that the number of rotations has increased by 8% from 2017 to 2018. The number of rotations indicates the number of times the company completely replenishes its inventory throughout the year. The higher the number, the higher the rotation speed. Fast rotation means that funds are freed as fast and goods sit in the storage for a shorter time. Using the information on hand, it can be claimed that the value of number of rotations for FY18 is higher than the one for FY17. Indeed, the days of inventory on hand is reduced because of its relation to the previous indicator. This implies an increase in the efficiency of the processes.

Table 11. Analysis model for inventory management of Restaurant X

Indicators	FY18	FY17	Difference
Turnover (€)	9 286 532	8 557 768	8.5%
Ending inventory (€)	235 833	234 516	0.6%
Number of rotations for inventory (no.)	39	36	7.9%
Days of Inventory on Hand (days)	9	10	-7.3%

Average sales/day (€/day)	25 443	23 446	8.5%
Released/inactive inventory (€)	-18 654		

The model suggests comparing the rotation number to industrial information. The inventory turnover ratio based on sales is 43.8 and 42.3 in FY18 and FY17, respectively. These values refer to the restaurant industry and are provided by CSIMarket Company's (2018) online database. However, the restaurant's included in the search are located in the USA, which might not be applicable. However, assuming that the data is reliable, Restaurant X's inventory turnover ratio is 5-6 points lower than the industry's ratio.

The final part of this model is the released or inactive inventory which, according to the calculations, equals to -18 654 €. According to the background theory of the model, a negative value is favorable to the company. The value means that 18 654€ of inventory needs to be released daily to match the average sales per day.

According to this model and the figures, Restaurant X's inventory process efficiency in FY18 is higher than during FY17, which is positive. When compared to the industry's information, Restaurant X's efficiency is average. It is safer to compare the efficiency ratios within the same company, instead of doing so against the entire industry.

5 Conclusions and Evaluation

This research thesis has explored the inventory processes in theory and in practice. Additionally, it has attempted to monetize the costs of the inventory management processes and measure efficiency using various efficiency metrics. This chapter concludes the most important findings, evaluates the research process and offers ideas for development.

There have been numerous suggestions to the commissioning company pinpointed throughout the thesis and here the most relevant ones are suggested. There are both positive and negative factors in the restaurant's inventory-related processes. It is vital for the company to recognize these, analyze them, measure them, plan and act. Improving process efficiency can benefit a company's competitiveness in the market. The advantages and disadvantages of the processes are analyzed below in terms of efficiency.

One of the advantages of the current inventory management system is the tight supply chain. The company has great control over the four suppliers. The managers should utilize volume discounts while minimizing freight costs. Another reason why this is one of the main advantages is that Restaurant X can pre-arrange the deliveries, thus having the premises for planning.

Other the other hand, the ordering process is unorganized. There are multiple employees handling the process. Ordering is triggered by human criticism and it is, often, completed based on estimations and human criticism. The obsolete stock levels spiked during FY18 and ordering too much inventory can result to unused and wasted goods. The ordering system should be based on facts as much as critical thinking. This can be done by using a production tool or an EOQ tool. In any case, the reorder quantity should be chosen so that ordering and holding costs are the lowest possible.

One advantage related to the receiving and storage area is the implementation of product and product group tags. These help the employees locate the goods as soon as they open the storage room door. This should shorten the duration of the receiving, putaway, and picking processes, all else equal. However, the tags are not useful unless they are followed by the employees. If the same good is stored in three different locations in the same storage, the tags are not helping with efficiency. This brings up another issue of the current system; warehouse organization.

A suggestion to the commissioning company is to invest resources into organizing the warehouse and storage areas in a logical manner that satisfies putaway, picking, and inventory counting tasks. It is evident that salary-related expenses are the costliest to the company. Time is a factor for these costs. If there is a way to reduce the time for the processes, efficiency would increase either by lowering costs or by dedicating that time to improve a different area. A suggestion is to start implementing the 5-S organization model and getting the employees engaged. Creating waste and counting lists that are sustainable and making sure that they arrive to the administrator is also very important. One way that this can happen is by using electronic devices which send the data to the administrator in real time.

The company invests a lot of resources into manually counting inventories. As mentioned, if all costs included into this category are summed, the total inventory count expenses would be the second highest expenses after production run. This process can be expedited by implementing scanners or other automated devices. Although this might not work for all goods, it can be applied to the packed goods. It is surprising that Restaurant X is following this method since the inventory control software is up-to-date. It is expected that the inventory obsolescence is the source of the problem.

Employees are expected to estimate the weight of foods at the end of the day or sometimes count small-sized foods for higher accuracy. Wrongly estimated waste will show as a discrepancy when the physical counts happen. The issue could be partially solved using an electronic scale for the goods that need to be weighted.

Another suggestion solution to the problem is to teach employees a simplified version of Work-in-Progress cap. This could establish the mindset of not producing endlessly unless there is a clear reason for it. Controling the levels of processed and finished inventory can reduce the occurrence of obsolescence.

Regarding the administration, inefficiencies can occur when item costs cannot be altered. However, this may be an internal safety control to prevent purchasers from buying other than the accepted items. Thus, this issue can be resolved by buying only prescribed goods.

Developing and sharing a process strategy with the employees could increase process efficiency, if implemented by all. This can be especially helpful for receiving, putaway, and picking. The process flowchart created for this thesis can assist to realizing this plan.

A disadvantage of the processes is that no efficiency measurements are used. Since there are often record inaccuracies, calculating the IRA% can be useful to see possible trends. Also, measuring the inventory turnover ratio at reasonable intervals is quick and useful because it gives an overview of the efficiency of ordering. For a deeper analysis, the restaurant should have segregated information for inventory. Having inventory values for raw materials, WiP, and finished goods, can give a more precise value for the inventory turnover ratio for each category. Additionally, forecasts should be compared to actual figures to identify trends and reduce inefficiencies.

On the other hand, the restaurant uses the GM ratio reports extensively, which is positive because the GM ratio is used as an inventory process efficiency tool, among other things.

To conclude, although the total value of the inventory processes cost is quite high, the metrics indicate that the inventory management processes are getting more efficient but it is lower than average. Also, according to the RXM, the restaurant's gross margin is much lower than companies in the same industry in Finland.

5.1 Evaluation of the research process

Overall, the research process was rather straightforward. The purpose of the thesis was clearly defined since the start. One of the investigative questions needed to be adapted to the circumstances so it was replaced with a question which suited better the demarkation of the thesis. The theoretical framework was quite time-consuming because the author wanted to explore different theories. There was good communication with the commissioning company and the thesis advisor. Receiving all qualitative and quantitative data lasted more than two months. The process of writing about the company's processes was made easy by the fact that the author has worked for the company. After receiving the financial figures, the process of editing and analyzing the data was relatively easy.

5.2 Reliability

The sources used in the theoretical framework are selected with caution. There is a variety of reliable sources involved in the writing of the theories. The managers were

honest during the interviews. They expressed freely their opinions and they recognize which parts of the processes should be improved.

One source, which is of doubtful credibility, is CSI market. This was used to benchmark the inventory turnover ratio of Restaurant X. However, the reliability of the source has been questioned in the empirical part and the reader has been advised to use it with critical thinking.

All in all, the quantitative results are company-specific but the research and analysis methods can be repeated and adapted to different companies from different industries and countries.

5.3 Ideas for development

The theoretical framework introduced the fundamentals of the Economic Order Quantity Model and one variation of it for perishables. An idea for further development would be an application of the EOQ model to meet the restaurant's requirements. In more detail, the model for perishables with dynamic demand and a buffer stock can be applied and examined. The model is highly mathematical and accurate under certain conditions but the company might challenge its usefulness. Therefore, applying the model to the restaurant's activities should not be on the top of the priority list. Both models would be rather difficult to be implemented if done manually, so it is suggested that they are programmed to the system to give the estimations on demand.

The topic would benefit from an evaluation of the materials planning process as conducted by top management. The information about this process was presented from Restaurant X's standpoint, therefore the entire picture is not given. Also, their inventory-related expenses can be included if a similar project is undertaken. Estimations based on the RXM's knowledge were used to apply the expenses related to top management.

Some other items that could have been included in the cost of stockout or opportunity cost and cost of funds. The research does not include the insurance and risk management costs because they were not available to the company. However, they should be taken into account if the research is used for another company.

Expanding the topic to other restaurants of the same franchise in Finland and abroad could raise awareness for the inefficiencies that exist in the processes.

This chapter has concluded the thesis with the key take-aways, evaluation, reliability and ideas for further research.

References

BBC News 2018. Burberry burns bags, clothes and perfume worth millions. URL: https://www.bbc.com/news/business-44885983. Accessed: 7 October 2018.

Bhimani, A., Horngren, C., Datar, S. & Foster, G. 2008. Management and Cost Accounting. 4th ed. Pearson Education Limited. Edinburgh Gate. URL: https://books.google.fi/books?id=r6n-rhedWqoC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. Accessed: 20 October 2018.

BPP Learning Media 2017. FIA Foundations in Management Accounting FMA (ACCA F2). BPP Learning Media.

Bragg, S. 2018. ABP #56 – Inventory Record Accuracy. The Accounting Best Practices Podcast. Podcast. URL: https://www.accountingtools.com/podcasts. Accessed: 18 October 2018.

Bragg, S. 2018. Inventory Management. 3rd ed. Accounting Tools. Centennial.

Braun, K. & Tietz, W. 2015. Managerial Accounting. Global Edition. 4th ed. Pearson Education. England.

Burja, V. & Burja, C. 2010. Analysis Model for Inventory Management. Annals of the University of Petroşani: Economics, 10, 1, pp. 43 – 50. URL: https://www.upet.ro/annals/economics/pdf/annals-2010-part1.pdf. Accessed: 20 October 2018.

Business Dictionary 2018. Opportunity cost. URL: http://www.businessdictionary.com/definition/opportunity-cost.html. Accessed: 28 August 2018.

Business Dictionary 2018. Pull system. URL: http://www.businessdictionary.com/definition/pull-system.html. Accessed: 1 October 2018.

Coronado, V. 13 November 2015. Optimizing the Warehouse to Maximize Space and Efficacy. LinkedIn. URL: https://www.linkedin.com/pulse/optimizing-warehouse-maximize-space-efficacy-victor-coronado. Accessed: 1 October 2018.

Corporate Finance Institute 2015. Cost of Goods Sold (COGS). URL: https://corporatefinanceinstitute.com/resources/knowledge/accounting/cost-of-goods-sold-cogs/. Accessed: 18 October 2018.

CSIMarket 2018. Restaurants Industry. URL: https://csimarket.com/Industry/industry_Efficiency.php?ind=914. Accessed: 11 November 2018.

Erlenkotter, D. 1990. Ford Whitman Harris and the Economic Order Quantity Model. Operations Research, 38, 6, pp. 937-946.

Expat Finland 2018. Wages, Terms & Conditions of Employment. URL: https://www.expat-finland.com/employment/wages_conditions.html. Accessed: 22 October 2018.

Financial Times 2018. Definition of perishable goods. URL: http://markets.ft.com/research/Lexicon/Term?term=perishable-goods. Accessed: 15 September 2018.

Gibson, C. 2008. Financial Reporting and Analysis: Using Financial Accounting Information. 11th ed. South-Western Cengage Learning. Mason. URL: https://books.google.fi/books?id=EMGjIz5QMfAC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. Accessed: 20 October 2018.

Goldsby, T, & Martichenko, R. 2005. Lean Sig Sigma Logistics. Strategic Development to Operational Success. J. Ross Publishing, Inc. Boca Raton. URL: https://books.google.fi/books?id=fp3ZJJzbW0EC&printsec=frontcover#v=onepage&q&f=false. Accessed: 3 November 2018.

Heisig, G. 2012. Planning Stability in Material Requirements Planning Systems. Volume 515 of Lecture Notes in Economics and Mathematical Systems. Springer Science & Business Media. Berlin. URL: https://books.google.fi/books?id=n3wQBwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. Accessed: 3 November 2018.

Hopp, W. & Spearman, M. 2004. To Pull or Not to Pull: What is the Question? Manufacturing & Service Operations Management, 6, 2, pp. 133-148. URL: https://pubsonline.informs.org/doi/pdf/10.1287/msom.1030.0028. Accessed: 5 October 2018.

Hugos, M. 2018. Essentials of Supply Chain Management. 4th ed. John Wiley & Sons, Inc. Hoboken. URL: https://books.google.fi/books?id=GWpODwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. Accessed: 3 October 2018.

IBM Knowledge Center 2013. Glossary. URL: https://www.ibm.com/support/knowledgecenter/en/SS6QYM_9.1.0/com.ibm.help.glossary.doc/MCSF_Glossary_A_63887_22331.html#T63887__automaticstorageandretrievalsystem. Accessed: 1 October 2018.

Ibraheem, A. & Murata, A. 2009. An optimal EOQ model for perishable products with varying demand pattern. In Fifth International Workshop on Computational Intelligence & Applications 10 – 12 November 2009. Hiroshima University. Hiroshima. URL: https://pdfs.semanticscholar.org/cd5f/38bb16659a1447d455553b587947071d3390.pdf. Accessed: 13 September 2018.

Investopedia. 2018. Inventory Management. URL: https://www.investopedia.com/terms/i/inventory-management.asp. Accessed: 26 March 2018.

Jones, R. 2008. Proving Continuous Improvement with Profit Ability. ASQ Quality Press. Milwaukee. URL: https://books.google.fi/books?id=L6kFGCiPmBEC&printsec=frontcover#v=onepage&q&f=false. Accessed: 10 October 2018.

Laing, E. 2018. Hedging your bets: how SMEs can manage currency risk. The Irish Times. URL: https://www.irishtimes.com/business/work/hedging-your-bets-how-smes-can-manage-currency-risk-1.3635929. Accessed: 24 September 2018.

Little, J. & Graves, S. & 2008. Little's Law. In Chhajed, D. & Lowe, T. Building Intuition: Insights from Basic Operations Management Models and Principles, pp. 81–100. Springer Science+Business Media LLC. New York. URL:

http://web.mit.edu/~sgraves/www/papers/Little%27s%20Law-Published.pdf. Accessed: 5 October 2018.

Mowen, M. & Hansen, D. & Heitger, D. 2015. Cornerstones of Managerial Accounting. 6th ed. Cengage Learning. Boston.

Quarterman, L. 2006. Strategos Guide To Cycle Counting & Inventory Accuracy. Strategos, Inc. Kansas City. URL: http://www.strategosinc.com/admin/buy/cc/CC_Guide02_sample.pdf. Accessed: 18 October 2018.

Rich, J. & Jones, J. 2017. Cornerstones of Financial Accounting. 4th ed. Cengage Learning. Boston. URL: https://books.google.fi/books?id=AqEuDwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. Accessed: 20 October 2018.

Robinson, T., Henry, E., Pirie, W. & Broihahn, M. 2012. International Financial Statement Analysis. 2nd ed. John Wiley & Sons, Inc. Hoboken. URL: https://books.google.fi/books?id=6fGaDWOUyBUC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false. Accessed: 20 October 2018.

Rubin, H. & Rubin, I. 2012. Qualitative Interviewing: The Art of Hearing Data. 3rd ed. Sage Publications, Inc. Thousand Oaks.

Russell, J. 2016. Banking on Kanban: Mastering Kanban to Boost Cash Flow, Minimize Inventory, and Maximize Delivery Performance. Dynamic Kanban, Inc. Ninety Six. URL: https://books.google.fi/books?id=tSumDAAAQBAJ&printsec=frontcover#v=onepage&q&f=false. Accessed: 6 October 2018.

Sheldon, D. 2008. Lean Materials Planning and Execution. A Guide to Internal and External Supply Management Excellence. J. Ross Publishing, Inc. URL: https://books.google.fi/books?id=0DFZW1jh2OYC&printsec=frontcover#v=onepage&q&f=false. Accessed: 4 November 2018.

Solution Matrix Limited 2018. Inventory, Inventory Management and Accounting. URL: https://www.business-case-analysis.com/inventory.html#fifo-vs-lifo. Accessed: 14 April 2018.

Swallow, J. 2013. Business Plans - making them realistic and effective. Lulu Enterprises Inc. Raleigh. URL: https://books.google.fi/books?id=q2i1AwAAQBAJ&pg=PA82&dq=smart+plan+business+measurable&hl=en&sa=X&ved=0ahUKEwiPpujRl5XeAhXFjywKHfH3BlQQ6AEIRDAF#v=onepage&q=smart%20plan%20business%20measurable&f=false. Accessed: 20 October 2018.

Westford University College 2016. FSN Analysis in Inventory Management. URL: https://mywestford.com/blog/fsn-analysis-in-inventory-management/. Accessed: 1 July 2018.

XXXXX XXXX XXXXX 2017. Financial Summary FY17. URL: https://XXXXXXX.theXXXXXXXXXt.com/XXXXXXXX/XXXX/DXXXXXXXXXXXXs/4XXXX0.pdf. Accessed: 25 March 2018.

Appendices

Appendix 1. Flowchart symbols explanation (Source: Lucidchart 2018)

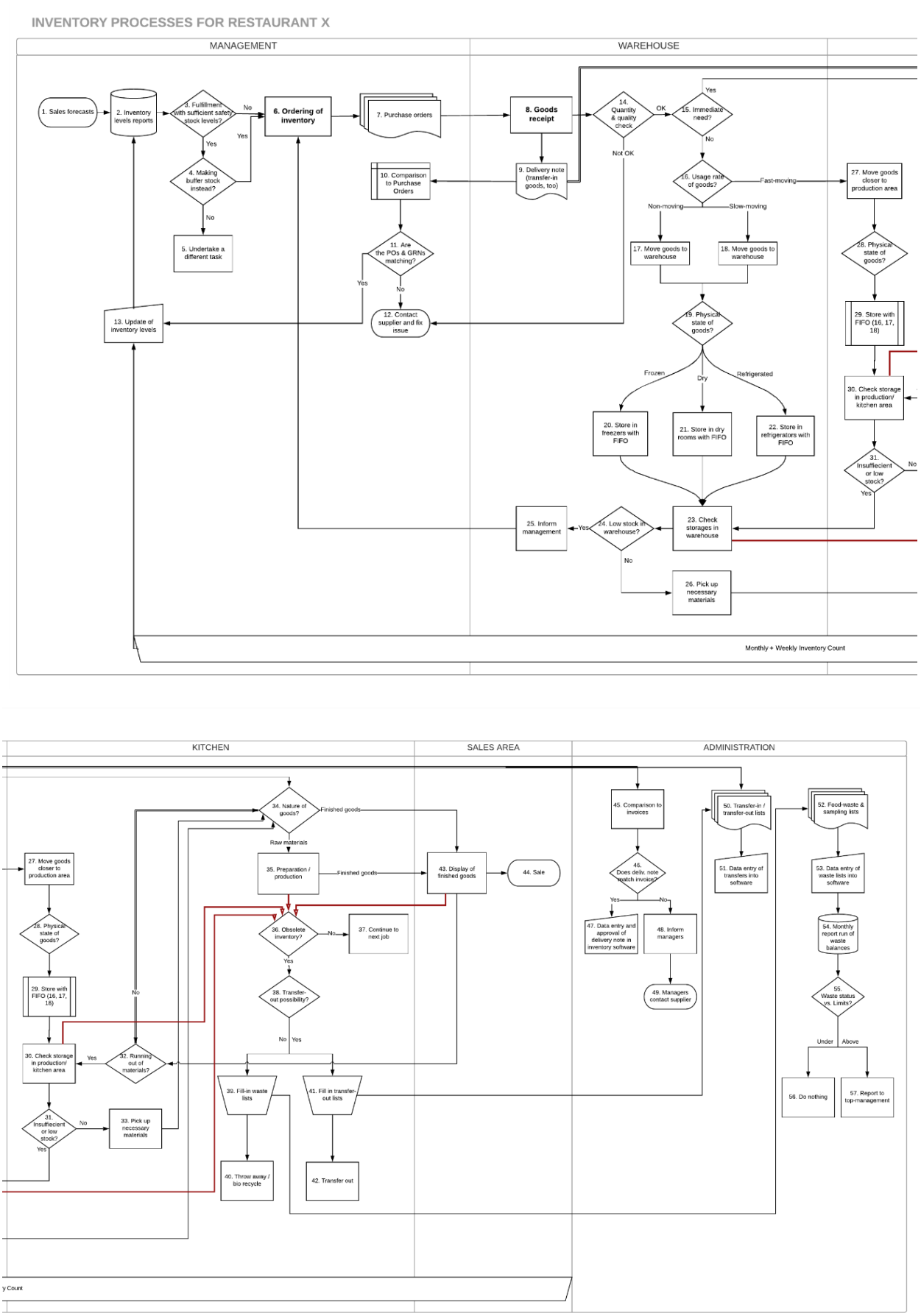
Flowchart Symbol	Name	Description
	Process symbol	Also known as an "Action Symbol," this shape represents a process, action, or function. It's the most widely-used symbol in flowcharting.
	Start/End symbol	Also known as the "Terminator Symbol," this symbol represents the start points, end points, and potential outcomes of a path. Often contains "Start" or "End" within the shape.
	Document symbol	Represents the input or output of a document, specifically. Examples of and input are receiving a report, email, or order. Examples of an output using a document symbol include generating a presentation, memo, or letter.
	Decision symbol	Indicates a question to be answered — usually yes/no or true/false. The flowchart path may then split off into different branches depending on the answer or consequences thereafter.

Figure 17. Flowchart symbols explanation 1

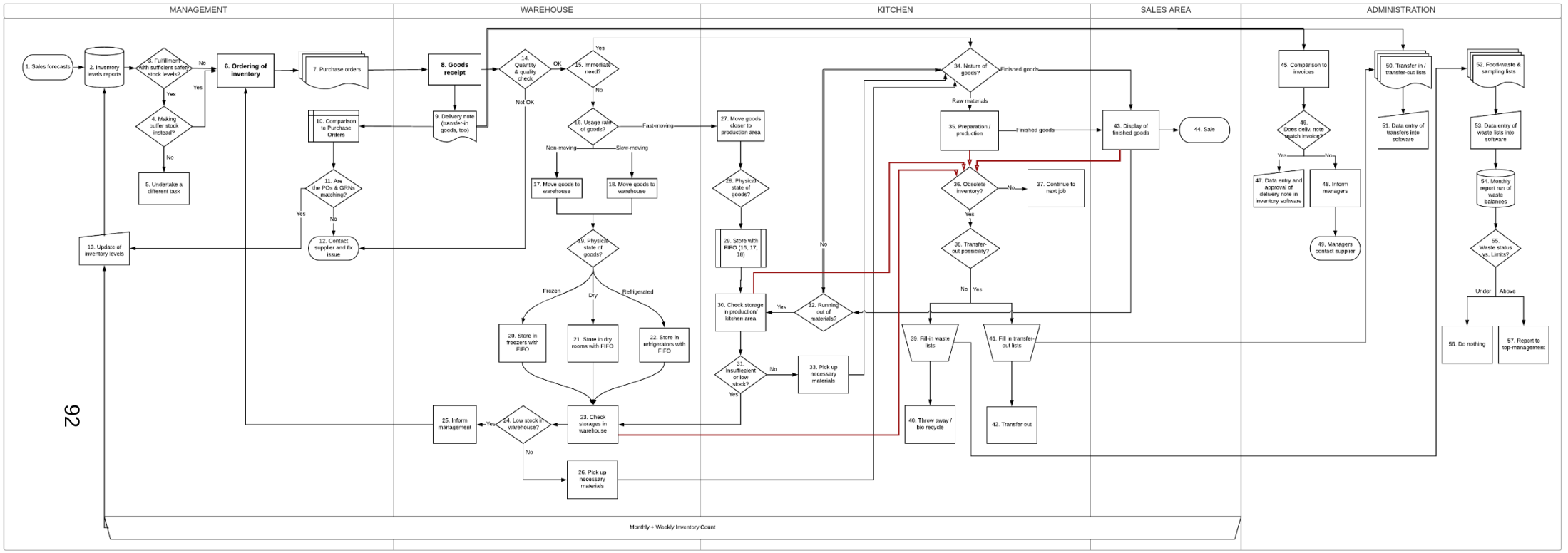
Flowchart Symbol	Name	Description
	Database symbol	Represents data housed on a storage service that will likely allow for searching and filtering by users.
	Predefined process symbol	Indicates a complicated process or operation that is well-known or defined elsewhere.
	Internal storage symbol	Commonly used to map out software designs, this shape indicates data that is stored within internal memory.
	Manual input symbol	Represents the manual input of data into a field or step in a process, usually through a keyboard or device. Example scenario includes the step in a login process where a user is prompted to enter data manually.
	Manual operation symbol	Indicates a step that must be done manually, not automatically.
	Multiple documents symbol	Represents multiple documents or reports.

Figure 18. Flowchart symbols explanation 2

Appendix 2. Restaurant X's inventory management flowchart



INVENTORY PROCESSES FOR RESTAURANT X



Appendix 3. Interview guide

Face-to-face interview with RA:

1. Description of tasks related to inventory
2. Average time needed for all tasks
3. In what situations is reporting necessary and to whom are the reports sent?
4. What cost information does the RA have access to?

Follow-up email questions with RA (adapted to meet confidentiality request)

1. The software you are using includes information about the item number, unit weight, unit price, currency, product ingredients, and supplier cost. Is there any other information that would be interesting to share?
2. Was it so that this information cannot be edited by you but only by the franchiser?
3. You mentioned that you check the delivery note against the invoices. a) Where do you get the invoices from? b) Are the invoices paid after the deliveries and after you check the delivery notes?
4. You mentioned that you have an Excel file with the delivery note claims. a) Who (which department) takes care of settling the differences? b) How are they settled? c) How often is the file checked?
5. I remember the product X example you used when explaining the "transfer-out" method from an old to new item. Transfer-out can be used when there is a new version of an older item. Correct? What about old items that are visibly different from the new items (for example, different packaging)? Can transfer out still be used?
6. Is sample waste recorded differently from production waste? And is it possible to be tracked?
7. You mentioned that you do monthly checks of the waste balances and if they exceed the limit, you make a report of the items and the waste volumes. a) Are these values defined by the franchiser? b) How are they defined? Example.

Pair face-to-face interview with the RM and PM:

1. What inventory classification tools are used? Examples: FSN (Fast-moving, Slow-moving, Non-moving stock), ABC ("A" being the most important inventory items which are responsible for the biggest portion of transactions), or some other analysis tool?
2. Is there an ordering strategy? Please, elaborate on what triggers ordering, how many people are responsible for it, what items are taken into account (volume discounts, freight costs, quality of goods, lead time, etc.)

3. How would you describe the purchasing activities? Can it be done through the software? Do PO's need approval? Is the process the same for all suppliers?
4. What happens after the physical count? Investigation, prevention, inventory balances adjustments?
5. Is there a way for you (except for visual observations) to know the inventory levels between physical counts? Is there an index for analyzing inventory record accuracy?
6. What about inventory efficiency indicators?
7. How many different items are there included in the inventory?
8. Estimation of duration in hours of each inventory related process.

Face-to-face interview with RXM:

1. How is the process of materials planning executed? Is it based on forecasts, historical data? If based on forecasts, a) who suggests those forecasts? b) what is the projected period (a month, week, day)?
2. Gross margin reports
3. Requested Profit and Loss Statement values

Phone call and follow-up email for clarifications.

Face-to-face interview with OM:

1. Prior experience and application of a similar project
2. Inventory-related costs from internal system
3. Discussion on processes