Problems and Improvement suggestions in the picking process of XX Vantaa warehouse.

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Abstract
Logistics is the backbone of any business. It is important for a company to have a well-coordinated picking process that results in good working conditions as well as meets the customers’ demands. Furthermore, a good warehouse management system provides a systematic product flow and work ergonomics. This study was conducted in XX Vantaa Finland. XX is one of the largest home furniture retail chains.

The task was to determine whether there was a necessity of order picking routing based on the pallet loading features and to decide how best to organize the picking process in order to have a good product flow. The objective of this thesis was to improve the physical logistic distribution inside the XX store or warehouse.

The implementation method was qualitative with abductive reasoning, and participant observation and interviews were the methods of data collection. In addition, pictures and small notes were recorded. The data was analysed qualitatively with progressive focusing. The main results were: Routing of any kind was not implemented leading to the fact that the unit load was not properly stacked. Misuse of the control rooms led to unnecessary walking in the warehouse and finally, there was a poor product flow inside the warehouse.

Order picking routing based on the pallet loading feature is necessary in the XX warehouse managements system. It is necessary to remove the picking list and replace it with a paperless picking process. Re-arrangement and better use of the control rooms should also be implemented.

Keywords
(Warehousing, order picking routing, lean process, pallet loading features)
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Acknowledgement

“Kindness is a language which the deaf can hear and the blind can see.” — Mark Twain

It has been a great experience. Thanks to everyone who has been part of my journey.
1 Introduction

Logistics is movement of materials from the supplier into an organization through operations within the organization to the end customer (Waters 2003, 6). It does not matter how well the products, either tangible or intangible, are manufactured and marketed; logistics play a vital role in the success of the product in any industry (Waters 2003, 19). The physical distribution of the product is what matters in having a successful outcome. Due to the rise of the internet, many warehouses and stores face drastic changes in meeting customer demands. The logistic process must adapt to the current environment of the market in order to have a competitive advantage. (Frazelle 2002.)

The picking process comprises of different steps that need specific information to a certain extent. When workers begin to work in the warehouse, they should have adequate instructions and practice on ways to collect the assigned products. The warehouse management system plays a key role in serving this type of co-ordination process. It is sensible to have an agile system in place due to having different types of goods and services under one roof. (Frazelle 2002.)

Most warehouse management systems do not support order picking routing based on pallet loading future, and this creates a toil on the workers (Bodis 2017). Having enough process information and a secure picking system is important. The material for the warehouse work process was provided in the learning process. In order to facilitate and improve the picking process, the process has an aim to aid the pickers with computer-guided routing based on the characteristics of the products and to see if it needs any significant changes.

XX Vantaa in Finland assigned this thesis specifically for the picking department. The author chose this topic due to his related experience in working life. The author had problems with the picking process and difficulties in adapting to it. XX is a leading retail chain that sells affordable furniture all around the world. Online shopping has shown growth in the recent years, and this has led to increase in online orders. It has led the company to change its retail direction over the years, introduce more online channels for selling their
products and update its business model domestically and internationally (Ingka Holding 2018). This trend of shoppers going online has led to changes in the operations of the picking department in the XX warehouse.

The objective of this thesis was to improve the physical logistic distribution inside the XX store/warehouse and determine if there was any necessity of routing in the picking process for their electronic retailing business. The purpose was to improve the picking department’s lead time and general operations and propose a picking layout plan to increase efficiency. The main research questions of this study were:

- Is there a necessity of ordering picking routing based on pallet loading feature?
- How best to organize the picking process in order to have a good product flow and increase productivity and ergonomics?

Since the picking process was still under development, it required to take into consideration all the information that was created during the past few years in the picking department. This was related to different topics, such as safety and ergonomics.

2 Theoretical framework

2.1 Lean process

Lean process is a method used to improve a process to maximize customers’ value and to minimize waste. Waste does not necessarily mean trash but extra work or activities which do not create any value to the customer. (Womack 2003). Lean process entails understanding the customers’ value and focusing on its key processes to constantly improve them. The objective of lean is to create value for customers through a value generating process that contains zero waste. (lean Enterprise Institute 2019.)
According to James P. Womack (2003 16), waste can be defined as any human activities that use resources but do not create any value. A good example of waste is the transport of goods from one destination to another without any purpose or having processing steps that are not needed. The critical initial point in lean thinking is value. The value in a lean process is all the necessary activities that a customer is willing to pay for which are; faster than the normal delivery, reduced lead time and additional extra service to a product.

According to Liker and convis, the process is studied first from the perspective of the customer. Understanding what brings customer value helps in pinpointing the waste that should be eliminated. This helps the customer to receive services without any interruption.

According to lean Enterprise Institute, there are seven types of waste that mostly occur in any process, and they include: Overproduction which means, producing more than what is needed by the next order or customer. Waiting is another form of waste because it contributes to other waste. Waiting is mostly due to workers or operators standing idle due to machine cycles or equipment fails. Conveyance waste occurs due to unnecessarily moving parts and products from a processing step to a warehouse or to a subsequent processing step. Performing unnecessary or incorrect processing is also a form of waste. Waste can occur due to having more than the minimum stock necessary for a specifically controlled pull system. Inspection, rework, and scrap create waste. Finally, motion waste is created when operators make movements that are straining or unnecessary, such as looking for parts, tools, documents and other materials.

This theory is meaningful and related to this research. The goal of this research was to present proposals on how to minimize waste and activities which do not create any value in the XX stores/warehouses. As stated above, this is the actual and core idea of the lean process.

2.2 Warehouse

According to Waters (2003, 283), “A warehouse is any location where stock of material is held on their journey through the supply chain. As well as storage
A warehouse can be used for several other activities”. In the presence of all the initiatives in e-commerce, efficient consumer responses, integration of the supply chain and just-in-time deliveries, there will never be a good coordination to the extent that the warehouse will be eliminated from the supply chain (Frazelle 2002, 9). Most commonly used terms used for warehousing are distribution and logistics centers.

According to Frazelle (2002, 272), in today’s network a single item passes through different warehouses that serve each function between point of manufacturing and customers. If possible, two or more functions can be combined in the same warehouse operations. Figure 1 below illustrates the roles of warehouses in the supply chain.

Figure 1: Roles of warehouse in the supply chain. (Frazelle 2002)

2.2.1 Warehouse layout

Warehouse layout means the physical arrangements of the storage racks, loading and unloading areas, equipment offices and rooms and all other
facilities. It has a substantial effect on the efficiency of operations. (Waters 2003.)

Most essential elements in any warehouse are the arrival bay, storage area and the departure bay. In the arrival bay, goods from different suppliers are delivered. (Waters 2003, 284.) Figure 2 below shows the warehouse layout.

![Basic warehouse layout](image)

Figure 2 Basic warehouse layout (Waters 2003)

2.2.2 Storage assignment policies

There are different types of storage location policies also known as slotting strategies. Frequently used are the terms random and dedicated policies. Random storage assignment policies, each pallet is assigned a location that is randomly chosen from all empty locations inside the warehouse. This strategy is mostly effective when the warehouse management system is manual, so that workers can work manually. (Hackman 2017, 15.)

The dedicated storage assignment has a tendency of assigning each stock keeping unit in a specific slot location (s). This type of policy mostly needs more space than the random storage policy because certain items cannot be stored in the locations assigned to another item even though the location is empty. Nevertheless, this policy tends to make the order pickers familiar with the
picking locations and the type of goods stored in that location. The policy be used to pick orders according to the sequence of stacking properties and routing. (Hackman 2017, 15.)

Family grouping or class-based assignment storage is one where the stock keeping units are grouped into classes. Each class is assigned to a dedicated storage area, but stock keeping units within a class are stored according to a randomized storage logic. (Hackman 2017, 209.) One of the most widely used class-based storage assignment policies is (ABC). It tends to assign the frequently requested stock keeping units to the best locations in the storage. Items are categorized in classes based on the number of times they appear in the order set. Class A items are relatively few items in numbers, but they account greatly for the activity in the warehouse. Class C items are large in number but account for a small amount of warehouse activates. Items that are between Class A and C are a categorized as Class B items. This type of storage assignment policy is based on the Pareto principle. After the items are classified, they are assigned to a dedicated area in the warehouse. There are many advanced storage systems designed for different warehouse needs. (Hackman 2017, 234.)

2.2.3 Layout of storage systems

The layout of storage area has a major impact on the efficiency of the operations. The basic storage in a warehouse is of floor space marked out in grid to identify different locations of materials either bulky or heavy. Another type of storage is shelving built in aisles with material typically in pallets (Waters, 2003, 293-295). Storage in warehouse is arrange in aisles which helps in reducing the ground area needed. There are different aisle types depending on the needs of the warehouse. The aisles may be quite high and can have different width. The basic aisles types are wide aisle, narrow aisles and vary narrow aisles. Smaller units are stored in bins which are containers arranged in pigeonholes that makes materials easy to find and pick. (Dave Piasecki, 2012.)

Majority of warehouses prefer using pallet racking system to maximize their storage area space that is available. This system has a significant storage advantage, but a lot must be considered. Selective racking is the most commonly used racking system which allows pallets to be accessed from the structure
aisles. It can be configured to almost any size required. It is suitable for picking. Second type of racking is drive in rack which is designed to maximize the use of floor space and to remove the poor utilization of vertical space in the warehouse. To archive this, the racking channels are built in a Z direction into which forklifts can enter the by holding the pallets in laterally. In the channels the profile supports then pallets on the side of each loading unit. These are mostly not suitable for picking. (Roodbergen, 2011.)

The third type of racking system is pallet flow racking also referred as gravity flow racks. By implementing (FIFO) loading system, the loads are stored at higher and removed at the lower end points. This type of system is partially suitable for picking due to the fact it’s only restricted to the floor level. Lastly, Shuttle racking system switches gravity lanes with level horizontal channels in which small machines stock or repossess the goods in racking lanes. They offer the most pallet density of all manual solutions this can be easily designed around a wide range of building layouts. Since it’s not designed to support picking operations it even creates a great risk in collision of shuttle operator. (Halbeisen 2015, 99-140.)

2.2.4 Rack layout concepts for warehouses

There are different layouts designed for order picking. It doesn’t matter if it concerns small parts order picking or case picking. A common feature is that, the picker must travel through the areas and making several stops as the goods are being picked. The first picking layout comprises of several pick aisles that comprise of racks on both sides which store products. The picker can change aisle by using the cross aisles. Typically, there are at least two cross aisles located at the front and the back of the warehouse, which has an advantage of more routing options which reduce travel distance. Increase in cross aisles seems a disadvantage, but it has an upward effect on the route length. Figure 3 below is a representation of rack layout with multiple blocks. (Roodbergen, 2011.)
Unit loads such as pallets are simply easy for picking which tends to make routing simply straight forward. This has led to managers not rethinking the designer of layout and traditional designer have based their assumptions on two things mainly which are cross aisles are straight and must meet picking aisles at right angle. Secondly, picking aisles are straight and are oriented in the same directions. The author writes from the construction point of view that limit efficiency and productivity.

The flying v layout is a layout that disapproves Cross aisle assumption that, cross aisles are straight and must meet picking aisles at right angle. Changes in design has led to travel distance to pick a single pallet shorter by 10%.

Fishbone layout disapproves cross aisle assumption that, picking aisles are straight and are oriented in the same directions. Fishbone layout has resulted in 20% shorter distance than traditional warehouse. The disadvantage of this layout is, it requires 3-5% more space than that of traditional layouts. This
designed layout has their limitations, but the aim was to get know more. The multiple block layout is still the best choice in random storage warehouse for order picking operations. (Goran Dukic & Opetuk Tihomir 2014, 9.)

![Fishbone and V layout in warehouse](image)

Figure 4: Fishbone and V layout in warehouse (Goran Dukic & Opetuk Tihomir 2014)

2.2.5 Product flow

The product flow of any material in the warehouse depends on the inbound and outbound location of the warehouse, in other words the receiving end and shipping end of the warehouse. (Hackman 2017.)

There are various types of configurations in product flow. In I-shaped product flow, the receiving and shipping are in the middle of the warehouse. This type of configuration tends to form I shaped product flow. In L flow type of configuration, the receiving and shipping are in the opposite sides but face in different directions forming an L shape structure as seen in Figure 5. When the storage locations are in the same side this tends to form other type of configuration and this is referred to as U flow configurations. As seen in the Figure 6 below. (Hackman 2017, 66.)
2.3 Order picking

Order-picking is defined as the process of retrieving items from storage locations in response to a specific customer request. It can also be defined as a warehousing operation that deals with picking of products from storage locations to satisfy customer demands or other in-factory operations such as assembly. (Bodis 2017.)

According to Frazelle (2002, 80), the estimated distributed cost in warehouse activities, order picking takes the largest percentage. This has mainly been
contributed by new processes and operating programs like Just IN Time (JIT) and Cycle Time Reduction in manufacturing, whereby manufacturing efficiency and cost reduction is of high importance. Other factors contributing to high cost of order picking operations have been because of quick response in consumer taste, marketing strategies like micro-marketing and megabrand strategies.

These factors have caused smaller orders to be transported to warehouses or delivered to customers more frequently and more accurately where more than one Stock keeping Units must be combined before being shipped out. This has led to increase in throughput storage and accuracy requirements to increase productivity. Increase in quality improvement and customer services emphasis has pressured organizations to improve the order picking activities, reducing product damages, reduction of transaction time and improving picking accuracy. Operating cost distribution of a typical warehouse illustrated in Figure 7 below, shows that 50% of cost contributed by order picking operations (Frazelle 2002, 259.)

![Operating cost distribution](image)

Figure 7: Operating cost distribution (Frazelle 2002)

The reason for this high cost is the fact that order picking still need involvement of human to perform picking as automating order picking systems needs a large
investment. There is increase in requirements which includes; fast, reliable and accurate pick up of Stock Keeping Units’ impacting company’s conventional response to hire more staff. This results in higher labour cost and more layoffs in the future due to volatile demand and uncertain business environment. Numerus ways exists in improving picking productivity with no need of increase in of staff and making large investments in automated systems. (Frazelle 2002.)

The following are picking productivity considerations when there’s increase in demand placed mainly to order picking systems;

Issue pack optimization: Is the process by which the customer can order either in full pallets amount, creating quarter or half pallets loads. It’s mainly done to avoid mistakes in counting, manual or physical handling. Similarly, by requesting customers to have their orders in full case quantities this save time, which results in reducing the extra packaging and counting which associated with loose case picking. (Frazelle 2002, 140.)

Pick-from-storage: To improve picking accuracy and productivity is to move the storage location to the pickers, preferably in one reserve storage location. This is due most of the pickers time is consume in travelling and searching for location of the goods to be picked. (Frazelle 2002, 142.)

Picking task simplification: By eliminating and/or combining order picking task, tend to simplify the process. The human activities involved in order picking may include traveling, extracting, reaching, bending, documenting, sorting, packing and searching for pick location. Figure 8 below shows the distribution of order pickers working time. (Frazelle 2002, 144.)
Figure 8: Distribution of an order pickers working time (Frazelle 2002).

Pick sequencing: There is great need in sequencing the locations visits in walk and pick systems in any case picking process if an order can occupy more than one pallet. When picker is touring and taking goods from the stage location it ought to be sequenced. This enables reduction of travel distance and building of a stable unit load. (Frazelle 2002, 174.)

Paper less picking: The most effective way of improving order picking is to be able to design the process that has no paper work, as this is the major source of inaccuracies and productivity losses. Pick to light systems, radio frequency data communications and voice input and output are existing technology that have been used to drop paper work successfully. (Frazelle 2002, 194-195.)
Table 1: Order Picking Work Elements and Means for Elimination (Frazelle 2002)

<table>
<thead>
<tr>
<th>Work elements</th>
<th>Bring pick location to picker</th>
<th>Stock-to-picker systems:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Main load AS/RS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Horizontal Carousel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vertical carousel</td>
</tr>
<tr>
<td>Documenting</td>
<td>Automate information flow</td>
<td>Computer-aided order</td>
</tr>
<tr>
<td></td>
<td></td>
<td>picking Automatic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>identification system</td>
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<tr>
<td></td>
<td></td>
<td>Light aided order</td>
</tr>
<tr>
<td></td>
<td></td>
<td>picking radio frequency</td>
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<tr>
<td></td>
<td></td>
<td>terminal headset</td>
</tr>
<tr>
<td>Reaching</td>
<td>Present item at waits level</td>
<td>Vertical carousels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Person-aboard As/RS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Miniload AS/RS</td>
</tr>
<tr>
<td>Searching</td>
<td>Bring pick locations to picker</td>
<td>Stock-to-picker systems</td>
</tr>
<tr>
<td></td>
<td>Take picker to pick location</td>
<td>Person-aboard AS/RS</td>
</tr>
<tr>
<td></td>
<td>Illuminate pick location</td>
<td></td>
</tr>
<tr>
<td>Extracting</td>
<td>Automated Dispensing</td>
<td>Automatic item pickers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Robotic order pickers</td>
</tr>
<tr>
<td>Counting</td>
<td>Weigh counting</td>
<td>Scale on picking</td>
</tr>
<tr>
<td></td>
<td>Pre-package in issue increments</td>
<td>vehicles</td>
</tr>
</tbody>
</table>

2.3.1 Order picking principles

There several order-picking system classifications. Pickers to part system is commonly used and is regarded as basic solution for picking process. The picker retrieves items from the picking location to complete a single order or batch of multiple order. It is mostly set up for pallet unit load with storage system made up of pallet racks. Conversely a gravity flow rack with storage of cartons or pallet
unit loads can be used. Using this type of principle optimization can be carried out with routing algorithms, items allocation, batching polices and paper less operations. (Dallari fabrizio 2014.)

Part to picker system solution is composed of storage & forward areas and material handling systems which connect them. Also known as feeding systems, the forward area is considered as picking bay. The unit load which is needed to fulfil the order is retrieved from the storage location and transferred to the picking bay. In the picking bay, a picker is situated at each area picking goods from the unit load. When all orders are picked, the rest of the goods are sent back to the storage area waiting for selection as a new retrieval operation. In this method the unit load can be either in large or small dimensions (Dallari et al. 2014).

Pick To box system composes of similar elements which include; storage & forward area, replenishment system of forward area and sorter. The forward area can be designed to have multiple picking zones. Each of them is assigned a picker. This picking zones are then connected by a conveyor with a box filled with orders. The orders picked are then placed in the conveyor with each corresponding partially or completely to customer orders. Therefore, line-end sorting per order is not a necessity anymore. On other hand box sorting on basis of the destination is enough since orders have been prepared already. The advantage of separating the forward area in multiple zones is the reduction of travel time. The solution is preferable when there is high number of items, medium size flows and small size orders. (Dallari et al. 2014).

Sorting system is composed of; storage area, forward area, replenishment system of the forward area and sorter. In the forward area retrieving of each single item results to batching of multiple orders which are kept in a conveyor connecting the forward area with the sorting area. The conveyor passes across the aisle of the forward area, so each picker can work in smaller area of the forward area. When considering using the system, it mainly depends on various factors; physical characteristics of goods, dimension, weight and shape of the
items to be handled. In the matters of productivity this method has the highest productivity than picker to parts solutions (Dallari et al. 2014)

2.3.2 Methods of picking

Different picking methods exist in the warehouse. Each is customized depending on the requirements of the business size of the warehouse and inventory polices, the man-power on hand and customer demand. These various methods can be used with the goal of reducing travel time, routing methods which determine the sequence and routes of traveling and trying to reduce the total travel distance. (Goran dukic 2009.)

Factors that contribute to the selection of order picking method include; characteristic of the products being handled, the total number of stocks keeping units, transactions and orders, picks per order, quantity per pick and picks per stock keeping unit. (Piasecki 2012.)

Single order picking is the most common type of picking. The picker is tasked with one order at a time and then travels to the warehouse to fulfil the required orders. The picker must complete the list of order before going to the next. Most cases the routes are not optimized (APS Fulfillment, Inc. 2015).

Batching/multi-order; picking multiple products in a single picking order method is efficient in reducing total travel distance. The method can be used for automated picking and/or manual picking. When used in manual picking situation, the method works by allowing the picker to have stock keeping unit stock keeping units that could handle multiple orders at a time (Goran dukic 2009). This type of picking may use extensive logic programming to consolidate orders and it may easily reduce travel time. (Modern material handling , 2018.)
Zone picking method tends to divide the warehouse in different zones and the workers are assigned in a specific zone. Each zone can use its own technology and storage system depending on what work best for the Stock Keeping Unit stored in that zone. The operations are mostly effective in large operations with high number of stocks keeping units. It provides specialization of picking techniques such as automated material handling systems in one zone and manual handling in the other zone (APS Fulfillment, Inc. 2015).
Wave picking method, the picking is done at the same time in each zone. The items that are picked are sorted and combined into individual orders. It’s the quickest methods which has the shortest cycle time for picking multiple orders, but the sorting may consume a lot of time depending on the procedure that has been designed. Operations with high total number of stocks keeping unit and moderate to high picks per order may benefit from wave picking. Wave picking can be used to isolate orders by detailed carriers, routes, or zones (APS Fulfillment, Inc. 2015).
2.3.3 Order picking routing

The total picking time is the time taken to travel to the storage location, picking time of product and other activities. In order picking, the total time taken to pick goods from a storage location has a substantial effect on the total cost and efficiency of picking process. As shown above in Figure 8 the total travel time takes about 55% of all the activities that the picker must do. Factors leading to inefficiency in order picking include; building configurations, existing storage, picking systems and order picking equipment. (Erim 2018).

It is important to try to reduce the time taken and travel time when performing order picking. One of the ways used to reduce travel time is optimization of picking routes. There are six order picking route methods; Transversal S shape method, Return Midpoint, Largest Gap, Composite/Joint and optimal routing.

Transversal also known as S shape policy is the most commonly used policy. The order pickers move in an aisle where goods must be picked and tend to navigate the whole aisles. The aisles that have no goods to be picked are skipped by the picker. If the number of aisles to be visited are odd there is an exception made to the last aisle and that is, the returns travel is performed there. If the order picking equipment cannot maneuver easily within the aisle, this method becomes useful. In the Figure 12 below, it can be illustrated how S shape heuristic is conducted. (Goran dukic 2009.)
Largest gap method, in this method, the picker gets into the first aisle up to the largest gap within the aisle. A gap is the distance between two items which are next to each other, or between a cross aisle and an item nearby it. The largest gap is the part not visited by the picker. In case the largest gap is between two nearby picks, the picker undertakes a return trip route from both ends of the aisle. The back aisle is only accessible through the first or the last aisle. This method becomes of importance when extra time to change aisles is short and the number of picks is not high. As seen in Figure 13. The selected item is also in accordance to the largest gap in the warehouse that has the central depot and not the aisles. It can be compared to S shape method where the picker starts at the depot and goes to the front of the aisle which is close to the depot that has at least one item. Therefore, this may be most left or right good in that aisle. The aisle is traversed entirely after each aisle at each rear end of the warehouse has been visited as far as the largest gap and the left from the same side that was visited or entered. The last aisle is crossed entirely to the front and they are entered from the front end as far as the largest gap. When all items are picked the picker returns to the depot. (Erim 2018.)
Return and midpoint method are two different methods; in return method, the order picker enters and leaves the aisles having items to pick from the front aisles. Midpoint method may similarly look like return method on the two halves of the warehouse, but only first and last aisles are crossed entirely when visited as shown in Figure 14 below. (Goran dukic 2009.)

Composite and combined method. Composite method combines each S shape method and return method. The aim is to reduce the travel distance between the furthest pick in two adjacent aisles for every aisle singly. Combined method additionally merges each S shape method and return method however with tiny elements of dynamic programming. When items are picked from one aisle, there are two possibilities that arise; whether to go to the rear end of an aisle or return to the front end. These two possibilities must be compared with each other to
select the shortest route. After an aisle has been left at front or rear end, a choice between alternatives ending at the back or at the front must be made. (Erim 2018.) As seen in Figure 15 below.

![Figure 15: Composite and combined (Erim, 2018).](image)

Optimal routing method calculates the shortest route, regardless of layout or location of an item. The optimal routes tend to have a mixture of S shape and largest Gap method. Most order picking operations use heuristic touring strategies. Figure 16 shows how the selected items are to be picked according to the optimal routing strategy in the warehouse. (Erim 2018.)

![Figure 16: Optimal routing method (Erim, 2018).](image)
2.3.4 Order picking equipment

Consideration on the equipment used helps in efficiency of the picking process. The key factor in any warehouse is the ability to have efficient material handling flow that will enable the flow of products from inbound to outbound process run smoothly and efficiently. Equipment used influences the storage control and protection of the product. Table 2 below represents the common equipment used in warehouse and the picking methods.

Table 2: Common equipment’s used in warehouse.

<table>
<thead>
<tr>
<th>PICKING METHODS</th>
<th>PICKING PRINCIPLES</th>
<th>COMMON EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case /single</td>
<td>pickers to part system</td>
<td>Manual Forklift Jack</td>
</tr>
<tr>
<td>Batch</td>
<td>Part to picker system</td>
<td>Picking list</td>
</tr>
<tr>
<td>Zone</td>
<td>Sorting system</td>
<td>Barcode Scanners</td>
</tr>
<tr>
<td>Wave</td>
<td>Pick To box system</td>
<td>Pick-to-voice</td>
</tr>
<tr>
<td></td>
<td>Automation</td>
<td>Pick-to-light</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dispensers</td>
</tr>
</tbody>
</table>

The most basic tool used in order picking is the pump it may be electric or non-electric. It can be used in both full serve warehouses and self-serve warehouses. It poses no danger and it is quite flexible, it is mostly used by lower level pickers and can handle one stock keeping unit at a time.
Pick by paper system is widely used around the world in different distribution centers. When the picker has conducted the picks for so long, the picker tends to sort picks in sequence manually. Sometimes the best pickers will try to pick from more than one list at one time by doing mental sorting of the picks by head. Paper based picking is slow and it is widely prone to errors due to the pickers doing routing activities manually or information can be misread or transpose to numbers. It is mostly prone to wrong products being selected. (Dallari Fabrizio 2014.)

Pick by label is a system in which the labels are consumed and placed in the selected item as picking takes place. It’s mostly used in case picking and orders can be batched together. In this case, the label may have an additional information printed on it. When the picking is done the items that have been batched can later be sorted by simply reading the label. This method has its accuracy at a reasonable rate. This type of equipment enforces good counts since picking must stop when there are no more labels to apply. (Sam Flanders 2002.)

Bar code scanners is an electronic device that decodes and physically captures information contained in a barcode. The scanner scans black and white elements of the barcode by illuminating the code with red light which is then converted into matching text. This text is delivered by the scanner to a computer software system that is connected to a database. Barcode scanners are variable and include diverse capabilities, some are better suited for certain industries.
due to reading distance and work volume capacity. An example of barcode scanner is the Omni directional barcode scanner which is highly advanced and very efficient. It can decode bad print, crumpled and damaged barcodes on products. It can be used mostly in inbound and outbound process in warehouse operations. The data is transmitted through the radio frequency network to the local terminal where the picker then follows through the information displaced in a tiny screen. Information such as location item, number, and other relevant information are displayed to support the picking process. (Sam Flanders 2002.). As seen in Figure 18 is a handheld barcode scanner

Figure 18 :Handheld barcode scanner.

Picking to light refers to the process in which the picker is directed under the control of fixed mount visual display known as LED display. These displays are mounted in the picking location and they direct the picker on where they should pick the goods from and the quantity required. This type of method can easily reduce error because the picker is always directed by light and is underneath the product that must be picked. In this case the picker doesn’t have to reference back to the picking list and back to the picking location. This method makes it simple for the picker to only focus on the light. The picking rates average around 220-240 lines per hour and can be as high as 500. The system can be used to verify that the right stock is in the location, and to cycle count location on hand
quantities. Since the picker is assisted to pick visually with light, they can proceed faster than if they were using a paper list. (Sam Flanders 2002.)

Figure 19: Pick to light (Kaiho 2019).

Voice picking has radio frequency-based systems. The picker is given instructions and listens to spoken words rather than paper and displays. The picker is directed by voice and can respond by voice. Voice picking has functionality like radio frequency scanners bar code system, this is because information that can be transmitted on a display can also be spoken to the worker. The system can be used to verify that the stock movement are done in a correct location just as in bar code system. The verification is achieved by speaking the part number or location check code when vesting the stock location. The check codes are mostly 2-4 characters. Voice system are faster because the picker has freedom with both hands and eyes while working. When there is a string of numbers and letters in the process to complete a transaction or a pick, it has permission to have a scanner to be attached to the device. Below in Figure 20 we see that the picker has headphones that transmit the information and has a scanner in her hands that verifies that the right goods have been picked. (Sam Flanders 2002.)
2.3.5 Ordering picking routing based on pallet loading futures

During order picking the picker collects and allocates product to stock keeping unit. Where position is a general problem, stock keeping unit can be either a pallet, bin or box. Will focus more on pallets as the main stock keeping unit. The stock keeping unit is responsible for forming a material handling unit, protecting the product and supporting material handling process. The pallet loading problem is a maximization problem. Where it handles packing the maximum number of identical rectangular boxes onto a rectangular pallet. Due to products having different stock keeping unit properties and the specified pallet loading features, bin packing and pallet loading problem become more complex. (Bodis, 2017.)

while each parameter of order picking influences the other each with different importance. These factors should be synchronized. In this it shows the complexity of warehouse system development. A lot of research been conducted in the field of routing optimization in warehouse. Many solutions have been defined in harmonizing storage location assignments and routing to decrease the time and distance. However, the physical products parameters which are weight, dimensions and type of stock keeping unit have been left out and are rarely considered when building a warehouse system. This influence a great deal the picking sequence to build a stable unit load (UL). There is a research conducted in pallet loading and bin packing problem, but the solutions are rarely harmonized with storage location assignment and routing algorithm. (Bodis, 2017.)
OPRP -PLF stand for order picking routing based on pallet loading features in this we define OPRP -PLF as a logistics system priority which requires the right picking sequence and pallet loading method to build a stable unit load and to avoid product damage. Well most of this system depend on several factored that include product properties, order picking list characterizes and order picking system. Well most of this system depend on several factored that include product properties, order picking list characterizes and order picking system.

Table 3 Depending Factors

<table>
<thead>
<tr>
<th>Product properties</th>
<th>Order picking list Characteristics</th>
<th>Order picking systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Ordered item</td>
<td>Previously picked units and the sequence</td>
</tr>
<tr>
<td>Shape</td>
<td>Order quantity</td>
<td>Product assignment in the warehouse.</td>
</tr>
<tr>
<td>Size</td>
<td>Length of picking list</td>
<td></td>
</tr>
<tr>
<td>Stock keeping unit</td>
<td>Number of product types on the list, with different stacking properties</td>
<td></td>
</tr>
<tr>
<td>Stacking properties</td>
<td>Special customer rules for pallet loading.</td>
<td></td>
</tr>
</tbody>
</table>

The products have several parameters which define their physical stacking properties and required picking sequence. Stock keeping unit can be bags or any amorphous unit but with this research will limit it into pallets because most of our goods are being ordered to fit into pallets. The products have several parameters which define their physical stacking properties and required picking sequence. The length of the picking list shows importance of routing optimization based on pallet loading features. Saving different items and high order, results into a lot of picking movements. Implementation of order picking routing promotes a significance in reduction of lead time, reduce damage of
goods, remove the need of knowledge of products and how to stack them in stock keeping unit. Therefore, this reduces the time to build a stable unit load in the picking process. (Bodis, 2017.)

3 Research implementation

3.1 The objective of the study and the research questions

The objective of this thesis was to improve the physical logistic distribution inside the XX store or warehouse and to find out whether there was any necessity of routing in the picking process for their electronic retailing business.

The research questions were:

• Is there a necessity of ordering picking routing based on pallet loading feature?
• How best to organize the picking process in order to have a good product flow and increase productivity and ergonomics?

3.2 Research method

There are several forms of research methods when trying to find appropriate ways of finding solutions to problems (walliman, 2011). The approach chosen for this thesis was the qualitative approach. According to Cohen (2007), qualitative research is a process of realistic inquiry that seeks in-depth understanding of social phenomena within their natural setting. It mostly focuses on the question ‘why’ rather than the question ‘what’ of social phenomena. Furthermore, it relies mainly on people’s direct experiences rather than measuring and going with a numerical approach.

The author used the qualitative approach with abductive reasoning. Abductive reasoning usually starts with an incomplete set of observations and flows to the likeliest observation of the given set. Abductive reasoning leads to a decision-
making that comes from the information at hand, which is often incomplete. (Bradford 2017.)

The focus is on participants and their perceptions and experiences, which plays a significant part in providing a literal representation of the structure, order, and broad patterns found among a group of participants. This type of research encompasses a range of philosophies research techniques, and the most common of them are observation, interviews and surveys. (Walliman, 2011) The best research methods that were chosen for this thesis were observation and interview.

3.3 Data collection and screening

This research project was initialized by conducting a direct and covert observation of the XX Vantaa warehouse conditions and its operations during the normal working hours. When it comes to direct observation, the researcher observes without posing tasks to the subjects (Huon 2007). According to Taylor-Powell and Steele (1996), the researcher may conduct covert observation without attracting attention. This means that people do not know that observations are being made. However, the researcher should always maintain ethics and morality.

Due to the complexity of the picking process, direct observation became unproductive, and participation in the process became of utmost importance. The author’s interest was to have relevant results, and due to this, participant observation was arranged and conducted after a period of one month. Kulich (2005) defines participant observation as a process which enables a researcher to learn about activities of people under study in a natural setting by observing and participating in those activities. The author wanted to form a real insight into the picking process in the warehouse as well as be involved in the process.

Kulich (2005) states that in participant observation, the researcher performs fieldwork, which means that he can conduct interviews, improve memory, look actively, write detailed notes and capture events. In the process of observing the picking process, pictures and small notes were recorded. Informal or
conversational interviews were conducted meaning that no predetermined questions were asked. The author remained as open and adaptable as he could, which meant that the researcher went with the flow. This was done during observation in order to have a clear understanding of the research setting and to have the ability to answer the research questions.

The author used books and articles to support the study. Relevant theory was brought into play and discussed in accordance with the research questions. Inclusion and exclusion criteria were used to collect relevant information about the theory. English articles and books, free books and evidence-based articles were included. Non-English books, books that required purchase and non-evidence-based books were excluded.

3.4 Data analysis

Qualitative data analysis is a process of organizing and explaining the data collected. It mostly involves making sense of the data and taking notes on patterns, themes, regularities and categories. (Cohen 2007, 436.) The most significant feature of qualitative data analysis is that it focuses on texts rather than numbers. This means that the researcher analyses transcripts of interviews, literature and notes from participant observation sessions. In this case, texts can also refer to pictures or images examined by the researcher (Bachman & Schutt 2001). In this thesis, the author analyzed the data textually out of the data collected from participant observation, interviews and pictures taken of the research setting.

Qualitative data analysis is a reflexive process also termed as progressive focusing. This means that the process begins initially when the data is collected and not at the end of the collection. The researcher should note down ideas about the meaning of texts and how they relate to certain issues when observing, writing notes or interviewing. Furthermore, the researcher should be able to pinpoint (=pinpoint) and identify important statements and propose ways of coding the data. There are steps in the qualitative data analysis, and these include the documentation of the data, categorization of the data into concepts, connection of the data to show how concepts might influence each other and, finally, legitimization and representing the account. (Bachman & Schutt 2001.)
The author was keen in the data process of this project. The author defined the meaning of the texts and tried to look for relationship among phenomena throughout the project process.

In research, observations are summarized into concept categories, which develops more with more observations. Over time, the categories are refined and linked, and a theory evolves. This systematic theory is known as grounded theory. As the observation, interviewing, note taking and reflection continue, researchers refine their problems and concepts and select indicators. Models are then developed which specify relationships among phenomena, and they often develop as the researchers gain experience in the setting. For a final analysis, the researchers check their models carefully against their notes and try to discover negative evidence on the incorrectness of the model. (Bachman & Schutt 2016.) In this thesis, the author summarized the observations and suggested that the model used in the setting had various faults.

4  Empirical findings

The most common system used in XX warehouse was the pickers to part system, which was applied manually in both the warehouse and market hall. Description of technological aspects, layout and product flow in XX Vantaa warehouse was discussed and linked to the findings and actual problems in the research setting.

4.1  XX picking process overview

4.1.1  Technology and equipment in XX warehouse

The most common technology used in the picking process was the use of barcode scanners and picking list. A barcode scanner is generally used in all warehouse activities which include receiving, inventory management and replenishment of goods. Barcode scanner was a vital tool used in the company. The company that provided the hardware for XX Vantaa was Honeywell. Whereas the barcode scanner used a web-based warehouse management system known as HMS. Figure 21 below illustrates HMS interface which was used by the picking department.
Isell was the other software used to help in aiding the pickers. When orders arrived, the software organized orders and requested the types of stock keeping unit needed and location was there for shown in the interface whether it was express delivery or transport delivery.

The reason for having a picking list was to aid the picker to know where to deliver the goods and the weight of the goods on the picking list helped the picker make a stable unit load and reduce damages.

There were two different types of picking equipment used, a manual pump jack and an electrical pump jack used in the self-serve area. The reasons for this were, customers would still visit the store and some parts of the warehouse were accessible to customers. If any forklift truck was used, it would pose danger to the customer. In the full serve area, reach trucks were used to help in the picking
process, where customers did not have access. In Figure 22 below is an illustration of both pump jacks.

![Figure 22: Manual and electric pump jack.](image)

At XX Vantaa, there were three types of unit loads used in the picking process. These were Fin pallets, Euro pallets, XX pallets made of wood and XX pallets made of paper. The use of trolleys was generally for orders that the customers would pick up from the store or orders directly when he or she visits the store. Table 4 below illustrates the differences in dimensions between these stocks keeping unit including its maximum capacity loads. Most of the paper pallets were assembled by the workers before the picking starts or during the picking. Time taken to set up the paper pallets was negligible at that point. Paper pallets were mainly used if there were no returns of any goods delivered.

Table 4: Different stock keeping units used in picking process.

<table>
<thead>
<tr>
<th>Items</th>
<th>Trolley</th>
<th>Small paper pallet</th>
<th>Small wooden pallet</th>
<th>Long paper pallet</th>
<th>Long wooden pallet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions (mm)</td>
<td>600*1000</td>
<td>800*1200</td>
<td>800*1200</td>
<td>800*2000</td>
<td>800*2000</td>
</tr>
<tr>
<td>Capacity load (kg)</td>
<td>150-250</td>
<td>300</td>
<td>500</td>
<td>300</td>
<td>500</td>
</tr>
</tbody>
</table>
The capacity of the stock keeping unit was limited even though it was well designed. The reason for not loading the stock keeping unit to its full capacity was that, when transporting goods, the third-party contractors would use pump jacks and if it was too heavy it would make work difficult and take more time offloading the goods. So, there was an agreement on the capacity of each stock keeping unit to have easy handling of goods.

4.1.2 Description of a warehouse layout

XX warehouse contains cross aisles in the full serve and self-serve area. This made it easy during picking of goods, changing routes and shortening routes. Figure 23 below Illustrates warehouse layout of XX Vantaa.
Figure 23: Warehouse layout of XX Vantaa.

The number in the Table 5 represent areas in the warehouse.

Table 5: Information table of warehouse layout.

<table>
<thead>
<tr>
<th>Area number</th>
<th>Area name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Entrance</td>
<td>Entrance of workers into the warehouse</td>
</tr>
<tr>
<td>2</td>
<td>Control rooms A and B</td>
<td>Used to control information on order picking</td>
</tr>
<tr>
<td>3</td>
<td>Customer picks and transport storage</td>
<td>Stores goods after picking has been completed</td>
</tr>
<tr>
<td></td>
<td>Full serve and self-serve area</td>
<td>Stores goods for customers</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Bay area</td>
<td>Packaging of goods and Receiving of goods</td>
</tr>
<tr>
<td>5</td>
<td>Express delivery area</td>
<td>Has quick except for goods that are express</td>
</tr>
</tbody>
</table>

Transport and customer pick up storage area

Transport storage was located near the bay as seen in figure 25 above. It was mostly used when holding picked goods that had a long lead time, that helped in making sure the bay was not full of picked goods and reduced congestion at the bay. Other storage location was the customer pick up storage, which were located near the express delivery. The aim of having this storage location was to hold customer goods that would be picked by the customers at the store at a specific time. A trolley was mostly used to store goods. That made it easy to deliver them to the customer. Figure 24 shows images of the transport storage area and customer pick storage area.

![Image of transport and customer pick up storage area](image.png)

**Figure 24:** Customer pick up & transport storage area.

Customer pick up area and express delivery
The customer pick-up area was the temporary holding area when the goods were already picked. That area serves customers who came into the store and did not want to pick goods by themselves. It was also situated near check-out machines; sales employs had a responsibility to check the goods and take payments from the customers. The other area was the express delivery area used when loading goods into vans ready for express delivery.

![Image](image_url)

Figure 25: Customer pick up area.

Control rooms A, B and packing area

Control rooms A and B are located at the entrance and at the bay respectively. The computers in control room A and B are used for both replenishment and by the picking team. For the picking team, the computers were used to print picking list and check the lead times for the order from the Isell and HMS warehouse management systems. Isell was used to get information on customers’ orders and print out the necessary information.
Figure 26: Control room A and B.

Figure 27 below illustrates the packing area. This part of the warehouse stores a computer and printer that prints all the necessary waybills and other related documents. Before the goods are loaded on to the truck they are scanned, packed then loaded into the truck.

Figure 27: Packing area.
4.1.3 Picking process and Products flow in XX warehouse

It was the picker’s responsibility to be well informed about the picking process beforehand. The picking process is well elaborated by flowchart shown in the Figure 28 below.

![Flowchart of XX picking process]

**Figure 28: XX picking process.**

Before the picking process begins, pickers were responsible to log in the barcode scanner and computer. If there was a necessity of printing the picking list, then the picker would log in to the computer and write down the storage locations of the goods that should be picked. They were normally written down manually on the picking list as seen in Figure 29. Unfortunately, XX picking system did not have any routing optimizations. The barcode scanner which operated on a different warehouse management system, HMS displayed the storage locations in ascending order just as the picking list as seen in the Figure 29.
Figure 29: Picking list.

The responsibility lies on the pickers to determine the best picking route. It did not help that much in supporting the picker to have an optimized picking route. The current storage policies in XX Vantaa were mostly designed to reduce the distance of the customer who visits the store. It did not take any considerations of the picking process. Due to this, the picking list played a critical role in the picking process.

When picking starts, the pickers were responsible in organizing their own route without routing optimization, some goods were picked and stacked in different ways. A good illustration is shown in Figure 30 below.
Figure 30: Picked goods.

After the picks were done, pickers confirmed the picks using the barcode scanner. This produced a confirmation document which was kept on the goods that have been picked. Then was used later when discharging goods to the customers. As seen the Figure 31 below.
Figure 31: Confirmation document.

The confirmation document was mostly printed in control room A. When pickers sent the goods to the bay, they had to walk back to the control room A to pick confirmation documents. As illustrated in Figure 32. The red color arrow shows the route that the pickers would have taken in order to pick up the confirmation documents in control room A and the green arrow represents the correction the pickers had to make in order to return to its normal product flow if goods are to be sent to the bay or transport storage. The blue arrow represents the normal product flow.
4.2 Observation

The author presents the findings gathered after the research done by use of various methods of collecting data. The first observation showed that to perform the picking, a picking list is printed out and it has information on the location. It is observed that, the list of items to be picked in this picking list lacks routing optimization and does not provide any information on which type of stock keeping unit to be used to start the process. This is clearly illustrated in Figure 29.

In the process of picking, it was observed that experience workers carry out the picking faster than non-experienced workers. This is due to that fact that experienced workers know more about the products. The work that is carried out in the warehouse is mostly repetitive and this gives an advantage of having
some type of automation and reducing the dependence of people. Observation made on the picking list and barcode discovered that routing of any kind was not implemented into the system. This was the responsibility of the workers in XX.

Due to not having any kind of routing in the warehouse, an approximation of time is given to the pickers that each pick should be conducted within one hour not depending on the size of task or route taken. Another observation was that, unit load that was not packed properly, and this brought about unloading the goods and rearranging them all over again, so they can produce a stable unit load. This is due to inexperience and fatigue at work. The result of this is loss of time and flow of the picking process.

Most of the picking depend on the picking list which has information on where the goods should be sent. A confirmation document is printed after the picking is done. As seen in Figure 31. When the picking is confirmed on the barcode scanner, a copy is printed in control room A as seen in the warehouse layout Figure 23. This tends to make the picker not have a consistent flow and must return if he or she should send the goods to the bay area or transport storage area. This has shown that the product flow is uneven; It is very advantageous for the worker who picked goods for customer pick up and customer storage locations as the control room A is located nearby.

4.3 Interview

Interviews were conducted with different workers in XX Vantaa. The research setting did not require any structured interview because most questions were asked to seek clarification about the process and the research setting. Informal or conversational interview was conducted meaning that no predetermined questions are asked. The researcher remains as open and adaptable as he can, this means that the researcher goes with the flow (Cohen, 2007). This was done during observation to have a clear understanding of the research setting and to have the ability to answer the research questions.
First is that, there is a necessity of routing optimizations in the warehouse. They insisted that routing based on pallet loading feature is a good form of routing that will help in reducing mistakes done by workers when orders are picked. They revealed that relying on experienced workers and staff sometimes is damaging, for they may be on holiday or on sick leave. This means the team is constantly affected.

Some candidates revealed the misuse of the control rooms which leads to unnecessary walking in the warehouse. This undefined walking distance is very difficult to be problem due to increase in staff turnover rate.

5 Improvement suggestions

As stated in the empirical findings, there is lack of routing optimization. It is suggested that, order picking routing based on pallet loading feature is necessary in XX warehouse managements system. Bodis (2017) states that unit load stacking is a general problem. A warehouse having different products may lead to bad stacking as seen the figure 34. This problem could be avoided by implementing order picking routing based on pallet loading feature. In addition, According Frazelle (2002), sequencing pick as a form of optimization can reduce travel time, reduce the damages that may occur and makes work more ergonomic. In walk -and- pick systems locations should be sequenced. This means, when an order has occupied more than one pallet the picking route should be sequenced. It enables the picker to build a stable unit load and reduce walking distance.

Another suggestion is the removal of the picking list replacing it with paperless picking process. There should be updates to make it a paperless picking process. According to Frazelle (2002), Paper picking process has disadvantages in that; it is easy to lose paper, reading papers requires a search through maze of information, which is tiring and transposing. Late communication of information is easy, creating a possibility of errors in inventory levels and order status, Printing, handling and filing of papers are expensive. Lastly, papers are easy to get damaged. Whereas, paperless is of advantage in that; it helps managers to anticipate and point out problems or major changes in activities
and patterns. It makes warehouse operations to be simplified and easy which eases communication of transactions to and from the warehouse operators and equipment. Lastly use of paperless systems makes it easy to monitor warehouse performance productivity, inventory accuracy, warehouse order cycle time and storage capacity thus increasing productivity.

Lastly, the update and use of the control rooms would be better even if the picking list would be eliminated. According to James P. Womack (2003), waste, which means activities which do not create any value to the customer should be avoided. He suggests that, lean thinking should be implemented, this means all the necessary activity that a customer is willing to pay. These activities include, fast delivery compared to normal delivery, change in picking process to reduce lead time, and avoidance of motion waste which means movements that are straining or unnecessary in the warehouse.

In the author’s opinion, the confirmation documents are still important and would be printed in different locations depending on the orders. Control room A will handle customer storage pick up and expresses delivery and control room B will handle transport storage order and order that are sent to the bay area. As workers will not have to depend on one control room for information, this will reduce the unnecessary walking in the warehouse and workers would focus on the task at hand. As illustrated by John J (2017), this will create a U product flow in the warehouse.

For this to be effective storage assignment policy in the warehouse should be revised to aid both customers who visit the store and the picking department.
Figure 33: U flow example.
6  Ethics, Reliability and validity

6.1  Ethics

Researchers normally do their researches with a well-intended purpose. In the process of conducting the research, there is a possibility that interaction with participants might cause harm. Psychological harm, financial harm and social harm could occur when planning. Due to this the researcher has a responsibility that, special mechanism is implemented to eliminate these harms (Polonsky 2004, 53). In this thesis, the author tried to avoid all the possible harms as much as possible by maintaining respect.

Privacy, confidentiality and anonymity must be considered by the researchers. The researchers should be careful on how the study will intrude people’s privacy. Furthermore, ways on how to protect information should be kept in place. Early negotiations with participants in the study should be done to protect and maintain confidentiality (Schutt 2011, 354). In this thesis, the author maintains confidentiality. All the documents with customers details have been censored, and all the details of participants have been kept private.

Intervention and support should always be in researchers mind throughout the thesis process. The researcher should act accordingly when observing harmful illegal or wrongful behavior. The researcher should be able to estimate whose interest should be supported, either his or the research setting. In this case, maintaining blameworthy knowledge might suppress some parts of the analysis so as not to disclose the wrongful behavior. Whereas, presenting what happened may cause conflict with the participants cutting short the ongoing process. The research should always aim at integrity and quality (Schutt, 2011). In this thesis, the author has quality information, yet he maintained integrity throughout the process.
6.2 Validity and reliability.

Validity is the meaningfulness of the research which is normally supported by the researchers through their measures (Drost 2019, 114). *Qualitative data validity is addressed through honesty, depth, richness and scope of data achieved.* It is improved through careful research and appropriate instrumentation (Cohen 2007, 133).

There are various types of validity which include; internal validity, this speaks to the validity of the research itself. This means that biasness should be minimized by curbing threats e.g. history, maturation, testing, instrumentation, selection, mortality, rivalry and demoralization (Drost 2019, 114).

According to Cohen, (2007), internal validity tends to show that the explanation of an event or set of data can be sustained by the data. Threats of validity can be minimized by; choosing appropriate time scale enough for the research, ensuring that adequate resources are there for the research and choose appropriate methodology and instrumentation for collecting data (Cohen, 2007, 146). In this thesis, the author avoided biasness, chose appropriate time frame for the project, chose appropriate methodology and ensured that resources are enough.

Reliability means consistency and stability of measurement over a variety of conditions. This means, the extent to which measurements are repeatable when different people perform the measurements on different occasions, under different conditions with different instruments which measure the same thing. Basically, same results should be obtained (Drost 2019). In observation, reliability is tested by the presence of replicability. This means, stability of observation in that, same observations and interpretations are made at distinctive times (Cohen 2007, 148).

6.3 Strengths and weaknesses

The author’s strength in this thesis was the ability to carefully observe the XX’s warehouse process, conducting meaningful interviews, and analyzing available information; recognizing the faults in the process and research setting.
The weakness was the inability to have access to numerical data and some. Lack of materials due to most requiring purchase.

8. Conclusion and discussion

XX is one of the biggest and successful business operated through a franchisee system. XX group is aimed at having continuous improvements, developments, expansions, innovations and long-lasting life. XX Industry manufactures the home furnishing products. It produces 10-20% of the total XX range and its focus is on furniture. There are more than 403 XX stores in 49 countries in the world. For a long time, XX has been combining Retail and Warehouse Processes. Having customers select their own furniture and pickup packages themselves in the warehouse has made it a unique strategy to reduce the cost per touch.

Order picking is the process of picking items from a specific staged location to meet a certain customer or supplier demand. There several order-picking system classifications which are; Pickers to part system, Part to picker system and Pick To box system. XX uses pickers to part system where, the picker retrieves items from the picking location to complete a single order or batch of multiple order. It is mostly set up for pallet unit load with storage system made up of pallet racks.

XX warehouse uses of bar code scanners and picking list. The barcode scanner is used in receiving and inventory management of goods. The picking list shows information for example where the goods should be sent and the weight of the goods. In XX Vantaa, there are three types of unit loads used in the picking process and these are Fin pallets, Euro pallets and XX pallet paper pallets.

Qualitative research method was used in this thesis and research techniques being observation and interviews. Data analysis method used was qualitative
with progressive focusing which means, the process began initially when data was collected not at the end of the collection.

The observations made at XX Vantaa are; First, the list of items to be picked in the picking list lacks routing optimization and does not provide any information on which type of stock keeping unit to be used to start the process. Second, unit load was not always packed properly due to inexperience and fatigue at work, this brought about rearranging them all the time. There existed no kind of routing in the warehouse. In accordance to this, approximation of time was given to the pickers that each pick should be conducted within a specific time and not depending on the size of task or route taken.

In the interviews carried out, participants mentioned that there is a necessity for routing optimizations based on pallet loading features in the warehouse. Some candidates revealed that there is misuse of the control rooms which leads to unnecessary walking in the warehouse. They also revealed that they mostly rely on experienced workers and staff which is sometimes of a disadvantage because, they might be on holiday or on sick leave.


Hackman, J 2017. warehouse & distribution science. Atlanta,: Georgia Institute of Technology.

Halbeisen, d. 2015. intralogistics:Guid to warehouse planning . Lund: studentlitterature.


Modern material handling . 2018. Modern material handling . Retrieved from Modern material handling : https://www.mmh.com


Research methodology. 2019. research-methodology. Retrieved from research-methodology.net : https://research-methodology.net/research-methods/qualitative-research/interviews/#_ftnref1


http://www.2wmc.com


www.supplychain247.com: 
https://www.supplychain247.com/article/how_does_XXs_inventory_management_supply_chain_strategy_work


http://verifiedlabel.com: 
http://verifiedlabel.com/knowledgecenter/know_barcodes.aspx

https://www.visual-paradigm.com/tutorials/bpmn1.jsp
