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Improving Efficiency of the Order Picking Process in the Case Company Warehouse

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Finally finished! One year of hard work, new friends, interesting lectures with interesting lecturers. One year ago I could only dream to be accepted to Master's degree as student. As first group of Logistics Master's students, we had interesting visits to Inex Partners Oy's new logistic centre and tour in Kesko's bit older facility, but efficient logistic centre in Hakkila. I'd like to thank Metropolia for giving me an opportunity to study in the most interesting program I could imagine.

The topic of the thesis has been crystal clear for me since the first meeting with main instructor of the thesis Dr. Juha Haimala. But after that it has been struggle to show others around me to see the topic in the same way and as clearly as I could. It all finally came together in the Final seminar presentation of Master's theses on 29.4.2016. It clearly showed me that every seminar participant understands what this study was about.

In this feeling, I like to thank my supervisor Dr. Juha Haimala for instructing me through the whole study. Without his tips received the outcome of this study might have been bit different. I also like to thank, Zinaida Grabovskaia, PhL, who guided me through all the thesis writing obstacles. Without her, this thesis would not have been finalized in such extent as it is. Thank you for giving me the critical feedback and by seeing the whole work a bit as outsider, and from this perspective, giving me advice in terms of writing this thesis. Furthermore, I feel honoured to thank all the interviewees' in the case company. Without them I would not receive such results from this study.

Finally, I thank you, my spouse Maria, for being so understanding to me during the whole year in school.

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Vantaa, 6 May 2016

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This study proposes an improvement plan for improving efficiency of the order picking process in the case company. The case company is looking for actions to increase profitability of its business. As the order picking can be one of the costliest warehouse operations, picking is a great place to improve efficiency and look into a possibility to increase profitability.

This study is conducted by using qualitative data gathering, and it involves the key stakeholders of the order picking process by conducting interviews and workshop. The selected research approach is a case study, and the study strives to find the starting point for the efficiency improvements by conducing the current state analysis of its existing picking order process. When the problem are identified, the study looks into the available knowledge and best practice on warehouse process improvements. Ideas from best practice are then applied to formulate the proposal for the case company. The outcome of this study is an improvement plan for the improved order picking process. The proposal is approved by the logistic manager of the case company, but the implementation stage is still pending.

The proposed improvement plan helps the case company to improve efficiency of its picking order process by introducing: item classification, removing the excess items from the inventory, and rethinking its picking routing. By using the popularity based item locations, coupled with optimal picking routing, the case company could increase efficiency of the picking process.

Keywords	order, picking, item management, lean, inventory, warehouse, ABC-analysis, improving efficiency,

Contents

1 Introduction

Warehouse activities are usually considered as a necessary evil to run a business. This often leads to lack of interest to warehouse activities from the management side. However, over the last decade the warehouse activities have come more often under the microscope, when analysing the company profitability. This has led to a conclusion for the need for companies to improve efficiency of warehousing and cutting off unnecessary costs of warehouse activities. In addition, since the current trend in markets has been e-commerce, it has also increased the importance of well-working warehouse operations.

To keep up with the changes in customer demand and to reach a higher customers satisfaction level, improvements in warehouse activities are needed. From the warehouse activities, the order picking is the costliest activity when comparing it to other activities (Frazelle, 2002). Therefore, improving the efficiency of the order picking process can lead to a happier customer and saved costs. The purpose of this thesis is to find areas where the case company can improve efficiency of its order picking process.

1.1 Case Company Background

The case company is a wholesaler and importer for spare parts, accessories and tools for passenger cars and utility vehicles. Main customers for the case company are retailers, car importers, workshops and vehicle industry companies in Finland. In addition, the case company is having some customers overseas but most of these companies have a parent company in Finland.

The case company has nearly 350,000 items in its product range, but it stores regularly around 90,000 items in its two warehouses in Vantaa, Finland. In addition to these two warehouses, the case company has a few outsourced warehouses for items that are needed to replenish the case company's two own warehouses. The main warehouse of the case company, named Ansa 2, has mainly rental workforce to operate the main activities in warehouse. These main activities are the order picking and the storing of the income products.

Presently, the main body of orders in the company's warehouse Ansa 2 are picked by a voice controlled picking system, which has reduced the errors in order picking. Special orders in Ansa 2 warehouse are picked by using pick-by-paper method. Items stored in the warehouse Ansa 2 consist from the main items that the case company is promoting, e.g. car heating items, carrying systems, vehicle chemicals and whole range of car spare parts.

1.2 Business Challenge

The case company of this Thesis is challenged by constant competition in the field of automotive aftermarket business, as well by challenges coming from the overall economic situation. In Finland, the worldwide economic situation is causing low numbers in new car sales. For new cars, the case company is promoting its accessory item range, such as car heating parts and carrying systems. Bad economic situation has led to the need to improve various company activities, including the case company's warehouse. To keep business profitable, the case company has to improve its processes and cut down unnecessary costs. As the order picking is the one of the highest costs in warehouse activities, it is natural place to start to improve efficiency and reduce the costs.

1.3 Objective and Outcome

The objective of this Thesis is to propose a more efficient way to pick up orders in Ansa 2 warehouse of the case company. To improve efficiency, this study will analyse the data gathered from the current warehouse operations and investigates what are the key points that are currently lacking when talking about improving efficiency of the warehouse picking process.

Efficiency improvements are based on the weaknesses found in the current state analysis. Improved efficiency could be related to a better layout, better positioning of the items in warehouse, or improved order picking routes, etc. The crucial point of this thesis is to conduct a thorough current state analysis so that to identified these points for improvement. Results of this analysis will point out which way of the improvements should be concentrated on.

The outcome of this thesis is proposal for the improvement plan for a more efficient order picking process for the case company. This proposal will be presented to the case company's key managers responsible for the picking process. The scope of this thesis will concentrate on the main warehouse Ansa 2 activities, as they are the core warehouse activities in the case company.

This study is written in 7 sections. Section 1 introduces the study. Section 2 describes methods how this study has been conducted. It explains research design and data collection and methods of the analysis of this study. Section 3 illustrates current state of order picking process. Section 4 presents best practices how to improve order picking process. Section 5 describes the initial proposal building process. Section 6 is about validation of proposal it will describe the feedback the proposal received. In section 7 this study discusses and draws conclusions from this Thesis.

2 Method and Material

This section discusses research approach, data collection and research strategy of this thesis. The idea of this section is to explain how this thesis is conducted in order to increase validity and reliability of the study.

2.1 Research Approach

Research is a search for knowledge and truth (Grover, 2015). The research approach shows how the study has been tackled and the chosen research approach will work as a blue print for the study (Grover, 2015). The definition on how to approach the issues in hand is crucial for integrity of the study. Researcher has to decide what kind of data and tools are needed to solve the issues. A well-chosen research strategy will work like a correct key to the lock.

Research approach can be divided into two groups, deductive and inductive approach. Deductive approach is based on truths, things that are knowingly true, e.g. every human is a mortal, Socrates is a human, so conclusion, Socrates is a mortal. This classic example states two facts, and based on these facts can conclusion be made that Socrates is a mortal. Figure 1 illustrates the deductive study approach, showing that in this approach the theory comes first, then hypothesis is made based on theory, then the theory is tested, and based on this the theory the hypothesis gets confirmed or rejected (Dudovskiy, 2016).

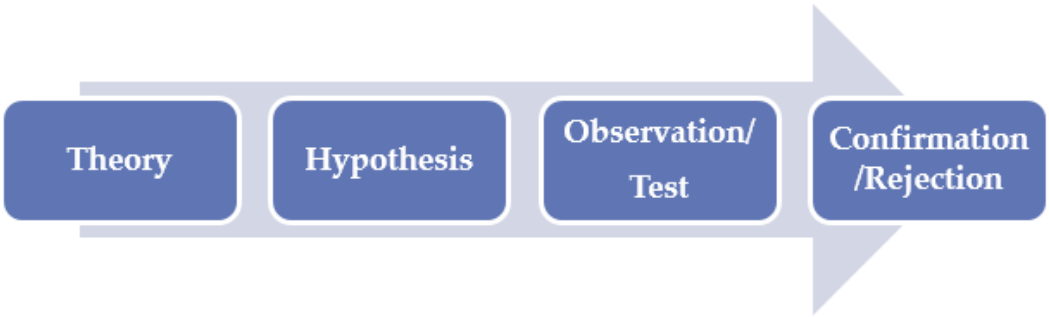


Figure 1. Deductive approach of study (Dudovskiy, 2016).

In deductive approach the data is mainly quantitative type of data. Quantitative data is relying on statistical and numerical data, the data type that can be measured. In deduc-

tive approach, the approach requires validity of data in order to reach the correct conclusions (Dudovskiy, 2016).

Inductive approach is basically opposite to deductive approach. In inductive approach the reasoning goes from known facts to unknowns. In Figure 2, the inductive approach is illustrated. Inductive approach starts with the challenge, aimed objective that needs to be answered. Researcher observes the challenge by collecting the qualitative data (Dudovskiy, 2016). Qualitative data is not numerical or statistical data. Qualitative data is something, which cannot be easily to measure. Qualitative data type is mainly data received from interviews, and workshops, etc.

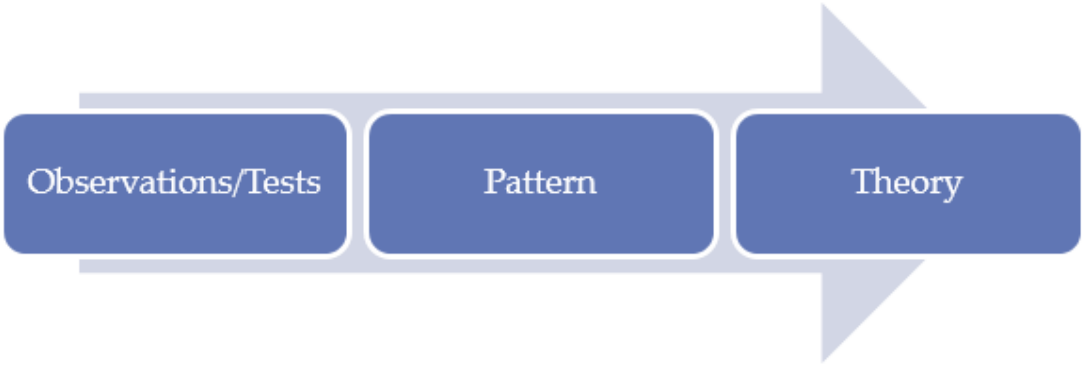


Figure 2. Inductive approach of study (Dudovskiy, 2016).

This thesis is following the inductive approach, with qualitative data collection. In this study the data is collected by interviews and by workshop. As the main question of this study is the improvement of the efficiency in the order picking process, the idea of this research approach is to gather data directly form key members of the picking process. By interviewing the key members of the process in hand, the researcher can have a first-hand knowledge about what section in process is not working. By gathering data from many interviews the researcher can add credibility to data collection and to study.

2.2 Research Design

Figure 3 illustrates the research design of this study. Figure 3 shows the steps made in this thesis, and it states the target for every step. Under these targets the data collection is shown, and the type of data that is used in these specific steps.

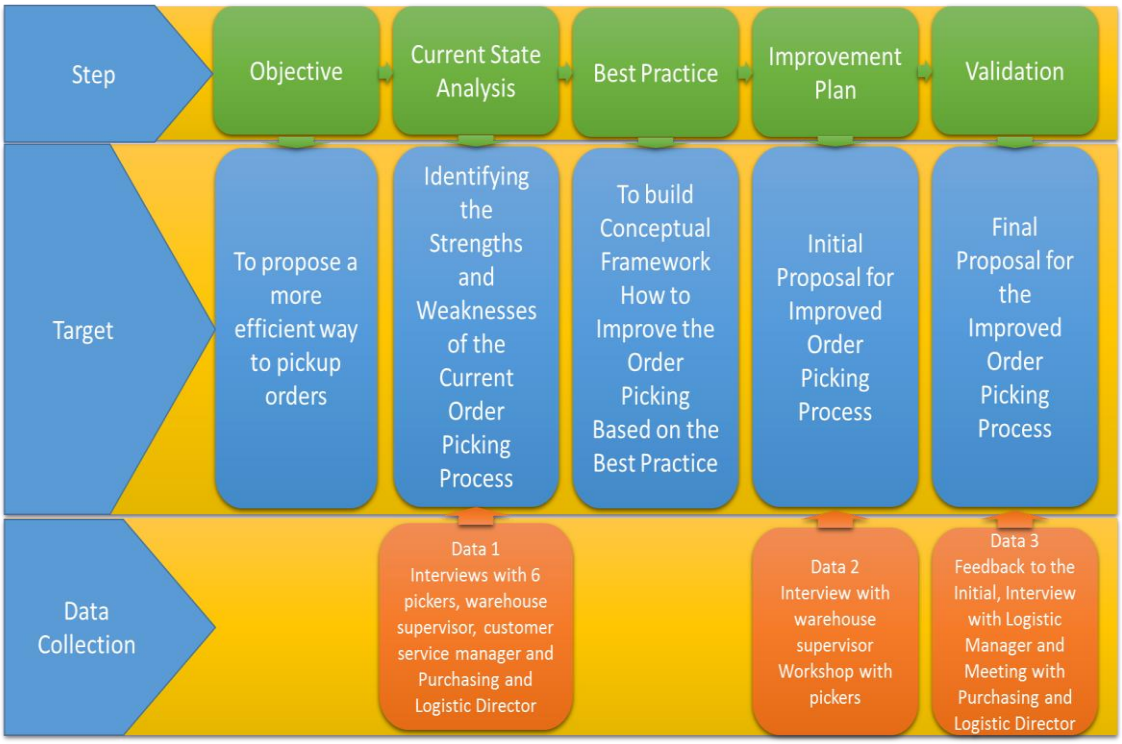


Figure 3. Research design steps and outcome with data inputs.

This study aims to find a more efficient way to pick customer order in the case company warehouse. This is conducted, first, by analysing the current state of order picking process. This is done by interviewing the key stakeholders of the picking process. Based on this current state analysis, the strengths and weaknesses of the current order picking process are identified. Secondly, in this thesis is build a conceptual framework based on the best practices found out from different literature sources. Literature topics are based on the weaknesses found in the current state analysis. Based on this conceptual framework, the study plans an initial proposal how to improve efficiency of the order picking process in the case company. For this initial proposal, the study involves input from the stakeholders by discussing suggestions for the initial proposal with key managers related to order picking in the case company. After that, the study collects feedback for the proposed improvements from the managers in charge of the order picking process. Thus, the final proposal is build.

With this kind of research design this thesis collects enough data for the analysis and proposal building parts. This proposal is then further improved through a validation process, which gives enough reliability to the results.

2.3 Data Collection and Analysis

For this thesis the data is collected in three rounds. Table 1 below shows a brief overview of Data collections 1-3 used in the study.

Table 1. Data collection rounds.

Data	Purpose	Data type	Data source	Analysis
Data 1	Identifying key strengths and weaknesses	1. Interviews with key stakeholders	-6 pickers, -Customer Service Manager, -Purchacing and Logistic Director, -Warehouse Supervisor	Section 3, CSA
Data 2	Building the proposal	1. Interview with key stakeholder	-Warehouse Supervisor	Section 5, Building the proposal
		2. Workshop	-3 pickers	
Data 3	Validating the proposal	1. Meeting with key manager and director	-Logistic Manager & Purchasing ang Logistic Director	Section 6, validation

Table 1 illustrates data collection rounds used in this study. Under headings it describes what purposes the data is used for, what type of data is used, what source the data is gathered from, and finally the section where the data is analysed. Data 1 collection is required for the current state analysis. This data collection provides data for the current state analysis of the case company order picking process. This results in identifying the strengths and weaknesses of the current process.

Data 1 consist of interviews with key stakeholders of the order picking process. Interviews are conducted with key persons involved with order picking process in the case company. The key persons include a range of informants from order pickers to the warehouse supervisor, and to Customer Service Manager and Purchasing and Logistic director.

Table 2 shows the details of the interviews and tells how the interviews are conducted.

Table 2. Interviews conducted for Data 1 collection.

Interviewee	Experience	Data stage	Date	Duration	Topic	Documented
1. Picker (paper and voice)	5 years	Data 1 Collection	9.2.2016	15 min.	Order picking process	Field notes
2. Picker (pick-up store)	5 years	Data 1 Collection	10.2.2016	10 min.	Order picking process	Field notes
3. Picker	5 years	Data 1 Collection	10.2.2016	17 min.	Order picking process	Field notes
4. Picker (paper and voice)	6 years	Data 1 Collection	10.3.2016	10 min	Order picking process	Field notes
5. Picker	3 years	Data 1 Collection	10.3.2016	10 min	Order picking process	Field notes
6. Picker (parttime front man)	4 years	Data 1 Collection	10.3.2016	15 min.	Order picking process	Field notes
7. Customer Service Manager	over 10 years	Data 1 Collection	10.2.2016	20 min.	Sales	Field notes
8. Warehouse supervisor	over 10 years	Data 1 Collection	10.2.2016	30 min.	Warehouse management	Field notes
9. Purchasing and Logistic Director	over 10 years	Data 1 Collection	10.2.2016	1 hr 10 min.	Purchasing and item management	Field notes

Table 2 illustrates the position of the interviewee, and the stage where particular interview data is used. Furthermore, Table 2 illustrates the date when the interview is conducted and the duration of the interview, and in the final column it shows how the interview is documented.

All the interviews are conducted by a semi-structured, face-to-face interviewing method. The interviews were semi-structured for picker interviews to get more content for interview. For example, if you ask questions what things are working and what things does not work in process, the regular answer is that everything is working relatively good. To get more content, questions for Data 1 collection was structured to go step by step through the whole process, with additional questions where needed. In this way, the interviewees started to be more critical and started to realize what things are really working and what things do not work or could work better. Interviews with managerial person were semi-structured, with some open-end questions. The idea behind this decision is based on knowledge that the chosen persons can be critical and knowledgeable. Therefore, questions were created only to steer the interview back on its track.

Data 2 collections is conducted for the proposal building stage. Data 2 consist from interview and workshop for initial proposal for order picking process. Initial proposal is conducted from data 2, conceptual framework and from the researcher's previous experience. Initial proposal is built in co-creation with key stakeholders to obtain data 2. The data 2 consists from opinions and improvement suggestions in interview and workshop. Interview and workshop are performed with order pickers and warehouse supervisor. From this gathered data, the initial proposal is built.

Table 3. Workshop and interview conducted to obtain data for the initial proposal.

Workshop					
Participant	Data stage	Date	Duration	Topic	Documented
1. Picker	Data 2 Collection	31.3.2016	45 min.	Picking routing	Field notes
2. Picker	Data 2 Collection	31.3.2016	45 min.	Picking routing	Field notes
3. Picker	Data 2 Collection	31.3.2016	45 min.	Picking routing	Field notes
Interview					
Participant	Data stage	Date	Duration	Topic	Documented
1. Warehouse Supervisor	Data 2 Collection	6.4.2016	30 min.	Item Management	Field notes

Table 3 shows the workshop and interview details conduct for Data 2 collection. In workshop three pickers were involved, and the workshop toured the whole picking routing in a search for solution to discovered issues in routing. One interview was conduct in a search for better item management. Interview was conducted with warehouse supervisor.

Data 3 collection is conducted for the proposal validation. Initial proposal is presented to key managerial stakeholder of the order picking process. To validate the proposal, interview is performed with logistic manager of the case company. With this interview, the feedback is gathered for final proposal. Final proposal is then hopeful taken into action in order picking process to improve its efficiency.

Table 4. Meetings and interviews for feedback to initial proposal.

Participant	Data stage	Date	Duration	Topic	Documented
1. Logistic Manager	Data 3 Collection	19.4.2016	15 min.	Feedback to Initial Proposal	Field notes
2. Purchasing and Logistic Director	Data 3 Collection	25.4.2016	N/A	Feedback to Initial Proposal	E-mail

Table 4 illustrates Data 3 collection phase. For validation of the proposal logistic manager of the case company was interviewed and e-mail request to validate the proposal was sent to purchasing and logistic director of the case company.

2.4 Validity and Reliability Plan

For ensuring credibility of the study, validity and reliability of study have to be evaluated. *Validity* of the study ensures that all the conclusions of the study are logical (Dudovskiy, 2016). To strengthen *validity* of the results, as much data as possible is

gathered that is relevant to the study. This way a study can be made internally valid (Quinton & Smallbone, 2006). In qualitative study, the more data that can be gathered, the more internal validity the study has.

In this study, internal validity is planned to be improved by ensuring that interviewed personnel will cover nearly one third of the order picking personnel and external validity is planned to be ensured by gathering best practice from several fields into a conceptual framework of this study. To ensure overall validity of the study, the outcome of this study has to meet its objective.

Reliability of the study ensures that another researcher can produce similar results by using the same research methods used in this study (Dudovskiy, 2016). Ensuring the *reliability* for the study can be problematic. Whenever the researcher is using the people as data source, the repeating of the results can be proven hard, as Quinton and Smallbone are arguing in their paper.

> *Reliability is sometime seen as an assessment of whether the same findings would be obtained if the research were repeated, or if someone else conducted it. This definition is problematic in business and management research, as any social context involving people makes replication of research very difficult (LeCompte and Goetz, 1982). In qualitative study, such issues can be either outside the boundaries of what you need to think about when doing qualitative research or a big problem, depending on which authors you consult.* (Quinton & Smallbone, 2006)

Data can give credibility to a study and quality of the data can increase the value of the study. Furthermore, well-documented data collection gives traceability to the study. This enables reproduction of results, and it gives possibility to repeat the research by another researcher. Collecting data from different data sources can strengthen the reliability of the study (Quinton & Smallbone, 2006).

In this study, reliability is planned to be ensured by taking the following steps. Firstly, to gather comprehensive data, data is collected from interviews and from a workshop from with order pickers, and discussing the results with key personnel of the picking process. Secondly, reliability is planned to be improved by ensuring the feedback to the proposal from the managerial level. In this manner, the results of this study will be more reliable. As the qualitative method has been chosen as the research method for this thesis, the reliability of the study is increased by interviewing many key stakeholders of the process. With many interviews the reliability of the interview results also increases.

In next section, current state of the order picking process is defined. Section 3 will sum up the strengths and weaknesses of the process.

3 Current State Analysis

This section of this Thesis is describing the current state of the studied order picking process. This state of this study is crucial, as it describes the strengths and weaknesses of the current process. In this section, the process background is clarified, giving a description in what kind of circumstances the process is taking place.

3.1 Overview of the CSA Procedure

Current state analysis is based on the interview results and the discussion results. The objective of the interviews was to find out what is not working in the order picking process. To receive critical answers and opinions from order pickers, the questions were constructed in such a way that it forces the interviewee to think through the whole order picking process. This way the likelihood of getting critical opinions and critical answers is higher. The reason to construct questionnaire in this manner is to get even timid persons to look for critical opinions. All the questions asked from the order pickers are visible in Appendix 1. Furthermore, the summary of all the interview results is visible in Appendix 2.

Current state was conduct by a series of interviews. Chosen persons for interviews are key members in the actual order picking and in the order picking management. Main answers were gathered from the persons who actually work directly with order picking, the order pickers. The reason behind this decision is that the pickers know from the first-hand what things are working and what things do not work in order picking. Pickers have the first-hand experience from the process required in this kind of study. Interviews where structured in such a manner that the pickers where forced to think through the whole order picking process.

Six order picker was interviewed, from total of 20 order pickers in case company Ansa 2 warehouse. Interviews with order pickers were showing similar trends, and the answers were already repeating themselves after three interviews. By interviewing the total of six order pickers, this thesis is getting more credibility it needs. To complete the current state for data collection, three additional interviews were conducted. These interviews were with the customer service manager, the warehouse supervisor and the newly appointed purchasing and logistic director. All the interviews were semi-structured and based on the interviewees' willingness to share their knowledge from

their area of their responsibility. Appendix 3 shows the questions asked in these interviews. Questions were used to keep the conversation on correct tracks. Summarized results from these interviews are collected in Appendix 2.

Based on the interview results, the current state of the order picking process was analysed. By categorizing the results into groups the results were analysed. Each category stated in Section 3.3 points to the main challenges revealed from the interviews. From these topics, the critical ones for improving the order picking process were chosen to address in this study.

3.2 Description of Ansa 2 Warehouse of the Case Company

The case company is a wholesaler and importer for spare parts, tools and accessories for passenger cars and utility vehicles. The case company serves businesses who work in retailing, maintenance, vehicle industry and vehicle equipping. The large portions of the customers are based in Finland, but in addition to domestic business, the case company is also exporting items to overseas. These overseas customers are mainly based in Europe, with the parent company in Finland (Oy Kaha Ab, 2016).

The case company has a main warehouse (Ansa 2) in Vantaa, in close proximity of the Helsinki International Airport. In addition, the case company has rented a warehouse (Ansa 4) from neighbouring estate. This additional warehouse gives the case company chance more easily to manage the whole item range the case company is promoting to its customers. To increase the storage capacity, the case company constructed an enlargement of its Ansa 2 warehouse (Maanrakennusliike E.M. Pekkinen Oy, 2016). Now the total warehouse size is 26,500 m^2, containing both Ansa 2 and Ansa 4 warehouses (Oy Kaha Ab, 2016).

Order picking methods. As the main target of this study is in the Ansa 2 warehouse's processes, the order picking description is based on this warehouse. Order picking in the case company Ansa 2 warehouse is done mainly by using the pick-by-voice method. In addition to voice picking some of the orders are picked by pick-by-paper method. These orders usually are export order and other specialized orders requiring flexibility of the paper picking. In the case company, the main workforce to pick and pack the orders comes from the company who rents the workforce to companies. Orders to pick are released by the warehouse's outbound supervisors, who also monitors the picking

and packing in the warehouse. They are controlling that all the order lines are picked in an orderly fashion. To aid the outbound supervisors, the rental company has placed the head of rent force in a same room where the supervisors are. This way they can communicated freely and control the whole picking process. The head of rent force, bundles the orders into a groups for efficiency reasons. By bundling the orders, the pickers can pick several orders at the same time as it would take to pick just one order. The reason behind this is the fact that pickers are travelling the same route in every order picking tour, so they are able to pick a few more orders at the same time.

Pick-by-voice. The picking starts when picker accepts the order by using the voice picking system. In voice picking, the voice tells to picker first the aisle where to go. When the picker reaches the correct aisle, the picker confirms this by responding “Ready” to voice picking system. After this, the voice picking system calls the warehouse shelf frame where to go, and the picker responds “Ready” when he or she reaches the correct frame. Now the voice picking systems calls the shelf address. To correctly respond to this calling the picker has to say the two-digit code written to address label in shelf beam. If the code is correct, the voice picking systems calls the item identity number. In this stage, the picker can ask the voice picking system to repeat the identity number again or he or she can ask the description of the item. The description can be an alias identify number or short description telling what kind of item is it. After the picker has located the correct item, the picker responds by saying “Ready” to voice picking system. At this point, the voice picking system calls the quantity of the products needed. When the picker has the correct quantity picked, he or she confirms this by saying “Ready”. If the picker has several orders to pick in same time, the voice picking systems calls in what order is this particular item meant to go. The picker confirms this by saying the two-digit numeral in picking label printed out in start of the picking. After all the ordered items are picked, the voice picking system states to picker to go the packing area. In the packing area, the picker chooses the cardboard box where all the picked items fit in, then the box is laid down to the conveyor for packer to pack the items.

Pick-by-paper. In paper picking, all the released orders are put into a box. The picker takes a top order paper and signs it to ERP by using barcode reader to read the barcode in a paper. Orders are in the same order in paper as the voice picking system is asking to pick. Order lines are picked and then the picker takes the items to packing

area and chooses the appropriate shipping unit for the items and lays it down to conveyor for the packing.

Warehouse layout. Another important factor for the order picking process is the actual layout of the warehouse. In the case company warehouse Ansa 2, the warehouse has been divided into a several warehouse sections (illustrated in Figure 3 below). This way the case company can better utilize the warehouse shelf capacity. These areas are: small item warehouse, normal picking area, high picking area and towbar picking area.

Small item warehouse, coded in ERP system as area 10, is basically a warehouse inside of warehouse. The small item warehouse consists from three floors with small item shelves in each floor. In one floor, there is 50 aisles and in one aisle there is around 100 shelves in 20 shelf frames. Floors are marked with letters, the ground floor is called A, the first floor is called B and the top floor is called M. In the top floor there is a cage area, for promotion products and for high value products. The cage has a limited access for pickers.

Next, the pallet racking area is called *normal picking area* and it is coded as area 4. In normal picking area, the picking is from pallet racking shelves, and the pickers are mainly moving in this area by forklifts called as low order picker truck. With these forklifts the pickers can reach items up to three meters high.

High picking area is the area coded as area 5 and it consists of the items located in high locations in racking shelves. Pickers are moving there by high order picking truck, which can reach up to six meters high.

The last picking area is called *towbar picking area*. This area is coded as area 1. Items belonging in to this area are heavy, specialized and dangerous goods items. Handling these items takes always some specialized handling, for example labelling the dangerous goods with proper warning labels, and marking the proper provisions to waybill. Heavy items, e.g. towbars, require strength from the picker as these items can weigh more than 20 kg. Items in area 1 are not place solely in one area, but they are located in normal racking area, small item area and in specialized towbar racking area. In all areas, the order picking route is ordered by ERP's routing numbering. This numbering has higher prioritization than address labels in racking.

Figure 3 is illustrating the Ansa 2 warehouse layout. This figure shows the all the warehouse aisles marked with aisle number.

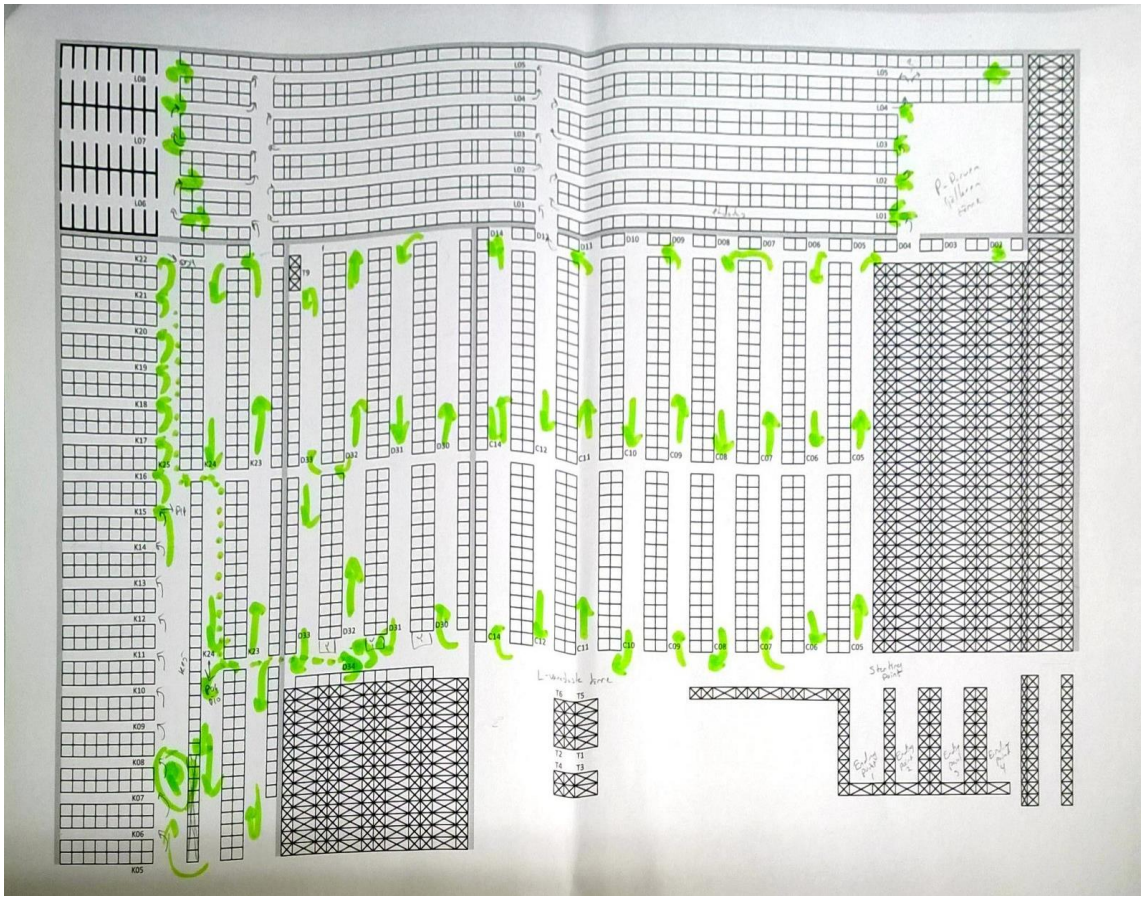


Figure 1. Illustration of the case company current order picking process flow.

Figure 3 illustrates the case company warehouse Ansa 2 layout. In this figure, the order picking process flow is drawn as green arrows. The green colour is marking the current picking route. The picking route sequence is ordered in ERP-system. The sequence is a 10-digit number, the order is that the lowest number is picked first and the highest number is picked last. If the sequence number is the same, then warehouse address is the one to order the picking sequence.

The figure shows the small item warehouse (in middle of the left side of the figure). Pallet racking is shown by the aisle numbers. Aisle numbers C05 - C14, D02 - D14 are located in the oldest part of the Ansa 2 warehouse. Aisles D30 - D33 are located in the so-called “Middle warehouse” and aisles K05 - K25 are located in the so-called “Kahla warehouse”. In “Kahla” section of the warehouse, P-Balcony is also located, where the slowest cycle item is located. P-Balcony is situated on top of the aisles K05 – K15.

Aisles L01 – L08 are located in the newest enlargement of the Ansa 2 warehouse, shown in the upper part of Figure 3. The reason for Ansa 2 warehouse is having number of warehouse sections is, because original Ansa 2 warehouse consist only area containing aisles C05 - C14 and small item warehouse. Kahla warehouse section was initially controlled by another company. When the Kahla section was transferred to the case company, they built the middle warehouse between the two original warehouses.

In Figure 3, the case company's automated storage systems is also visible, marked as T1, T2, T3, T4, T5, T6 and T9. These automated systems are located down the middle of Figure 3 and at the end of the aisle D33 in the middle warehouse. Finally, the packing area of the case company's warehouse Ansa 2 is located at the bottom right corner.

3.3 Findings from the Current State Analysis

Based on the results of the interviews, shown in Appendix 2, the findings were categorized into groups. Categorizing the results will help to find solutions to improve the process issues. All the findings are based on the interviews conducted for data 1 collection. Purpose of the interviews was not just to look for weaknesses, but also to discover what are the strengths and the key points in the picking process that are working well.

Next sub-sections discuss the identified findings and strengths and weaknesses categories.

3.3.1 Strengths of the Current Order Picking Process

Reason to list and to discover strengths of the order picking process is to find out the things that are not to be touched in process improvements. This subsection lists the strengths the interviews considered that are working.

Categorizing the strengths in to groups is bit hard as the interviews were not able bringing up several points that are working in picking process. As for this reason the strengths are not categorized in to bigger groups. Due to this, below are describe the all of the strengths of the order picking process.

The first thing that the interviewees stated is that *picking process* as it is, is working well. Interviewees did not find anything that requires changing in picking process.

> *"Pick-by-voice is working really well here in the case company".*

Above quotation was heard from every order picker during the interviews. The pickers are considering that voice picking is good picking method that leaves pickers hands free to use the actual picking and manoeuvring the fork lift.

Picking methods were another thing that interviewees consider that is working well. Especially the dual method of picking was considered as good. *Pick-by-paper* was considered as a flexible way to pick items, as it gives free of choice to choose in which order to pick the items.

> *"Picking-by-paper is good as it is giving choice to choose in what route to take when picking orders".*

Above quotation from the interviews is showing that pickers who has used to pick by paper, sees the flexibility of the paper picking. Paper picking is showing immediately all the items to be picked in that specific order. This gives the picker the freedom to choose in what order is he or she going to pick the items. Voice picking is more rigid in this matter, as it follows the predetermined route.

Pick-by-voice method was considered as fast and nearly errorless method to pick items. In addition to these, the *packing area* of the case company Ansa 2 warehouse is consider as well working and easy place to operate as a picker, especially when the picker knows how to act in packing area.

3.3.2 Weaknesses of the Current Order Picking Process

This subsection lists and categorizes the weaknesses of the current order picking process. All the weaknesses discovered in the current state are from interviews with key persons responsible for order picking process.

Categorizing the weaknesses into major themes will help the solution finding process, and it will give some leverage to tackle to issues. Weaknesses discovered in the current state of the order picking process are categorized into three themes.

The first theme consists from issues related to *item management*. Item management is the key factor when improving the efficiency of the order picking process. Item management can be considered as one of the biggest issues in order to develop the order picking process. Poorly handle item management can have an effect on efficiency of the order picking. Furthermore, items that are poorly labelled can slow down the order picking process, as the items are not identified immediately.

Item management was the first category in the current state analysis that needed investigation. The interviews revealed that the case company is not using any kind of item classification in order to manage all the items in the case company's Ansa 2 warehouse. By using the item classification the case company could monitor what items do not cycle fast enough and could consider the placement of these items in warehouse. Furthermore, the storable items are decided solely by the product manager of the case company. The case company has around 20 product managers and related managers, who decide what items are stored in the case company warehouse. Groundings behind these decisions are not visible. Furthermore, the item identification is causing some problems in order picking process. As the picking number can vary from the actual item number that is placed to the item. For example, picking number can be "X12345", but number in item can be "12.MX.345DD". To recognize the correct item, takes some serious reasoning from the pickers. Although the experiences pickers can identify the items, it still takes unnecessary time to identify the items.

The second theme is *order routing* issues, this theme consists of (a) layout issues, (b) placement of the products and (c) routing of the picking process. In routing issues, the couple of particular points in picking route were discovered to cause backtracking during order picking process.

Picking routing was generally though as a good one, but it has some issues that force the picker to backtrack. Backtracking is unnecessary movement back to area where the picker has already been. The case company is using routing numbering to order the routes in picking. This routing number is prioritized to be the first, and it is 10-digit number in the case company's ERP-system. If the routing numbering is not valid for

certain parts of the warehouse, it can cause the pickers to travel unnecessarily back and forth in warehouse. It increases the traveling distance and takes more time to finish the order picking.

> *"It is frustrating to need to travel back to P-Balcony after picking from aisle D34".*

Above quotation from the several pickers is illustrating the increasing of the traveling distance. It also raises the question why the all the pickers are pointing out the need to go to P-Balcony after the picking from the D34. P-Balcony is considered as an item graveyard in the case company. For this reason, there should not be too much of picking form the P-Balcony. Item supposedly place in P-Balcony are items that soon to be obsolete.

Furthermore, when a picker takes several orders to pick at the same time, the routing takes the picker first to the packing area to drop off ready orders, and then routes back to the so-called middle warehouse, to pick up items picked from high picking area. After this, the rest of the orders can be dropped off to packing area. This forces the picker to travel first to packing area, then to unifying area, and finally to packing area. Travel distance can be double compare to optimal picking routing.

Finally, issues concerning *waste removal* from the shelving in the warehouse of the case company. Many interviewees consider that trashes in picking shelves are slowing down them. Although the issue is not new thing in the case company warehouse, it should be stated as weakness. This is because pickers know about it, but for some reason it is fully comprehended by few pickers.

> *"We know who pickers leave the trashes into shelves are, and we have say about it to them, but obviously do not care about it."*

Above quotation heard from a few interviewed pickers can be seen as disrespect to others and to common rules in warehouse. Based on the interviews the struggle to get all the pickers to pull together in this matter is on-going process in the case company, and the implementation of 5S-method has started during the data 1 collection. 5S can be considered as a tool to solve the trashing issues in the case company.

3.4 Summary of Key Findings and Selected Areas for Improvement

In order to improve the efficiency of order picking process in the case company's Ansa 2 warehouse, the above issues are needed to be treated and solve. This subsection discusses key findings, and summarizes them at the end.

Based on the findings, the order picking process is a well working process in the case company Ansa 2 warehouse. The paper picking and the voice picking are both working well, and they are complimenting each other's. For these reasons the picking methods should stay as they are at the moment. In future if the picking quantities increase, another order picking method should be considered. Although the process in generally works well, it does not mean that there is anything to improve to be more efficient. Figure 4 shows the strengths in the current order picking process.

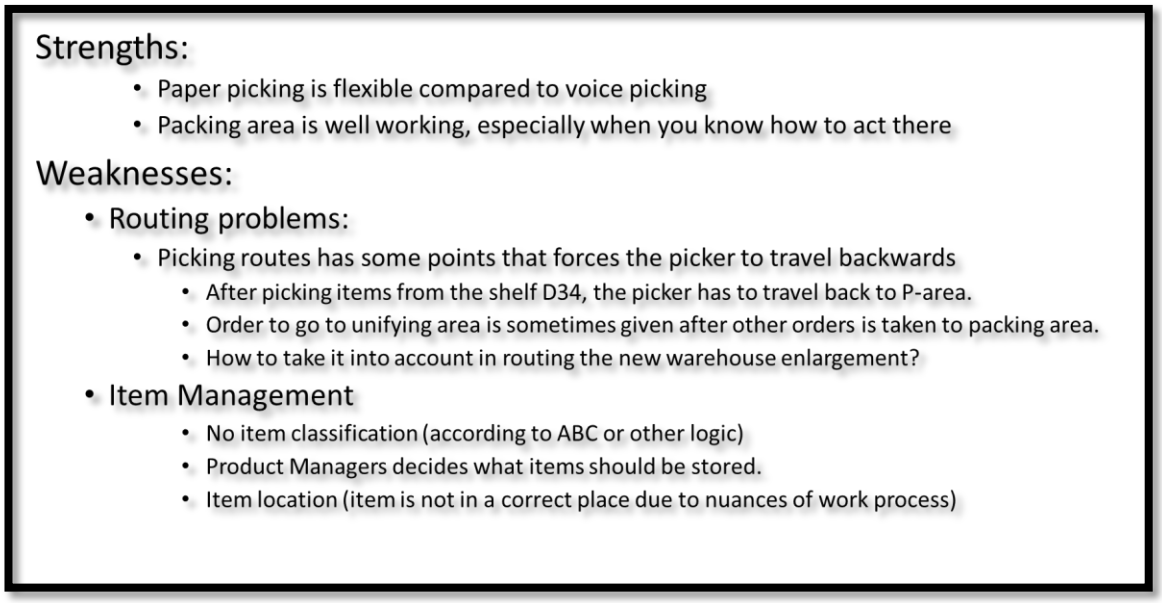


Figure 4. Illustration on strengths and weaknesses discovered in the Current State Analysis.

In addition to the strengths, Figure 4 also illustrates the weaknesses found out in the current state analysis. For *the Order picking process* to be efficient enough, the *item management* needs to be improved. Poorly managed items can effect seriously on order picking efficiency, and cycle times when items are located on shelves taking into account their frequencies in customer orders. On the other hand, if the replenishment of the items is not based on their demand, the capital tied up to inventories may increase, and influence on the profitability of the business, and fills up most of the storage places in warehouse. When the replenishment strategy causes back-orders, it may

severely damage customer satisfaction. To tackle this challenge, the item classification could be useful tool to recognize the slow moving items. At the moment, the case company is not yet using any kind ABC-analysis method. Furthermore, the strategy what to store where in order to keep the customer order lead time as short as possible also should be revised, and ideally there should be a harmonized way suggested for making the decisions for it among product managers.

After the item management is in order, the actual *order picking process* needs to some improvements, too. From the interviews with order pickers, it came up that at some points the pickers are forced to travel backwards while picking items which causes inefficiencies. In order to improve the order routing, the current layout should be reassessed from the picking process efficiency perspective. The efficiency of the current layout of the warehouse has to be verified especially focusing on the match with today's item portfolio. Finding the optimal way of routing pickers in the warehouse is vital because a wrong kind of a layout can cause unnecessary movements for the pickers in the warehouse. As the case company has expanded the warehouse, an assessment on how larger the footprint could be utilized in the picking process should be carried out.

Finally, various types of *wastes* cause a lot of headaches in the warehouse. Without a proper way to clean and eliminate wastes, the efficiency of order picking process may decrease. If order pickers are forced to struggle through wastes to reach to the items, it could influence negatively both on the efficiency of the picking process and the pickers' motivation to work. The case company has taken the first steps towards Lean's 5S-method, to eliminate all waste. The 5S method does not only reduce or eliminate waste, but also forces one to find a place for all the equipment in warehouse. If the equipment does not have an allocated place in a warehouse, it could be considered as extra equipment. As suggested by Lean 5S method, all extra equipment should be discarded, in order to have well working and lean warehouse (Kaizenworld, 2015).

Summing up, the findings from the current state analysis were categorized according to: the picking process, picking methods and packing area which make *the strengths* of the picking process. In the weaknesses category, there are: item management, picking routing, and waste removal. Thus, after conducting the CSA, all the weaknesses are taken as the focus for improvement in this thesis, since they are interrelated. Next sec-

tions focus on finding best practice to tackle these challenges as discussed in existing knowledge and literature.

4 Best Practice for Improving the Picking Process

This section discusses the best practice found from existing knowledge and literature source. The idea of this section is to develop a conceptual framework to be utilized in the development of the initial proposal for improving the efficiency of the picking process.

4.1 Warehousing Management in Wholesale and Importing Companies

Warehouse is a facility to store items in for ensuring item availability to customers (Farahani, et al., 2011). As the demand for the items cannot be predicted very accurately, the manner of storing items in a warehouse can help to ensure the availability of certain items to customers. To ensure the item availability to customer, without increasing costs of inventory, an effective warehouse management is needed (Farahani, et al., 2011).

Warehouse management can be seen as mission control unit in warehouse. Not only is the warehouse management responsible of shelving, picking and shipping of the items, but is about confirming the overall quality of all warehouse operations (Frazelle, 2002). Quality in operations is consisting from shelving quality of the items. It includes also in what accuracy is the items shelved into their locations and in what quantity. Most visible quality is the quality of the picking. Customer can see easily if the quality in picking is lacking, by receiving wrong item, or wrong quantity of the ordered item. Key challenges for warehouse management are to ensure that correct item is shipped to customer in correct quantity. Most of the warehouses use a separate quality department to handle and correct possible quality issues in warehouse operations.

A working warehouse has a few key functions to answer to customer orders (Frazelle, 2002). To get items inside the warehouse, items need to be received in receiving area. In receiving area, the items are inspected for any defects, based on the ordered items in quality of items or in quantity of items. Any defects in items are reported to supplier. From receiving area, the items are transferred directly to shipping area, if the item belongs to a backorder or it is cross-docked (Frazelle, 2002). Backorder is case when ordered item or correct quantity of the ordered item is not available. Backorder is order that is waiting the moment the correct item or correct quantity of the ordered item has arrived to warehouse. In cross-docking the items are transfer directly to shipping area

when the items arrive the warehouse. Items can be consolidated with rest of the order and the order is then send to customer. Otherwise the items are stored into designated storage shelving based on the need of the item in warehouse. Item can be placed into reserve place if the actual picking location is not depleting. In order to respond the customer needs, an item wanted in customer order is needed to pick from storage shelving. In order to do that order pickers are needed. Pickers pick the items based on the order from the storage and transfer them to packing area, where the items are packed and labelled with address labels. A delivery note describing what items the package is containing is usually placed on the side of the package in sticker pouch. Finished order is then shipped to customer by some mode of transport. Transport method is stated in original order placed by customer. There can be seen some increasing trends in warehousing currently. Next paragraph will take closer look on those trends.

One of the leading warehouse trends is *automation* and *advanced picking technologies*. Level of warehouse *automation* has been increasing for some years now, in most of warehouses. As business practitioners believe, the largest logistics automation system so far has been built by the Finnish retailing organization S-Group. Their subsidiary Inex Partners Oy, responsible for logistics in organization, built new warehouse with automatic storing and picking systems in Sipoo. In addition to this current consumer goods logistic centre, the S-Group is currently building a larger logistic centre, which would replace the current grocery goods logistic centre in Espoo (Witron Logistik + Informatik GmbH, 2013). This new grocery logistic centre will be fully automated. This is the first time in Finland that this size of automation system is built. Smaller size automation system have been built or are being planned to be built in several places. For example, Also Finland is currently building an automated logistic centre in Tampere region. Most of the automated systems are high rise storage systems aiming at space savings compared with more conventional approaches.

Another trend, a*dvanced picking technologies,* such as pick-by-vision and pick-by-voice*,* has become more common. The reason to develop the picking technology is to free pickers' hands to other activities and to reduce the picking errors. The most common advanced picking technology currently is pick-by-voice method. This picking method releases pickers' hands to actual picking and the method also frees pickers' vision (Optiscan Group, 2016; Dematic, 2016). With pick-by-voice picking method the picking accuracy can be nearly 100% (Dematic , 2016; Optiscan Group, 2016). Another increasing trend in picking technology is pick-by-light. In this picking method, a light

signal is showing to picker where to pick next. In most case next to light there can be a display showing the quantity to pick. This picking method is most usually used in small areas or in closed environments that the picker can see the light immediately from the place where he or she is. In many automated systems are using the pick-by-light method, to show the picker where to pick (Constructor Group, 2015).

In past years especially in Finland, the use of *rental workforce* has been increased. Companies expected to gain savings by using the rental workforce to do their "hands-on" jobs. This trend has been visible especially in warehouse business. Many companies are outsourcing their warehouse workers to a rental company, which then takes the responsibility for the warehouse operations. By using the rental workforce, the company can reduce or increase more easily the needed amount of workers in warehouse. This flexibility enables the companies to save human resource based costs in warehouse compared to only own workforce. Rental companies are taking bigger and bigger role in warehouse operations, as they are not only concentrating on picking processes or other individual warehouse processes, but they can also improve overall warehouse operations based on their experience from the other cooperation companies. These efficient improvements can save the company's money and the rental company's money (Ahokangas, 2014) (Alleron Oy, 2016) (Suomen Transval, 2016).

Warehousing in general is expensive, it can make up two to five percent costs of sales of a corporation (Frazelle, 2002). Warehousing costs are formed from asset costs, acquisition costs and shortage costs (Farahani, et al., 2011). Asset costs are formed from capital costs, e.g. a standard banking interest, inventory service costs, e.g. taxes and insurances, contingency costs, e.g. pilferage, deterioration of stock, and obsolescence of items. Acquisition costs are formed from many areas of general acquisition. Costs are categorized in following groups, office supplies costs, e.g. papers, forms, postage, etc., communications equipment, e.g. telecommunications, IT-hardware, purchase order activities, e.g. planning, entry, processing, inspection, follow-up time. Furthermore, in acquisitions costs are acquisition management, tracking and expediting actions of the shipments. Shortage costs are based on unsatisfactory level of stock or even stock outs. (Farahani, et al., 2011) All of these costs are effecting on company's cash flows and should be handled effectively. At the same time, an effective way to manage inventory can reduce warehouse costs and increase customer service level (Farahani, et al., 2011). In automotive importer and wholesale business the habit of the over stock their warehouses are a cost increasing habit. The reason to over stock is generally kept as a

customer service level and to have item availability as high as possible. Nevertheless, to have high item availability in one hand is a good thing, but on the other hand it is increasing overall costs of the warehouse and the whole company.

Summing up, modern companies store items to ensure the item availability to their customers. The ideal situation would be to ship items directly to customers from the manufacturer without necessity to store items. Unfortunately, this vision is not the reality for most of the companies yet. Customers expect to receive their ordered items after a reasonable lead time, and a supply chain always needs inventories in order to meet the customer expectations. Still, the strategy what to store and in what kinds of quantities needs careful planning, or the slow moving items fill the warehouse and tie up capital that could result in higher returns elsewhere. Working warehouse, stores only the items that are necessity to store for the company business, whether it is a core business item, accessory or spare part to it.

One perhaps future trends that is currently on top is 3D-printing. By buying “blueprints” in computer file from a selling company, the customer could then print the item by using 3D printer. As the 3D printing technology is not yet fully supported by the overall technology, it is still in at the level of thoughts. Items the current 3D technology is capable of printing is still quite flimsy, as the materials used in printing are not fully sturdy enough. However, in the future, one could argue that by developing the 3D-printing technology, warehouses as we know them can become obsolete. Unfortunately, current technology does not yet fully allow this kind of thinking. Basically the technology is already available.

Speaking about removing the warehouse, the lean management is currently trying to achieve efficient supply chains without excess warehousing. The following section discusses the lean management.

4.2 Lean Management

Lean is not only philosophy to do things in a company, but it is an operating system (Basu & Wright, 2008). Lean system emphasis on efficiency of activities and minimizing the inventory levels. Lean system is all about removing any waste that from processes to make it more efficient. Waste is all that the end customer is not willing to pay for (Voehl, et al., 2014).

Perfect lean operating model would have no traveling time, no storages and no waiting time (Voehl, et al., 2014). Lean way of thinking is to identify and eliminate wastes. In lean system the waste is not only normal household garbage, but also the activities that do not produce any value to end customer. The value in lean system is all the actions the end customer is ready to pay for. These actions can be labelling the product, adding an extra item or service to original product, or faster delivery compare to normal method of delivery. In order to have fully operating lean system, the lean thinking needs to be implemented to all and every function in the company. This means that every worker has to act in a lean way. Furthermore, to fully grasp the lean philosophy, the lean thinking needs to be part of everyday operations in all aspects of the company, i.e. the directors and managers of the company need to work in unison with all the employees of the company. The lean system has lot of tools to identify and eliminate waste, but get full benefit from the tools the lean concept needs to be understood. Lean philosophy reaches for perfection but will never truly reach it.

In lean management, the key point is to always seek the imperfections to make whole process to more efficient. Lean has its own word for this, Kaizen. Kaizen is Japanese word meaning “change for better” (Voehl, et al., 2014). Change for better is often translated to continuous improvement. This can be taken as a key function of the lean management. Kaizen, the continuous improvement, is about taken all the workers and manager in to account to find imperfections and to improve them. Continuous improvement is all about engaging all the workers for process improvement. Kaizen is the fundamental philosophy in lean management for successful and sustainable process improvement.

Summing up, to identify and to eliminate waste from the processes, the lean philosophy has many tools to help and to aid the waste identification and elimination process. Some of the lean tools help to organize the materials in use, to identify mistakes, to balance the production based on the orders and to organize workplace. Lean is not only to clean wastes from the processes but it is all about activating the workforce to take responsibility from their activities and making sure that everything is working smoothly (Voehl, et al., 2014). Lean philosophy can improve the efficiency of order picking process, by identifying the wastes in picking process. These wastes can be unnecessary traveling distances to pick items, and unnecessary storing of certain items.

4.3 Item Management

Item management is all about handling the all aspects concerning the item. These aspects are, e.g. item description, dimensions, weight, material type, average costs per item, environment where item should be store in, (Frazelle, 2002) etc. Item management is the way the company is handling the items in warehouse. Item management chooses items to store and the quantity of the storable items. Item management is about ensuring the availability of the items to internal or external customers (Slater, 2010). With proper item management, warehouse management can influence on warehouse efficiency. The efficiency can be improved by grounded decisions about item availability, item classification, and popularity based storing.

Lean way of managing the items is to remove the warehouse all together. It might be the most optimal way to manage the items, to send them directly from manufacturing to end customer. This way all the warehouses in the supply chain can be avoid. To reason to have warehouses, is to ensure anticipated customer demand, to meet the production requirements, to have protection against possible stock outs, and to have some protection against the possible price increase (Stevenson, 2005).

Other reasons for to store items in warehouse is to gain independency of operations, to reach balance between supply and demand, and it also creates a buffer stock between distribution and business critical processes (Mentzer, et al., 2007; Grant, et al., 2006). By storing the items in warehouse the companies can ensure the flow of items to customers, i.e. by storing items the company can avoid the stock outs. Item management's main objective is to ensure availability of items with minimizing both inventory value and to minimizing the stock outs (Slater, 2010). Item management is in this sense balancing between with minimum inventory value and with fear of stock outs.

To decide what to store and what to order from the manufacturer, is critical decision to company. In the end companies themselves decides where the limit goes what to store and what to order from manufacturer based on the customer demand. Usually the basic guideline here is to see how popular the certain item is, and possible criticalness of it. The company has to know what items are critical to store for availability and what items are not so critical to have in warehouse. Perhaps one of the oldest inventory management tool for this instance, is called Pareto method or ABC-analysis (Stevenson, 2005). Pareto method and ABC-analysis can be argued that they are dif-

ferent things, although generally they are often unified in to be same thing. Pareto-method is all about 80/20, meaning that 80 % of the items are bringing 20 % of all the profits, and 20 % of the items are bringing 80 % of the profit. This generalization rarely is correct, as the percentage is usually something else. In this aspect the ABC-analysis is better solution for item classification.

The classification of items by ABC-analysis can be made in many ways, based on item popularity contra money it is providing to company. Frazelle (2002) argues that basing the classification on money perspective is wrong, but basing the classification on cube movement, true value of ABC-analysis can be achieved. Cube movement is critical to warehouse management in general. All the racking systems are planned based on cubes of the items, and it is in this perspective a proper way to analysis the items. By classifying the items based on volume popularity, space required by the items needed to fulfil the year's demand can be identified. Based on this, proper storage place can be decided. It will provide data on items which would be based on grounded reasons to place in close proximity of the output point of the warehouse, and should be place bit further away from the output point.

Business practice suggests that effective item management can remarkably reduce the total warehouse carrying costs (Farahani, et al., 2011). With proper item management, the company can reduce its warehouse costs and still keep customer satisfaction levels high. Total warehouse carrying costs can be categorized in to three categories, holding costs, procurement costs and shortage costs (Farahani, et al., 2011). Holding costs includes capital costs as a capital tied in items, service costs, as taxes and insurance costs, risk costs, as damage to item or obsolete item, and storage space costs (Farahani, et al., 2011). Listed cost factors show clearly what is generally though that all the costs concerning the items, is the procurement costs. That is not a case, total cost in storing items in warehouse comes from many different sources. Solely in procurement costs can be calculated procurement department's office supplies, as procurement form, telecommunication equipment, etc. With rationalized item management, the total costs of the warehouse can be reduced, when total costs of the item are compared to profits the item is generating when sold to customer.

Moreover, proper and optimised inventory management can improve the warehouse efficiency remarkably, as the storage shelves are only booked for items that are actually sold in regular intervals. Items that are not sold in regular intervals reserves storage

space from other items and can force the warehouse workforce to travel further, as the bigger warehouse is needed to store items. Furthermore, the unsold items are creating costs to company as they are needed to inspected, move to another place and also to counting inventories for accountants to clarify the warehouse value. All the capital that is tied up to unsold items in warehouse, is cash removed from other profitable actions or investments (Slater, 2010).

Finally, to avoid falling back to a warehouse with excess items in it, it is necessary to evaluate the procurement strategy. If the procurement department keeps doing procurements as they have done it always, there is danger to have warehouse piling up of excess items into recently cleaned storage racking. In order to evaluate the procurement strategy and actions, analysis of the current procurement actions should be done. Furthermore, the groundings of the procurement decision is need to evaluated, is there a reasonable demand forecasts or are the decision based on the ones feeling. With recalibrated procurement operations, the company could establish more optimal item quantities without losing the service level. In order to have optimal procurement strategy, there needs to be cooperation with other departments of a company (Gudehus & Kotzab, 2009). With correct items in stock, the next step is to place them in the right place in the warehouse.

Summing up, to reduce the travel time and distance, the most popular items should be in an easy reach and fast access, which is possible by using ABC-analysis. Routing of the picking process is discussed in next section to find out what are the possible ways to make routing more efficient.

4.4 Picking Orders and Picking Routing

Order picking is the basically the warehouse activity, where warehouse workers, called as pickers, picks customer ordered items from the warehouse shelving. Customer order is transferred from sales department or directly from the customer to picking management, where the picking line or lines are send to pickers to pick. Picking line is a line describing what item in what quantity is need to be picked. Picking line usually contains also storage location where particular item can be found. In advanced picking systems the picker can refer to automated storage system or other similar system (Frazelle, 2002). Picker is a person or machine that is bringing the ordered item to packing station or to other picker to transfer it to next station the item is needed.

By picking only one picking line at the time, can be prove to be inefficient way to pick. Often the case is that many orders are picked at the same time. In these cases, the route the picker is taking to be able to pick all the ordered items in an efficient way, comes in crucial. Picking route could be seen as roadmap or navigator for the picker. Picking route, when planned properly can reduce the overall distance the picker travels during the picking. There are many things that can effect on traveling distance of the pickers. One of the ruling ways to roadmap the picking route is S-Shape or serpentine picking (Frazelle, 2002). In Figure 5, is drawn a serpentine picking and main line picking with side trips. One of the main aspects that effects on picking route method, is it S-Shape or mainline with side trips method, is the layout of the whole warehouse. When the starting point and ending point of the picking is nearly in same place, the S-Shape picking route can be more efficient compare to mainline with side trip route. Furthermore, one of the biggest effects on traveling distance of the picker is the location of the items in shelving. If in every picking tour the picker needs to travel through all the aisles in warehouse, picking work is containing all the items in warehouse, or the items are put in shelves by randomly.

From all the activities in a warehouse, order picking process is the costliest of them all (Frazelle, 2002). Picking the ordered items from the warehouse is the most difficult and underestimated activity in warehouse (Gudehus & Kotzab, 2009). The order picking is about to picking items according to the customer order. Usually the customer order is transferred to warehouse from the sales department. Usually warehouse supervisors' sort and approves the order and releases it to pickers to pick. Based on the picking strategy, the picker can go to a particular storage location to pick the ordered item, or the automation system can bring the ordered item to picker. Despite of the picking strategy, the key idea is to get the customer ordered item to picker who can transfer the item to consolidation area to be packed and shipped to customer.

Picking strategy has a big influence on the picking process, whether it is about getting the picker to item or item to picker. Conventional picking strategy is to send a picker to item. This picking strategy is most common way of pick ordered items from the warehouse. Modern way of picking items is to send the item to picker. This picking strategy requires high level of investments on automation systems, but it can provide more efficient way of picking items, i.e. the machinery do not take coffee breaks during the shifts. (Gudehus & Kotzab, 2009)

Several aspects in warehouse can have an effect on order picking efficiency. The biggest aspects effecting on efficiency is organizational underestimation on warehouse activities (Gudehus & Kotzab, 2009; Frazelle, 2002). There are companies whose managers and office employees see the warehouse as a necessity to run a business, rather than opportunity to make more profit. Warehouse neglects can cause possible extra profits to slip by and also un-satisfaction among the warehouse employees. It can be said that there is a thick wall between the office and warehouse, as it should be more or less transparent wall or no wall in first place between office and warehouse. Second aspects affecting on picking efficiency is inefficient warehouse processes (Frazelle, 2002). Storing of items and picking of items is too often based on the feeling, not on demand or popularity of the items. Inefficient storing strategy or lack of it can cause picking routing to increasing the travel distances and travel times.

In order to improve the efficiency of the order picking, based on the best practices and literature it can be put in three actions. These three actions are warehouse layout, picking method and order picking routing.

Warehouse layout can have significant effect on picking effective. Constructing the warehouse layout is lot like building puzzle (Frazelle, 2002). Warehouse layout comes from the activities that are need in warehouse. Placing them in warehouse optimally, in such a way that they are complementing each other, needs to be in balance. Layout is usually bit more than just placing pieces into a puzzle (Krajweski, et al., 2007). Each piece is requiring elements to work properly. These elements can be small buffer bins or consolidation area in it. Nevertheless, they all must be taken into account, in order to plan working layout. Most often layouts are planned only for current processes, as the possibilities to modify and adapt it to work also in near future, when the processes and technologies will change. Especially in warehouse, the storage layout is significantly effecting on picking effectiveness. The way the shelving is based on the warehouse can cause pickers traveling time extension.

Picking methods can be categorized in to two main categories, picker to item and item to picker. These categories are explained below.

Picker to item is conventional way of pick items in warehouse. This method is the least mechanized picking method (Gudehus & Kotzab, 2009). Only requirements for this

method are basically piece of paper and picker. The piece of paper acts as a picking list to show what items are required to pick in order to fulfil the customer order. Based on the order the picker travels to item location to pick the item and delivers it to customer or to shipping area through consolidation area and/or packing area. Item to picker method uses more mechanized systems in order to get the ordered item to customer or to shipping area. Most often these systems are called automated systems, as they are using automated systems to deliver the item. There are many levels of automation in market, with different levels of automation in them (Constructor Group, 2015).

Picker to item as mentioned earlier is the least mechanized picking method. Nevertheless, most warehouses are using some level of mechanized picking aids to increase the picking efficiency of the picking process. Although the pick-by-paper is the commonly used picking method in most of the companies, there are new picking aids that can left pickers' hands free (Lahtinen & Pulli, 2012). Some of these picking aids are pick-by-voice, pick-by-light and pick-by-vision.

Routing is greatly effecting on picking effectiveness. Choosing the picking route is based lot on the arrangement of the storage shelving. Presently, there are typically two options how to route the picking route (Frazelle, 2002). *Serpentine picking* is routed to pass by every storage location. This picking routing method can be taken as one of the most commonly used in many warehouses. To have effective picking in serpentine route, the item location is critical. If the items are placed in shelving in random order, the picker has to travel through all the location to pick items. If the most popular items are locating in first two shelves, the picker travel distance is shorter. This requires that start and end point of the picking is locating in same place, because total distance is the shortest than when the starting and ending point of the picking is in opposite directions.

An example illustration of picking routes is shown in Figure 5 below.

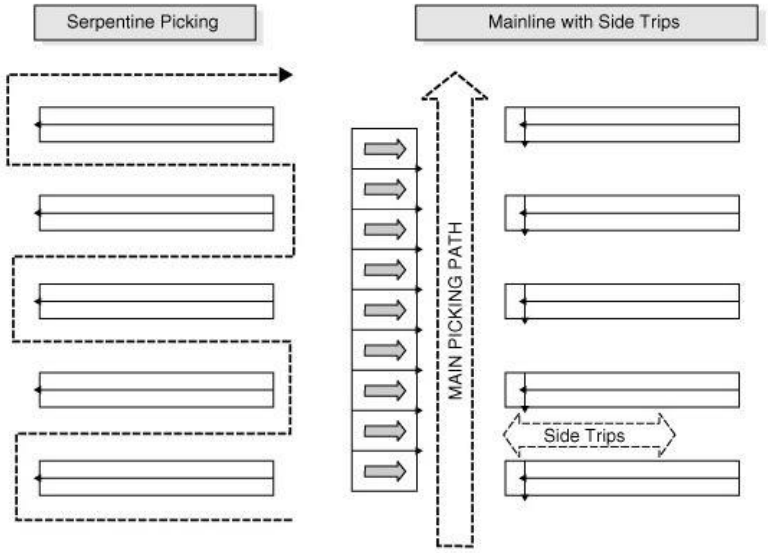


Figure 5. Picking routes (Frazelle, 2002).

The second option for picking routes, also shown in Figure 5, is *side trips from the main aisle*. In this method, the picker is traveling along the main aisle and makes side trips from it to storage shelving to pick items. This method is better compared to serpentine if the items are locating in random order in storage. Even though, the placing the most popular items in start of each aisle, can furthermore shorten the pickers traveling distance. In side trip method the starting point and ending point of picking are not in same place.

Summing up, the order picking effectiveness can be seen, in the end, as a summary of all the aspects mentioned and discussed in this section. The next section sums up all of these and creates a conceptual framework from them.

4.5 Conceptual Framework of This Thesis

This section draws a conceptual framework of this thesis. The conceptual framework is used further in Section 5, for building a proposal to solve the issues found in Section 3, the current state analysis.

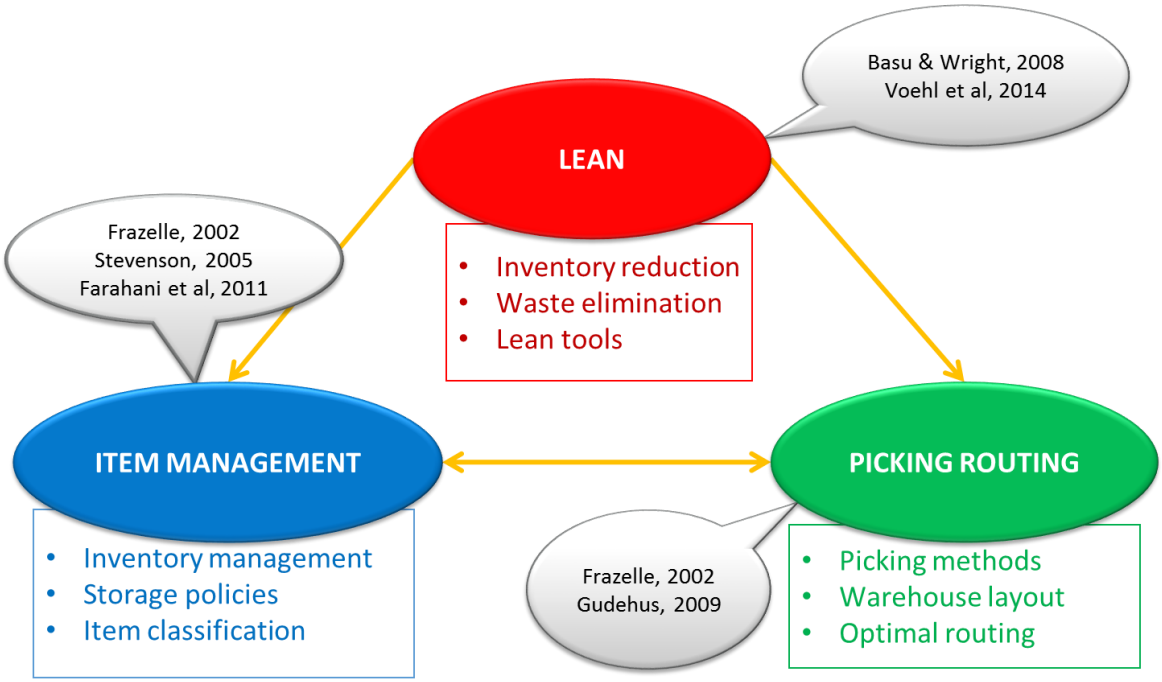


Figure 6. Conceptual Framework for improving the order picking.

Figure 6 illustrates the conceptual framework of this thesis. It consists of three main areas where best practice was identified for improving the order picking process. First, it is the lean management which points to the key concept for improving efficiency in term of eliminating waste. Second, it is the item management, and third, it is the best practice related to picking routing.

Lean itself is basically a philosophy to make things more efficiently (Voehl, et al., 2014). The lean concept is to identify and eliminate any waste from the process, and this way to improve the efficiency. Although Lean philosophy is filled with different kind tools for aiding the identification and elimination of waste, the grasping the true meaning of the Lean philosophy is the key thing to embrace. With Lean philosophy embraced, the inventory reduction would be the first step to take on road to more efficient order picking process. In Lean philosophy the all the aspects need to live and breathe the same Lean philosophy in order to grasp the whole potential of Lean management can offer into efficiency of the warehouse operations.

Item management can be chosen one of the key aspects for improving the efficiency of the picking process. Proper item management can reduce the total warehouse carrying costs, but also proper item management can effect on traveling distance of the picker in warehouse. With shorter traveling distance the picking process is using less time to

pick the ordered items. Not only reduce the inventory, the item management needs to have lean philosophy in it. If the item management keeps doing the things the way they have been always done, Lean philosophy has not been establishing in the whole company. In this matter the item classification and constant monitoring of it, is an essence to have Leaner inventory. Based on the item classification, the items can be placed on shelves based on the item popularity, this can lead to more efficient order picking routing as the pickers do not have to travel long distances to pick the items.

To be able to sustain a lower, more optimal inventory level, the procurement strategy needs to be evaluated. Only removing the excess items from the warehouse, optimal inventory levels will last as long as the procurements have been taken into action. No changes to procurement, the inventory levels will soon be at the same level before the remove of the excess items. Procurement strategy needs to be evaluated in a spirit of keeping the inventory levels without losing the item availability. In order to do this all the key departments needs to be taken into same negotiation where the procurement strategy evaluated. Proper procurement strategy can lead to a leaner warehouse and to a Lean company.

In addition to Lean philosophy and item management which make a direct symbiosis together, *the Order picking* routing is not separated from these. In a face of inventory reduction, the required location to place all the items in warehouse is reduced. This way the pickers traveling distance can be shortened in warehouse when picking items. Along the inventory reduction any other waste can also be identified and eliminated. This leads to usage of Lean tools, on a road to leaner warehouse. Eliminating the unnecessary moved in order picking can improve efficiency of the picking order process.

In next section of this thesis, the initial proposal is built with key stakeholders of the picking process of the case company.

5 Building Proposal for the Case Company

This section presents the building stage of the initial proposal. Intention of this section is to draw a picture how the proposal is build and with what building blocks. This section uses best practice identified in Section 4 and Data 2 for building the proposal. Idea is to build the proposal for solve issues identified in Section 3.

5.1 Overview of the Proposal Building Stage

In this study, the initial proposal is built on the results from the current state analysis. As soon as the challenges in the current order picking process were identified, the ideas from best practice and available knowledge were searched for. The best practice was discovered from literature and identified ideas from lean management, item management, and order picking and picking routing. Lean management was selected as it can be seen as an umbrella topic to the whole study as the lean focuses on making things efficiently. Item management covered the subjects how to classify items, and what benefits inventory reduction can bring to the company. Finally, the order picking and picking routing methods were discussed to find best practice in these topics. As soon as best practice was discovered from literature, it was applied to the case company issues and merged into building the relevant proposal.

The proposal was built in co-creative manner with the key stakeholders of the case company from the order picking process. This co-creation stage of the proposal building makes Data 2 collection. Data 2 was collected based on the interviews and discussion with the stakeholders. In addition to interviews, a workshop was conducted to find solutions to picking routing. Key stakeholders consisted from the order pickers, and the warehouse supervisors. Building of the initial proposal was done in two different ways, which both focused on one main field of the problem areas, namely the item management and picking routing.

To solve *the item management issues*, one-on-one discussion were conducted with warehouse supervisor. Objective of this one-on-one discussion was to discuss and find a suitable solution to item management issues found out in the current state analysis. These issues were (a) the absence of the item classification, (b) excess items in inventory, and (c) location of the items in warehouse. To conduct this discussion, the preliminary question form was created. Questions which were included in this form are visible

in Appendix 4. Although the preliminary questions were formulated, the discussion was conducted as semi-structured or even open question discussion, at some points, as a more or less informal discussion between colleagues in all the company issues. The main weight of this discussion was placed on the item management, and especially (a) how to classify the items in Ansa 2 warehouse, (b) how to reduce the overall storing quantities, and (c) where and how to place storable items.

Picking routing problems were discussed and solved in a workshop with three order pickers. Objective of this workshop was to discuss and solve those issues in picking routing that are causing the pickers to travel extra distance. This workshop was a toured exercise through whole current picking routing in Ansa 2 warehouse. When the problem areas were confirmed and discussed, the workshop participants discussed possible alternatives to solve these problems. The pickers for this discussion were chosen amongst the rental pickers. This selection was based on the foreman's choice and the willingness of the order pickers to be an assist to this proposal building. The decision to involve the pickers into creating and trying out the new picking route was made for the reason that these pickers are traveling around the warehouse every day. Based on the experience of the pickers, the routing workshop provided an insider view to problems and suggested real alternatives for these problems. The workshop continued for 30 minutes for the picking routing investigation and the trial to new routes. As a result of these fruitful discussions and the workshop, the whole touring and solving took nearly one hour to complete.

The following sub-sections describe the stakeholder suggestions as data 2 findings and formulate the improvement proposal for the case company.

5.2 Findings of Data Collection 2

This sub-section of this study presents the findings from data collection 2. Data collection 2 consisted from stakeholder suggestions to the item management and picking routing issues found in the current state analysis. *Item management* issues consist from the challenges related to three main issues: (a) item classification, (b) inventory reduction and (c) locating of the items. *Order picking routing* issues consisted from (a) the backtracking issues and (b) routing issues related to the new enlargement part of the Ansa 2 warehouse.

Table 5 illustrates the issues discussed and suggested in Data 2 collection. In first column, the table shows the main area where the particular issue occurs. In second column, it shortly names the suggestion for the issue, and in the third column it gives a description for the suggestion to each particular issue.

Table 5. Suggestions to improving the issues (as found from the current state analysis).

	CSA (key results)	Issues Raised in Data 2	Suggestions
1.	Picking Routing	Aisle C05 is full of shelving equipment	Place the equipment into proper area.
2.	Picking Routing	How to fit enlargement part into picking routing?	Entering enlargement part from three different aisles, from D04, D12 and K23.
3.	Picking Routing	How to fit P-Balcony into picking routing?	Entering the P-Balcony needs to be divided as there is two sets of stairs to P-Balcony. P-Balcony is divided into to routing areas to minimize the traveling
4.	Picking Routing	How to merge the D34 and unifying places into picking route?	D34 is second to last place to pick, and unifying area is the last pick location.
5.	Item Management	Is there a reason for the inventory reduction?	"At the moment the there is too many cooks in a product management, that new product lines are opened every month. It makes warehouse operations extremely difficult as the new product lines contains items that do not sell, as well as the procurement quantities are suggesting."
6.	Item Management	How to reduce inventory quantities?	First, there needs to be one big sweep to throw away all excess items. Secondly, the procurement amounts needs to be made reasonable for all the parties in a case company.
7.	Item Management	Should item classification be taken into use?	Yes, it should be taken into use. Though it is feared to be too laborious to be taken into use.
8.	Item Management	How should the items be located into Ansa 2 warehouse?	Items should be located in warehouse in item family aisles, e.g. one aisle is reserved for only one item family. Inside the item family, the items should be locating by popularity of the item.

In Table 4, the weaknesses of the order picking process were categorized into two main categorize. These categorize are item management and picking routing. Each weakness found out in section three, the current state analysis, were discussed and dealt with in the workshop or during the interviews.

Parts 2 to 4 in Table 5 are issues regarding the *picking routing* issues found out in the current state analysis Part 1 is the only one which was discovered during the workshop, which has not come up earlier during the current state analysis. Key stakeholders were involved in discussions and in proposal building stage. All the key stakeholders gave their expertise in to discussions, and helped to build a proposal. Key stakeholders' suggestions are illustrated in Table 5 above.

During a tour within the workshop, it was discovered that *aisle number C05* is often jammed with pallets, trucks and other related equipment from the workers who are shelving the items into storage. It was mentioned in the workshop that the equipment is usually left into in aisle C05 even during the evening shift, when the shelving workers has already left from work. This issue was discussed and it was pointed that the shelving equipment should be placed after the shift into their proper place in the receiving area. This is important since there is a place for this equipment, since all the equipment has a designed place in the receiving area. It was decided that by doing things in this way, aisle C05 could be less jammed during the evening shifts, when most of the order picking is taking place, and the main body of the order pickers are present.

In addition, the enlargement part and its incorporation into the main warehousing area was discussed. Part 2 in Table 5, workshop discussed how to solve the enlargement part picking in routing wise. Because the workshop thought that the picking routing in aisles C05 to C14 and D02 to D14 are now clear and problem free, the workshop tour continued to enlargement part. It was suggested that, because the enlargement part is big compared to other parts of the warehouse, and it has long aisles in different position compared to other shelving in Ansa 2 warehouse, the picking in the enlargement part would be divided into three parts. In this enlargement part, there are aisles L01 to L05 with additional specialized shelving in aisle L06 to L08. The enlargement part is visualized in Appendix 5's top part of the table. The division into three parts can be done in this way.

Firstly, for optimizing the picking, the right hand side of the enlargement should be picked after aisle D04 is picked. After this part of the enlargement part is picked, the picker would return to D04 and D05 aisles. The middle part of the enlargement part is picked after aisle D12. After the middle part of enlargement part is done, the picker should continue picking in C12 and C14 aisles all the way to K23, from where the picker is picking the final part of the enlargement part. With this kind of picking logic, the

workshop participants thought that the pickers' traveling distance would be optimal. Picking would then make the S-shape picking, as visualized in Figure 8.

Next suggestion related to backtracking. One of the biggest issues, found out in the current state analysis, was backtracking between aisle D34 and P-Balcony, illustrated in Table 5, in part 3. Aisle D34 is located in the middle part of Ansa 2 warehouse shown earlier in Figure 3. As revealed from the current state analysis, the picking routing system was ordering the pickers to travel, after picking from the aisle D34, to P-Balcony. This caused the pickers to make a U-turn and travel to a far part of Ansa 2 warehouse. This issue was brought up by every picker that was interviewed for this study. Workshop discussed this issue, and came up with a plan how to divide the P-Balcony into two picking sections. This solution was come up because the P-Balcony has two set of staircases, which located basically in each end of the balcony.

The solution to the backtracking issue suggested in the discussions was as follows. When the picker picks items under the balcony, aisles K05 to K15, before picking aisle K05, the picker should be forced to climb the stairs up to the balcony to pick the balcony aisles P06 - P09. After this, the picker continues the picking with the picking of aisles K06 to K15. After K15 picking, the picker is again forced to climb the stairs back to the balcony to pick the rest of the balcony aisles, P10 to P13. This solution was seen as the logical way to pick the items from the P-Balcony without unnecessary movement back and forth. This solution was called "dividing the item graveyard picking".

After picking in the P-Balcony, the picker continues the picking in aisles K16 to K22. After successfully picking the aisle K22, the picker starts traveling back to the ending point of the picking, the packing area. Before the picker reaches the packing area, the picking routing is ordering the picking from aisles D34. This solution was regarded as a logical option by the workshop. This way any backtracking should be avoided, at least, in the same extent as it was discovered in the current state analysis. In other words, this solution should lessen the backtracking. This solution was called "Final aisle picking".

Final issue raised up in the current state analysis related to the picking routing, and it is illustrated in part 4 of Table 5. Issue again is about backtracking between packing area and unifying area, where all the high picked items are placed. To minimize the backtracking, the workshop decided that picking from the unifying area should be after aisle

D34 picking and before going to packing area. As this issue is not entirely solved by the case company's ERP, but more of voice picking issue as the voice picking system is it ordering the picking from the unifying area after the packing area is reached. Solution for this issue requires the discussions with voice picking system supplier.

Finally, in the workshop it was discussed about the possible changes in the layout of the warehouse. During this thesis, there has been held a series of talks about purchase of new automated storage systems. These talks are already in the planning phase, and the plan is to move the current automated storage to the middle part of the warehouse, where the automated storage system, coded as T9 in ERP-system of the case company, is already located. This moving will have an effect on aisles D32 and D33, as they are going to be removed partly. Due to this plans to move the automated systems, there is going to be some change also in the picking routing. In the workshop it was decided to revisit the routing as soon as the moving of the automated storage systems is completed.

Issues found in the current state analysis concerning the *item management*, were discussed with the warehouse supervisor during the spring 2016. When seeking out solutions to issues in item management, the interview was conducted with this particular warehouse supervisor. Interview was informal, with questions to guide the direction of the interview. These questions are visible in Appendix 4. Parts 5 to 8 in Table 5 illustrate the issues and suggestions to the item management issues.

As seen from parts 5 and 6 of Table 5, discussion was held about the total quantities of the Ansa 2 warehouse inventory to be possibly reduced and if so, how the reducing should be handled. The first reaction was that the excess inventory quantities should be removed from the warehouse, and to seek all the items that are not sold at all for a certain time. It was stated also that there seems to be a new item line opened up nearly every month, and these new items requires storage based as they purchased just in case if they could be sold to the case company's customers. The action of how the reduction should be handled was suggested to make a big sweep to scrap all the excess items and to see is it truly reducing the overall inventory quantities. Based on another comment earlier in the spring, it was suggested that inventory reduction could be done by reducing the procurement quantities. This suggestion can be very long and tedious process. Based on these two comments, best option to reduce the inventory, should include both action. Firstly, a big sweep to remove the excess items from the

inventory, which is followed by the recheck of the procurement quantities and strategies, to keep the inventory quantities in the optimal level.

In relation to the excess items in inventory, the item classification was brought up in discussion. Part 7 in Table 5 illustrates this issue. The overall reaction to item classification was that it should be taken in to action in the case company, but it is feared to be too laborious action to be taken in to use. It has to be noted that not all the actions are easy to be taken, when efficiency of different processes is improved. Some actions are more laborious than others, but nevertheless, if the laborious action brings efficiency into process and creates additional profit to company, it should be taken into action. In the end of the discussion the item classification can be key thing to improve the item management. Properly handled and created classification system can bring better item management to case company.

The issue in part 3 in Table 5 raised also another issue along with the routing issue. This issue related to the question why all pickers claim that they have to backtrack to P-Balcony. This issue is discussed as a part 8 of Table 5. P-Balcony is nicknamed in the case company as the item graveyard, where the items go when they are about to get rid of. It clearly shows that item graveyard is not stepping up to its name, since popular items are placed in P-Balcony. The question is should the case company still keep random shelving strategy or should the item be located in warehouse based on their classification. Issue has been discussed with warehouse supervisor along the way of spring of 2016. Warehouse supervisor considers the placing the items based on their classification in each item family. This means that all the items are in same aisle with other items from the same manufacturer. Inside the item families the item should be placed by the popularity of the item, in way that, most popular items in item family are placed in closest to starting point of the picking route.

Based on the above suggestions from workshop and warehouse supervisor interview, initial proposal is build. The following the subsection draws the proposal, what is presented to logistic manager for validation purposes.

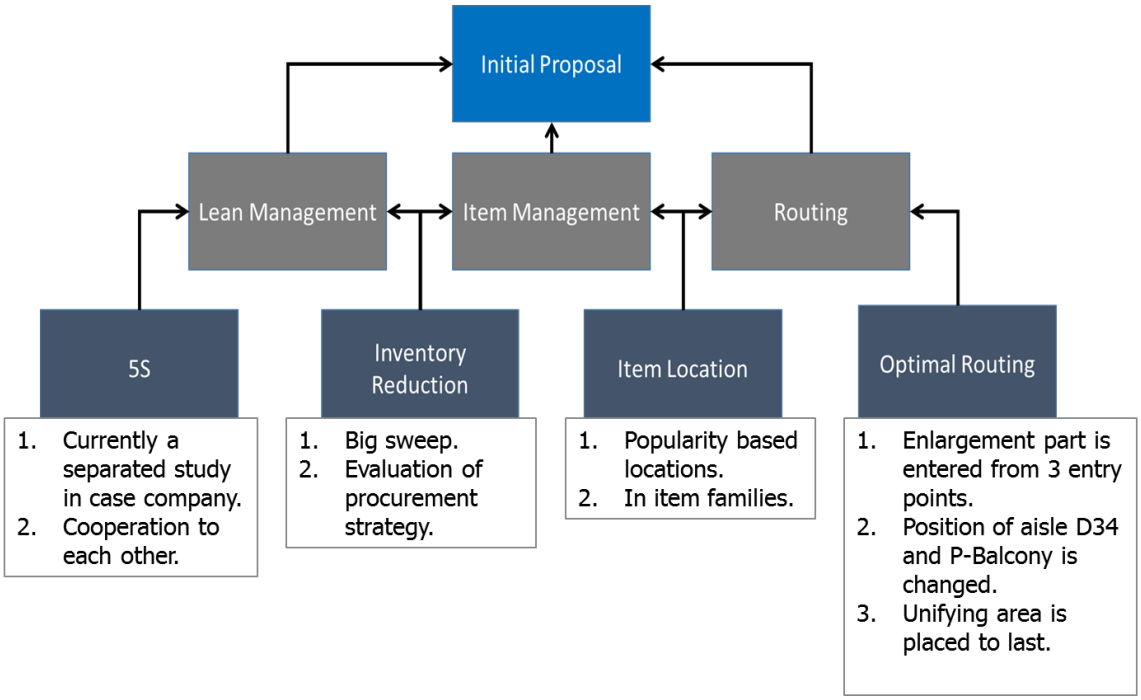
5.3 Proposal Draft

Table 6 illustrates the building blocks of the initial proposal. The proposal is co-created with the key stakeholders in the picking process of the case company. Building of the

proposal is based on the current state analysis, best practice, key stakeholders' suggestions (data 2) including the previous experience of the researcher.

Table 6 shows building blocks of the initial proposal for improving the order picking in the Ansa 2 warehouse of the case company.

Table 6. Building blocks of the initial proposal.



As seen in Table 6, the logic of the order picking improvement is related to the main topics explored in the conceptual framework. These three topics are *lean management, item management* and *picking routing*. Lean management is taken into account in this proposal as the case company is already taking steps towards to a more lean management. The evidence of it is the introducing lean tool 5S in Ansa 2 warehouse. This introduction of 5S is planned to be fully adopted in Ansa 2 warehouse by the end of the year 2016. As mentioned in Section 4, conceptual framework, true lean management is not only adopting one lean tool in the company but it is also about adopting the lean thinking and philosophy. Accordingly, the main principles of lean were selected as improvement tools for (a) reduction of waste in inventories and (b) the 5S-tool as one of the main lean tools to identify the waste and removing of the waste in other areas of the warehouse. Thus, this block of the improvement proposal can be easily grounded as highly relevant and the topic that led to the concrete improvement suggestions (a) to reduce the inventory and (b) to reduce waste in the warehouse of the case company.

Inventory reduction is in close relationship with item management and can be this way link it to lean management. It can be debate should the lean management be the umbrella topic for item management or should be in same level as the item management. Inventory reduction closely related to item management, as the good item management is core of working warehouse. Inventory reduction can be operated few different way, but in the case company workable way of operating is to classify the all the item, for better analysis of the inventory items. After classification of items and analysis of them, excess items should be visible. Excess items can then be removed from the warehouse by scrapping them or by selling them, e.g. to highest bidder. To prevent the excess items to pile up in to warehouse, the procurement strategy is needed to be re-evaluated. If the procurement strategy is good and purchasing programs are working there is no need to change them. In case of non-working procurement strategy and misused purchasing programs, the actions of procurement department are needed to analyse and roles and responsibilities of the workers should review.

The proposal draft summarized the suggestions from the stakeholders, which were addressed based on the results for the current state analysis. The proposal has also suggested the best practice that was identified as relevant for improving the order picking in this study. Next sub-section explains the proposed Improvement plan.

5.4 Proposed Improvement Plan

Based on the suggestions identified above, this section presents the *proposed Improvement plan* for a more efficient Order picking process. Following the request form the key stakeholder (Logistic Manager), the improvement plan was built as a visual shown in Figure 7 below. Text in the proposal contains the details and background where the proposal got it inspiration from and on what logic it is based.

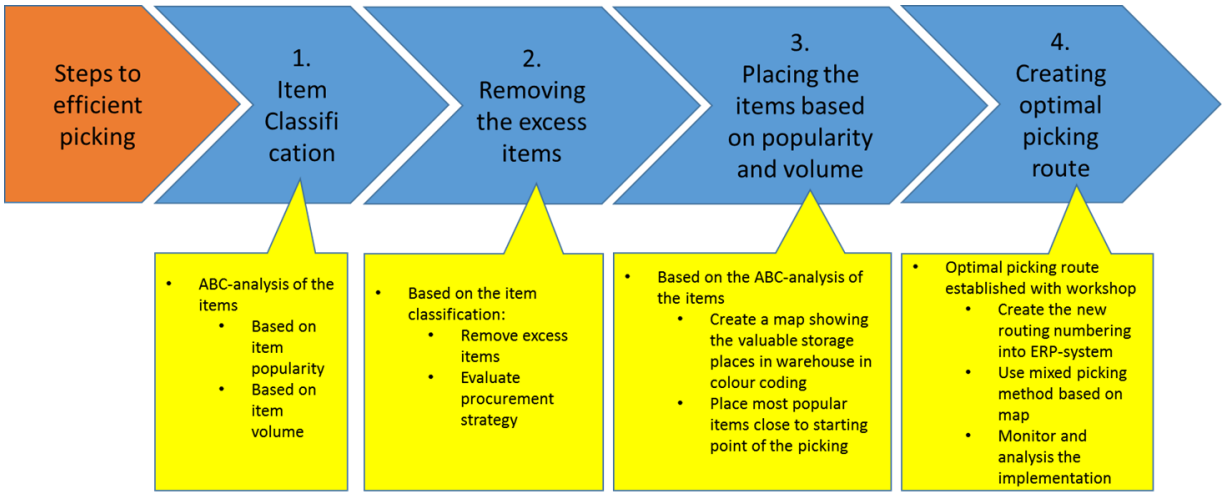


Figure 7. Proposed Improvement plan to the order picking.

Figure 7 illustrates the *proposed Improvement plan* for a more efficient order picking process. This diagram was proposed as input from the main stakeholder, the logistic manager of the case company, with additional text to complete the initial proposal. The Improvement proposal is structured according to the logic and concrete best practices identified in the available knowledge.

This proposal has been built by following *the Lean philosophy*, visible here in removing *the waste* from the process. These wastes were identified as (a) *extra traveling distances* of the pickers and (b) *excess items* in warehouse which are classified either separately (as removing the excess items above) or under relevant areas (if they make part of a bigger group of issues (as extra travelling distances).

If described in the order of steps, first, the Improvement proposal is laying its weight on (1) *Item classification*, which was discovered as not properly established in the case company. Based on this item classification, all the other steps, illustrated in Table 6, are possible and can have value in them only after introducing an effective item classification.

Proposed item classification for the case company is an ABC type of classification. This ABC-classification should be based on (a) the item popularity and (b) item volume. Item popularity would ultimately tell the true demand of the item in relations to other items. Item volume in this proposal is related to volume of the one item in terms of item dimensions. This would describe the space needed to store the item in warehouse.

Next, based on introducing the item classification, the case company has a possibility identify (2) *the Excess items* in warehouse, and could remove them in one *big sweep*. This big sweep would need to have the more planning before it can be implemented, as for what to do with the removed items, for example, to send them either to an auction or simply scrap them. Main idea behind the removing of excess items is to remove all the direct and indirect costs to these items. To prevent the excess items to build up in future, *the procurement actions* are needed to recheck and change the actions that are building up the excess items into warehouse. Importantly, the procurement was identified as one of the weaknesses from the current state analysis. It is here, in the excess item management, that procurement actions can become very relevant.

Based on the item classification and after removing all the excess items, (3) *Planning of the Item location* can truly start. Main idea behind this new item location is to place the items in such a manner that they are easy to reach. Basic principle is (a) to place the most popular items closer to the starting and ending points of the picking. By placing the items closer to the starting ending point of the picking, the pickers' *traveling distance* could shorten dramatically. This could mean that fewer pickers could pick the same amount of items from the warehouse as the current number of pickers are picking. In the case company, it would be valuable to also (b) to place the items by their volume. This decision needs to be made based on the analysis how much space the item needs from the warehouse to fulfil the demand, based on the item cycle times. In this proposal, *warehouse layout* is presented in a map, showing where to place the items is suggested. With this warehouse layout map, the case company could determine the most valuable storage locations to items that are popular. Figure 8 is illustrating example of the warehouse layout map.

Figure 8 shown the example of the warehouse layout map explaining the proposal of how items can be placed the in warehouse.

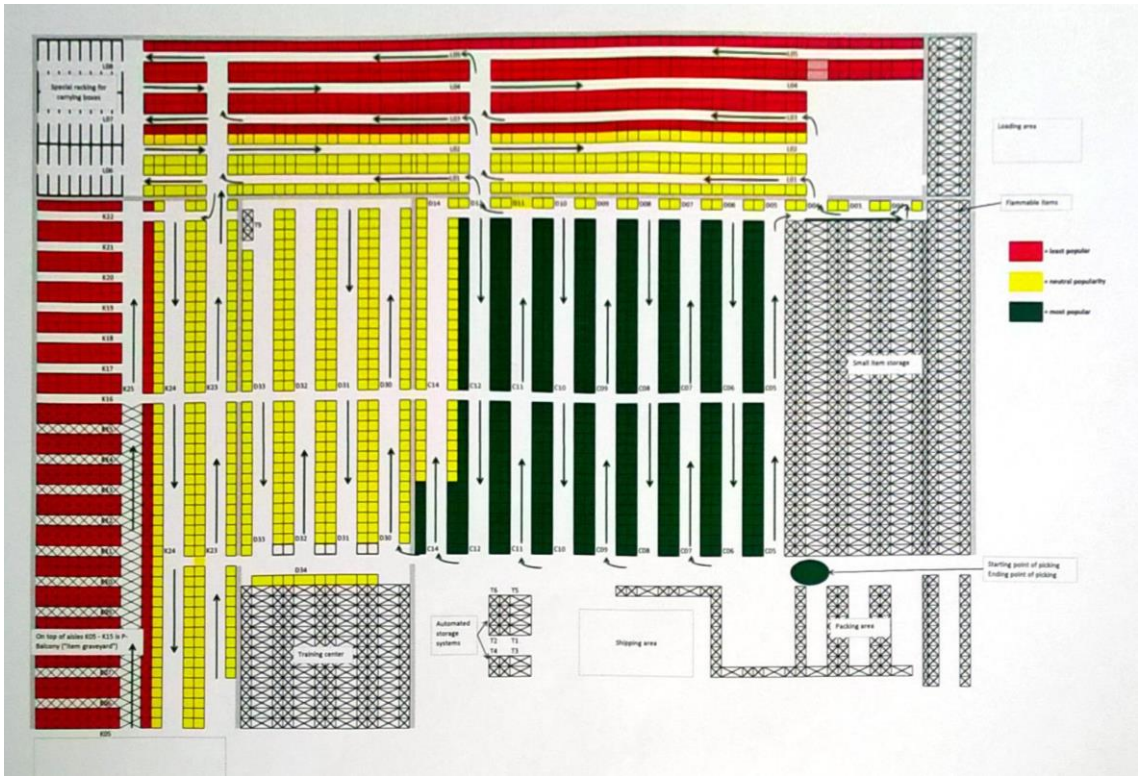


Figure 8. Example of warehouse layout map how to place items in warehouse.

The new picking routing is illustrated by arrows in Figure 8. Top part of the picture is illustrating an enlargement part of the warehouse. The picking area is divided in to three parts, based on three entry points into enlargement part. The map shows also example how to place items by their classification into Ansa 2 warehouse. Green circle in low right hand corner is showing the starting and ending point of the picking. Green, yellow and red blocks are showing the item locations based on their popularity. Green colour is showing the highest popularity, yellow colour is showing neutral popularity item locations and red is showing the least popularity items. Popularity is in this map described as a how many picks the item is having in a certain amount of time.

Next, the picking routing and item locations are going in hand to hand in this study. Picking routing for this proposal is done cover all the aisles and storage shelves to reach the optimal outcome in search of the efficient order picking process. The picking routing is using mixed method of routing to prevent possible jams and extra traveling distance.

Next, efficient picking process' requires (4) *the efficient routing*. In this study, the improvements relate to (a) creating the new isle numbering and placing them into the

ERP, so that the picking system will utilize the new numbers; (b) use of mixed picking methods, and (c) monitoring and analysis of the routing changes. This last point is important since improvements in a warehouse need to be done in a very careful manner. To create the optimal picking routing, “laws” of a particular warehouse need to be known and observed when proposing an improvement. This knowledge includes, first of all, the information on what kinds of transfer equipment is used to pick the items, and in what kind of environment these transfer equipment is moving. Are the pickers moving by foot, by kick cycles, or by forklifts, all these requires certain elements to be used as they are intended to. In the case company, the pickers are moving by the forklifts, and therefore they need a certain space around them to safely operate in a warehouse. In this sense, unnecessary picking from the dead-end aisles can cause extra waiting time for pickers. This why the picking routing and item locations are going in hand to hand, in this study.

Furthermore, the Improvement plan also includes the strengths found out in the current state analysis. For example, it suggests to keep using *(b) mixed picking methods*, namely picking-by-voice and picking-by-paper. Although the picking-by-voice is a more efficient picking method, as it is releasing the picker’s hands to do the actual picking, this study suggests to keep on using the pick-by-paper method as it gives the flexibility to pick orders that would benefit from pick-by-paper method’s flexibility. Otherwise, for the regular orders, the pick-by-voice shows the efficiency which is required in the current order volumes.

6 Validation of the Proposal

This section discusses about validation of the proposal presented in previous section. Validation of the proposal speaks about the quality of the proposal, is the proposal valid in terms of taking it in to action in the company.

6.1 Overview of the Validation Stage

In validation stage, the proposal is tested by the decision makers of the case company. After viewing the proposal, the decision makers of the case company approves or disapproves the proposed improvements.

Proposal of this study was validated by the logistic manager of the case company. Logistic manager is the main stakeholder for the warehouse operations in the case company. Although not anymore in a board of managers, the logistic manager prepares logistical cases and presents them to newly appointed purchasing and logistic director of the case company. The case company's purchasing and logistic director is former purchasing manager of the case company. In that sense, he is well aware of the procurement situation of the case company. However, the logistic part itself is the part of this responsibility where he still is learning. This introduction grounds the decision to present the proposal of this study to this logistic manager, who is well aware of the logistics issues in the case company. In addition to logistic manager validation, the proposal was presented to purchasing and logistic director. With this, proposal could have more credibility in terms of validation of the proposal.

In the next sub-sections, the feedback to the proposal is discussed.

6.2 Findings of Data Collection 3

For the validation purposes and for the approval of the proposal, the logistic manager of the case company was interviewed. The proposal was handed over to the logistic manager for the evaluation of the proposal. After the preliminary evaluation, the proposal was reviewed together with the researcher of this thesis. Overall, the feeling of the logistic manager is that the proposal is in line with the strategy of the case company

and managerial thinking. The Logistic manager commented that all the aspects of the proposal are already known amongst the managers of the case company, but there was not yet an opportunity to improve the situation. Feedback of the logistic manager also included the acknowledgement that the researcher of this study is well aware of the challenges from the previous cases and appreciated the solutions developed in the proposal for the case company.

As seen from the citation below, the feedback included not only the acknowledgement of the challenges, but also pointed to the reason behind the main challenges, as seen by the management. The feedback received from the logistic manager included, for example, this statement:

> *"We are aware of issues raised in this proposal, but based on the lack of the storage space in warehouse, the actions to solve these issues have not been taken, yet".*
>
> - *Logistics manager*

This quotation for the initial proposal from the logistic manager of the case company illustrates the general feeling about these discussed challenges. Logistic manager felt that issues on item management have already been known in the case company, but improvements have not been taken in place due to spatial issues in warehouse. These spatial issues that the logistic manager is referring to, point to the shortage of warehouse storage space. One solution to this spatial shortage is the addition of a new enlargement part of the Ansa 2 warehouse. This new enlargement part is increasing the warehouse capacity, and giving more storage places to items the case company is storing in its warehouse. In building stage of the proposal for the thesis, this enlargement part was taken into account, in the sense that the proposal suggested to incorporate this new enlargement area in the picking routing. Secondly, the proposal also suggested what item should be placed into this new enlargement part of the warehouse.

In the feedback, the logistic manager stressed that he understands the issue of decreasing the pickers traveling distance. This challenge was proposed to be solved by placing the items closer to starting and ending point of the order picking. This suggestion resonated positively with his own understanding of this solution.

Logistic manager also recognizes the problem in backtracking, between certain aisles described in the previous sections. However, he feels that it could be sorted by purely modifying the picking routing itself. From his opinion, this solution would solve the backtracking issue, but as the same time, it would not decrease the overall distances the pickers are traveling, when picking up the items from the warehouse.

Next section presents the final proposal of this study.

6.3 Final Proposal

From the feedback received from the logistic manager of the case company, there were no changes made for an initial proposal. The initial proposal stays as it is described in Section 4 and consists of two parts: the Improvement plan and the proposed warehouse layout map for new picking routing and example of how to place items based on popularity (see Figures 7 and 8 above).

The only suggestions from the logistic manager was to simplify the proposal text and to make it in bullet point style, especially the current state analysis phase of the describing the found strengths and weaknesses. From the logistic manager's feedback, it does not come clear if or when the proposal is going to be taken into action, or is it put into drawer to wait for some better time.

6.4 Recommendations

As for the recommendations, this study suggests the following steps to be taken next:

Firstly, start item classification immediately, and to access the full potential of the classification. Item classification is the keystone in the improvement of the efficiency of the order picking process in this proposal. Item classification also serves as a foundation for many other actions, since most of the improvement steps are logically based on this classification.

Secondly, thorough item classification, the case company can also approach the problem of removing the excess items, which have not been sold for some time. This action can save money in terms decreasing the item handling costs which can be achieved by removing these unsold items. Moreover, a released space from the excess items can

be used for new popular items, which could return more profit than the items that do not sell.

Thirdly, evaluation of the procurement strategy is essential for reducing the inventory levels in the case company. Without evaluation of the procurement strategy, inventory levels can increase into levels that can be unbearable for the case company in a long run. Capital tied in inventory, could be released from excess items, and it could be used in other activities in order to make the case company more profitable as it is. Reduced inventory levels could improve the efficiency of the case company order picking process. With fewer items in warehouse, items are scattered a smaller area. Smaller area to pass during the order picking process, smaller is the distance the pickers need to take.

Fourthly, routing the order pickers are taking could be even shorter, if the items are placed into storage by their popularity. By placing the most popular items closest to starting point of the picking process overall distance the pickers are traveling during the process, could be significantly shorter. During the current picking process most of the picking is happening all over the warehouse, which is area of around 18,000 m^2. If the popular items are placed into area of 10,000 m^2, the traveling distance of the pickers could be half compared to randomly placed items.

Fifth, the new improved picking routing should be established. The suggestion for this new routing was developed in the workshop, and the new established routes should be taken in action. This new picking routing is solution to issues found out in the current state analysis, by removing the backtracking issues in aisle D34 and P-Balcony. It also removes the issues in enlargement part picking, by dividing the enlargement part into three picking zones. New picking route is not enough to improve the efficiency of the picking process in the case company, as the items needs to be placed into warehouse by their popularity.

Finally, to help the placing the items into warehouse, proposed warehouse layout map could be a helpful tool. With this warehouse layout map, there could be in colour coding the warehouse locations that could reserve for items that are most popular, and locations that are reserve to items that are not as popular. In this warehouse layout map, picking route can be drawn, to be able see what could be an optimal routing through the picking aisles.

Summing up the recommendations above, to receive more efficiency from the picking, this study recommends placing items in the warehouse based on their popularity. If done in this manner, the pickers' distance which they travel in the warehouse would be shorter than it currently is, since these routes used for picking up popular items are used more often and thus need to be shorter. The picking routing suggested in this proposal was made in a generic manner, so that to leave space for further suggestions how to increase efficiency in the picking, no matter where the items are located in a warehouse.

7 Discussion and Conclusions

This section discusses the summary and conclusions of the thesis. This section contains summary of the thesis, managerial implications, and evaluation of the thesis in terms of outcome vs objective, and reliability and validity of this thesis. Idea of this section is to discuss the results of the study and draw conclusions from them. This section will conclude this thesis.

7.1 Summary

The business challenge of this study was to improve the efficiency of the current order picking process. As in many other businesses, the picking process is seen in the case company as one of the highest cost producing process in all the warehouse costs. Therefore, the objective in this thesis was to propose a more efficient way to pick orders.

As the outcome, this study proposes an improvement plan for increasing efficiency of the order picking process in the case company. The case company is looking for actions to increase profitability of its business. As the order picking can be one of the costliest warehouse operations, picking is a great place to improve efficiency and look into a possibility to increase profitability.

This study was conducted by using qualitative data gathering, and it involved the key stakeholders of the order picking process by conducting interviews and workshop. The selected research approach is a case study, as the study strived to find the starting point for the efficiency improvements. It was done by conducing the current state analysis of its existing picking order process. Firstly, the analysis of the existing picking order process identified the key strengths and weaknesses of the process. Secondly, the results were categorized into themes, and key weaknesses were identified in item management and picking routing issues. Solutions for weaknesses of the process were searched from best practice and available business knowledge, and based on the findings, the conceptual framework was formed for building the proposal.

When the challenges were identified, the study looked into the available knowledge and best practice in warehouse process improvements. Ideas were searched from lean management for improving efficiency and, furthermore, from item management concentrated on inventory management, storage policies and item classification. In order to improve efficiency of the picking process, the improvements concentrated on picking methods, warehouse layout and optimal routing to establish a picking routing. Based on these ideas, additional interviews were conducted and stakeholders involved in the workshop in order to create a proposal. The initial proposal suggested an improvement plan to improve the picking process efficiency in the case company.

The outcome of this study is an improvement plan for the improved order picking process. The proposal is approved by the logistic manager of the case company, but the implementation stage is still pending. The proposal was built by adapting the lean philosophy into the company picking process. Proposal suggests item classification, which is missing from the case company's item management. The item management and especially the item classification can be viewed as the keystones of the whole efficiency improvement. Additionally, inventory reduction is suggested as a key factor when improving efficiency of the picking process. As a result, if the total amount of the stored items is lower, the faster the picking process could be faster. If the inventory is reduced, it also releases the capital tied in items to other operations or activities. Although picking one item amongst 100 items is quite fast, it could take a longer time if the item that is needed is nearly almost every time picked from the other end of the warehouse. However, if the items are placed by the their popularity, in such a manner that the most popular items are in a shorter distance away from the origin of the picker's starting point, the traveling distance then becomes shorter. This is one of the suggestions in the proposal.

The proposal also suggests that the first action, in a chain of improvement actions, should be to introduce item classification first, so that to be able to place the items based on popularity. This will become a major source of savings for the case company, since currently the items are placed in racking randomly. This is especially visible in Section 3 of this thesis. All the pickers interviewed for the current state analysis were commenting that it is frustrating to travel backwards to P-Balcony. P-Balcony is known in the case company as an item graveyard. As such a term exists for the racking area, there should not be too many pickings in a day for it. The item graveyard is a place

where the items are spending their last time in the warehouse, as they are doomed to be obsolete.

Next, the proposal stresses that, despite the fact that picking routing can be viewed as easiest to be moved and easiest to get total blame if the order picking is not working properly, nevertheless, it is worthwhile to analyse also other aspects effecting on the order picking process. Still, the optimal picking route is essence to pick orders effectively from the warehouse to customer who ordered the item. The proposal suggests to use the S-Shape picking route, as it is the most effective way to route the pickers in the case company's warehouse.

The proposed improvement plan helps the case company should help to improve efficiency of its picking order process by introducing: item classification, removing the excess items from the inventory, and rethinking its picking routing. By using the popularity based item locations, coupled with optimal picking routing, the case company could increase efficiency of the picking process. Order picking process can thus be seen as the key to improving the total process. As the picking is the highest costs from all the warehouse operations, the whole process should be analysed and made it as smooth process as possible. With attention to the picking process, the costs can be reduced compared to its profits.

7.2 Managerial Implications

For the managerial implications, this thesis emphasizes the need to pay more attention to warehouse operations.

Firstly, the case company should start to use the item classification for the items that the case company is promoting. Item classification could also lead to re-thinking of the excess items in the warehouse. With many managers to decide what to store, and without any transparent item classification system, the current warehouse is soon going to be on the verge of needing more storage space. By taking the item classification into action in the case company, immediate improvements to a more efficient warehouse operations can be achieved. Furthermore, there should be a role to monitor the items classification. This would enable the possibility to intervene to piling up of the excess items into the warehouse. Persons involved into monitoring the item classification,

should be in cooperation with the procurement department and warehouse. This way, the item classification could stay up to date.

Secondly, excess items needs to be removed, and the procurement strategy needs to be re-evaluated. Without evaluating the procurement strategy, the company can easily slide back to doing business the old way. Into evaluation of the procurement strategy needs to be involved all the product managers of the case company, procurement department and warehouse management. By involving all the key members of the procurement into the same evaluation of procurement strategy, all the parties would get in same page of on what groundings the procurement decision should be done. By involving warehouse management into evaluation, evaluation team could receive vital information about storage costs on the storable items. Warehouse management can also calculate needed storage space based on the interval of procuring items, i.e. what is the item cycle. This would enable warehouse to reserve storages for items, it would also increase transparency to see when certain items are desired to arrive to warehouse.

Thirdly, creating a warehouse layout map could help to show where the best places to popular items are located and placing these items into storage shelving. By storing the items based on popularity, it could increase efficiency of the order picking process. In the end, sending correct items to customers is the main objective of warehouse operations. If the correct item is located into the furthest place of the warehouse, it would increase the time used in picking the correct item from the warehouse. Furthermore, the warehouse layout map could show the optimal route to picking orders from the warehouse.

Finally, the optimal picking routing could be considered and taken into action. During this study, a workshop created a sample picking routing for touring all the warehouse aisles as optimal as possible. Although the picking routing is optimal even in the current random placing of the items, the case company could get even more efficient process by placing items based on the popularity of the items.

To add the continuous improvement perspective into the process, all the aspects mentioned above should be evaluated on a regular basis. When basic functions are on a good level in terms of process efficiency, next there could be room for more advanced technologies that would improve the efficiency even further.

7.3 Evaluation of the Thesis

Researcher's objective in this thesis was to improve the current order picking process. In order to do that, interviews were conducted with key stakeholders of the picking process. The interviews were conduct without any negative in them, and interview results were relevant to study.

Immediate steps after the study is implementing a new picking routing into the current picking process. The picking route was developed in a co-creation with order pickers. New picking route would solve the backtracking issues found out in the current state analysis. Picking route will be implemented during the May 2016. At this point of the study, further steps are still to be planned. If the proposal is taken into action, item classification based analysis should be started during the summer time, as it this most crucial part of the whole proposal.

Although the researcher's neutrality to study can be criticized, the researcher did all the necessary action to be detached from the findings of the study. This can be seen in interviews, which were conducted with random pickers, with whom the researcher has never worked together. Thus, the results of the study can be considered reliable. Next, as can be seen in picker interviews, though all the pickers started with no critical comments to say about the picking process, as they understood that this is a study to improve the picking process, answers started to be more critical. Furthermore, seriousness of the pickers also showed in the pickers coming back to the researcher and adding details and sharing their observations, which they felt could be left out the from original interview. After the interviews, the all the interviewees' were encourages to come speak again if they felt that something was not mentioned during the interview.

Building of the proposal for this study was done by gathering ideas from best practice and available knowledge from literature. By doing this, the researcher could see that spending time in library can be very productive. From the literature, there were found interesting solutions to warehouse issues in the case company. Although not all of them were presented in this study, they gave lot of thinking and new points of view. Researcher felts that different kind of literature were completing other topics found during the library search and the real case analysis. This can be though as a one of the most valuable things during library search.

On the down side, the feedback to the proposal could be more extensive. However, the researcher was lucky to receive feedback from the logistic manager, who is ultimately responsible for the picking process and knows best about the efficiency of the picking process in the case company. At this point, the proposal is still waiting for feedback from Purchasing and Logistic Director.

7.3.1 Outcome vs Objective

The objective of this study was to propose an improvement plan to improve efficiency in the current picking process. The objective was initially set to propose a more efficient way of picking orders. With all the aspects listed in the proposal, item classification, removing the excess items, placing items in storage based on the popularity of the itme and optimal picking route, the objective could be seen to be reached.

> *"Study was carried out quite straightforward, as these are all the things that should be taken in such an organization. And they are quite typical for this arrangement."*
> *Juha Haimala, DSc (Tech), Principal Lecturer, Head of Industrial Management*

Above quotation from the main instructor of this thesis shows the nature of the study and evaluated the proposed improvement plan. In this sense the outcome of this thesis is on the level with the set objective of the thesis. The outcome of the study is an improvement plan to improve efficiency of the current order picking process. With proposed improvements, the order picking process could receive better efficiency of the modern picking process.

7.3.2 Reliability and Validity

Reliability of this study asks if the same study could be done similarly with same research tools. To ensure reliability in this study, 6 out of about 20 order pickers were interviewed. To increase the reliability the answers from the pickers were consistent. Reliability could be confirmed, as after interviewing all pickers it was obvious that most of the answers were recurring in every interview. This consistency of the answers did increase the overall reliability of the study.

Validity of the study was ensured by using interviewing and workshop as tools. The chosen tools could be seen to be valid choice as the interview results were consistent with goals of the thesis. Furthermore, validity of the study was insured by interviewing several stakeholders. In this manner the interviewing was very effective method to conduct this study.

7.4 Closing Words

Improving the efficiency of the warehouse can be seen a critical phase to a company. The business environment is quickly showing what the study has tackled the right weak point in the process. In this study, all warehouse personnel were eager to help, as they could clearly see improvements needs in the current warehouse activities. As the picking activity is considered as one of the highest costs of the warehouse, it is clearly a place to start the improvements. However, without further improvements into the current warehouse operations, achieved improvements can stay as marginal and the true value of the improvements can be short-lived.

Finally, the proposed improvement plan for order picking process is not only affecting the picking process itself, but it can effect have a bigger influence on the item management itself. Item classification is one of the easiest ways to improve the inventory of the company, and is the first step towards a more profitable way to handle items in the company's warehouse.

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Interview form for order pickers / Data 1 collection

Interview form for order pickers / Data 1 collection

Background:

1. Role:
2. Employer:
3. Experience:

Questions:

1. What do you think about order picking process in general?
2. What things do you think are working well in order picking process?
3. And what things are not working well enough?
4. What parts of order picking feels “hard” or “difficult”?
    a. when signing the order for picking
    b. choosing the correct transport unit
    c. choosing and using the picking aids
    d. locating correct picking address (order routing)
    e. finding the correct item (item labelling)
    f. choosing the correct quantity
    g. delivering the picked items to packing area / packing the items
5. What else would bring up in this interview?

Summary of Interview Results

Summary of Interview Results

+ Paper picking brings flexibility into order picking process. It gives a choice which item to pick first. In voice picking the, the voice tells what pick and in what order
+ Packing area is working well, especially when picker knows how to act in there.
– Picking route in some points faulty. Especially from aisle D34 to P-balcony, from packing area to consolidation area and in aisle D32 back and forth movement.
– Put away of items, items are not in proper places.
– Identifying some of the items, especially the oil items, is hard due to a unclear identify number, (picking number contra item number)
– Narrowness of places during the rush hours.
– Ergonomic, when picking heavy items. Shelf beams prevents proper lifting position. Can cause backaches?
– Cleanliness of picking position. Same pickers tend to leave trashes to shelves, although they are instructed to take trashes to garbage. Can cause the reason for item put away issues?
– Sometimes computers for accepting picking and for packing details are locked, and log in details are missing(?) (Log in details has usually been attach to frame of the monitor)
– No ABC-analysis used in item management.
– Items are stored more now, as the bank interest are 0 %
    - Items are likely more profitable than holding the capital in bank account
    - If and when the bank interest is more than 2,5 % the cycle time of items can be increased. Now the item cycle time is around 3.
– Product Managers define what items should be held in warehouse all the time.
– Customer satisfaction surveys are not held at the moment, but few years back it was held in a yearly basis.
    - Back then there was only one survey form that was given to all the customers. As the customers' presents from different kind of fields, the survey could not catch the true meaning of the satisfaction survey.
– Employee satisfaction survey has been presented to be held in side the company, but was consider not needed at this point…
– Customers are treated on an equal footing, but if necessary "the good customers" can have better service
    - Nevertheless, everybody are served something.

Summary of Supervisor Interviews

"Coffee table" talk with warehouse supervisor 30 min.	10.2.2016
Talk with warehouse supervisor was informal. Topics were related to general warehouse management, item management and to implementation plans for lean tool	
Notable citations form this talk:	
- Many items do not have any other history markings than inventory accounting marks, no sales markings	
- Warehouse management is not using ABC-analysis or other classification for items.	
- Implementation plans and actions for lean tools 5S.	
Interview with sales group supervisor 20 min.	10.2.2016
Questions:	
- Has the company taken any customer satisfaction surveys?	
- Is sales monitoring its performance with any indicators?	
- Has sales determine any service level for the customers?	
- Is sales monitoring delivery ratio?	
Summary of the answers:	
- Customer satisfaction survey is not conducted at the moment. Few years ago customer satisfaction surveys were conducted, but they were too generic to hit correct objectives.	
- There are several indicators, for monitoring the sales performance, e.g. received phone calls and created order lines.	
- Sales are not directly performing any categorization for its customers, but if orderd items are next to nothing, the "better" customers are served first. Bottom line is that for all the customers the company is trying to deliver something.	
Interview with purchasing and logistic director 70 min.	10.2.2016
Questions:	
- What the company is including in procurement costs?	
- On what groundings is the purchaced decisions made?	
- Is purchasing using any indicators to monitor the perfomance?	
Summary of the answers:	
- Procurement costs includes: purchase itself, freight costs, warehouse costs and purchase costs	
- For puchase, the company is using purchace software, which is calculating forecasting.	
- ABC-analysis is not used. Total item cycle is low at the moment, because bank interest are pratically 0%. The company sees that there is more profit by procuring excess items and selling them, than by keeping the cash in bank account.	
- Items are having sort of classification, decided by product managers.	

Interview Form for Proposal Building

Item Management

1. Item classification
    a. Should the item classification be taken into use?
        i. Yes, why?
        ii. No, why?
    b. If item classification is taken into use, in what it should be based on?
        i. ABC-classification? (Capital tied, Volume, Pieces, Popularity)
        ii. Pareto-method? (80%/20%)
        iii. Something else, what?
    c. If classification is taken into use, how should it be...?
        i. ...defined?
        ii. ...sustained?
        iii. ...monitored?
2. Reducing the Storable Item Quantity
    a. Do you think, that inventory reduction should be taken into account in case company?
        i. Yes, why?
        ii. No, why?
    b. If you think that inventory should be reduced, how would you do it?
        i. Reducing the procurement quantities?
        ii. Removing the excess quantities?
        iii. In some other manner, how?
3. Item Location
    a. How would you place the items into warehouse?
        i. By randomly (current state)?
        ii. By item families?
        iii. By item classification?
4. Anything else based on item management?

Warehouse Sketch for Building an Optimal Picking Route