Thesis

Bin Location Setup

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October 2018
Degree Program in Logistics Engineering
School of Technology

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jamk.fi

Description

Author(s) Dmitrieva, Anna	Type of publication Bachelor's Thesis	Date October, 2018
	Number of pages 60	Language of publication: English
		Permission for web publication: x

Title of publication
BIN LOCATION SETUP

Degree programme
Logistics Engineering

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Assigned by
Mattokymppi Oy

The bin location setup was done for the company Mattokymppi providing carpets and rugs and offering carpet-related services such as carpet tailoring. The company operates in Jyväskylä, Tampere, Helsinki, Vantaa and Espoo and has six shops and a wholesale functioning as a warehouse in Jyväskylä. In 2018 Mattokymppi moved its warehouse into a new building located in Jyväskylä, Seppälänkangas and needed the bin location setup to be done.

The objective was to create the efficient bin system implying easier, faster and more accurate put-away and picking, simple navigation, program integration and ease of the expansion of the system of the arranged bins. Other aspects related to the bins management were covered such as allocation of products stored in bins, technologies defining bins and programs used for managing bins with the purpose of possible maximizing the reached outcome of the set bins for the company Mattokymppi.

In order to reach the objective the following four methods were used: quantitative, qualitative, evaluative and action research methods.

The final result was the complete bin location setup being utilized in the warehouse Mattokymppi.

Keywords
Warehousing, bins, bins setup, inventory, product allocation, zones, sections, labelling, barcoding, inventory management system

Miscellanous

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1 Introduction to the study

The new warehouse of the company Mattokymppi received a new bin setup. The company provides its customers with carpets and rugs and offers carpet-related services such as carpet tailoring. The company has an extensive variety of ready carpets according to their characteristics that are divided into categories: machine-made or handmade carpets and rugs made of, for example, viscose, cotton, wool, synthetic, etc.

The company operates in Jyväskylä, Tampere, Helsinki, Vantaa and Espoo and has six shops and a wholesale functioning as a warehouse in Jyväskylä. All the carpets are bought directly from the factories located in Turkey, Egypt, Belgium, Germany, Greece and Holland and they arrive in Finland in sea containers. In Mattokymppi there are around four hundred retailers providing service to the customers and contributing to the turnover that is about 5.8 million euros.

In order to reach the main goal different possible bins management systems were considered for the company until the best practical solution was found and agreed on by all the people involved in warehousing including the employer' and employees'. The work was done during the spring and autumn of 2018 soon after Mattokymppi moved its warehouse into a new building located in Seppälänkangas, Jyväskylä.

|mattokymppi

Figure 1. Mattokymppi logo (Mattokymppi)

Figure 2. Mattokymppi warehouse (Mattokymppi)

1.1 Purpose

The purpose of the thesis was to manage the bins at the Mattokymppi warehouse in the most effective and practical way so that the layout of the bins could bring efficiency and that the implemented bins arrangement could still be used effectively in the future if changes happen at the warehouse. Effective usage of the bins includes easier, faster and more accurate put-away and picking, simple navigation, program integration and ease of the expansion of the system of the arranged bins.

In the thesis work the bins setup was examined as well as other aspects related to the bins management such as the allocation of the products stored in the bins, technologies defining the bins and programs used for managing them. The purpose of every implemented and suggested solution was also clarified in every specified chapter concerning every designed solution.

1.2 Background

The role of the warehouse is to meet the demand of the customers and to deliver the assigned goods in the right quantity at the right price at the right time. A warehouse should tackle challenges and problems quickly so that they do not hinder the supply process. Deliberating all the sources of possible obstacles beforehand is an assurance for successful profitable and secure warehouse operations in the long-term. A proper layout or design contributes to the shortening of the working time for picking, consolidating and packing the orders if finding and picking an item in the warehouse is simple, quick and easy. Consequently, this contributes to decreasing losses in the warehouse in terms of expenses and time in the long run and enables the warehouse operations to be more efficient, which leads to a suitable, competitive price for the customers.

The design of the warehouse should be easy to understand to the workers as long as they are the ones who will work in the designed and planned facilities. At the same time the design of the warehouse should be easy to adjust to meet the future changes if needed.

A well elaborated layout serves as a strong platform for further assured improvements of all warehouse operations focused on harmonic and fluid circulation of the inventory. Moreover, without a well arranged layout that also includes bins it is impossible to further improve the warehouse and stay competitive as the operations will tend to underperform in spite of any smart implemented technologies. This is why the bin location setup plays a colossal role and why it should be arranged in the best possible way. The process of building a layout consists of data collection, space calculations, division of areas and bin locations.

In the thesis work the arrangement of the bins and its further implementation in the SunManager system were considered as well as other related topics connected with the bins.

1.3 Research questions

In order to meet the purpose of the thesis work the following research questions are formed:

- *Question # 1:*

How to manage the codes of the bins at the warehouse so that their arrangement can stay effective for a longer period of time?

According to Martin Murray storage sections must be defined for each storage type, storage levels, locations for all the products and mixed products (Murray 2012, 56). These factors affect the coding. It should be functional and easy to adapt to changes in the future, too. Letters and numbers with dots, commas and other signs can be used in order to separate defined sections, levels and exact locations. The emphasis is on providing a coding system maneuvers to expand and modify the storage facilities and to keep the precise location names of the products for the future.

- *Question #2:*
  What arrangements can increase the efficiency of the set bins so that the ease, speed and quality of putting away and picking can be improved?

Management of the set bins with the specific products located in them shows the history of product circulation over time and gives a clearer view on the efficiency of the placed products in certain bins. It is easier to keep track of the products and assess the correctness of the product locations with the help of the programs that integrate different warehouse data together and give suggestions for further improvements.

Another arrangement is the use of barcodes defining the bin locations and barcode readers with a software transferring the arrived goods to the designated bins, completing bin-to-bin transaction or marking the picked number of goods from a certain bin.

Thus, warehouse programs can increase the efficiency of the set bins in terms of time as well as minimizing the costs. Technologies can also benefit warehouse management and should be considered as well.

- *Question #3:*
  What are the distinctive features of different programs for managing the bins that are usually used in the warehouses?

There are different warehouse management systems such as the very warehouse management or WMS, supply chain management or SCM and enterprise resource planning or ERP for managing the inventory. There is no need to use different systems at the same time as duplicating the inventory data into different systems takes plenty of time and does not create the maximum output for inventory management.

Distinctive features between different warehouse management systems are angles from which the data is processed. For example, WMS is good for controlling inventory and streamlining warehouse operations, while SCM manages demand planning and transportation management. The ERP, on the other hand, can be used for dealing with human resources, customer relationship management, SCM and accounting.

Warehouse management systems can stand alone or they can be a part of ERP systems supporting the latest technological advances within the warehouse including automation, RFID and voice recognition. At the same time ERPs can be integrated with the CRM systems and give information about the integrated output of the company (Richards 2011, 137).

1.4 Research methods

Based on the purpose and research questions of the study the following research methods were defined:

- Method #1:
  The quantitative method was used to gain an understanding and a picture of the current situation of the studied topic such as a warehouse by collecting information in the form of data or numerical data and by creating usable applicable statistics (DeFranzo 2011) that can give value to the subject with the help of the theory as well. In other words, theory and statistics are interlaced and support the descriptive goal (Brannen 1995, 19). In case of Mattokymppi collecting the available data was based on observations in the warehouse about the space utilization including racks, equipment and inventory, on in-

terviewing the manager about the operations and on studies of the theory about the subject. In this method the plane layout was created as a sample for further comparisons, improvements and analysis of the drawbacks and advantages of the possible layout variations in terms of suitability for the company, validity and ease. The proposed layout can be found in the Implementation part, “Mattokymppi warehouse structure”. Nevertheless, the improvement of the layout was based on a mixture of both quantitative and qualitative methods because only together they enabled to study the subject at all the levels (Brannen 1995, 15) and bring a stronger outcome in the form of a denominated layout.

- Method #2:
  The qualitative method focuses on meaning in context and requires a data collection instrument that is sensitive to underlying that meaning when collecting and interpreting data (Merriam & Tisdell 2016, 2). In other words, it is based on the statistical treatment or analysis of the collected data: space calculation, types of the racks and their space utilization for further anticipating the possible number of the racks, bins and their future designated locations in order to carry out the bin setup for the warehouse in the equipping phase. Hence, the raised ideas are approved or disapproved based on an analysis of the theory (Brannen 1995, 19). The method was practically used in the Implementation part concerning Mattokymppi’s bin locations through processing the probable assumptions and content analysis and reaching an outcome in the form of the denominated layout.

- Method #3:
  The evaluative method is employed on the basis of an analysis of the given performance of the bin layout and it is observed from a foreseen goal-related point of view as well as an unforeseen goal-free one. Broadly speaking, goal-related evaluation is focused on the relative degree to which a given product effectively meets a previously specified goal, while goal-free evaluation measures the effectiveness of a given product exclusively in terms of its actual effects - the goals and motivations of the producer are ignored. (Calidoni-

Lundberg 2006, 24-25.) As a result, the actual method can extend the limits of the topic and bind its direct results with the prominent outcomes by analyzing and evaluating possible corrections and add-ins in relation to the actual designated layout to make it more effective, long-lasting and easy to use. The following analysis was done in the Implementation chapter "Recommendations" and in the chapter "Evaluation". Evaluation is focused on proving that changes in the targets are due only to the specific policies undertaken (Khandker 2009, 8) such as the setup of the bins.

- Method #4:
  The action research method is known as "doing by learning". The researcher studies a problem systematically and ensures that the intervention is based on theoretical considerations (O'Brien 1998). As long as the layout of the warehouse was being equipped with racks and the location of the new upcoming racks was vulnerable to the waves of modifications in the warehouse, the outline for the bins and the products filling them was modified during the whole process of the bin implementation at Mattokymppi warehouse based on the theoretical research and suitability for the company.

Combining of different methods within a single piece of research raises the question of movement between paradigms on the levels of epistemology and theory and enables outcomes to be high-rated. The enumerative and analytic inductions reflecting the first two methods propose different starting points: enumerative induction abstracts by generalizing whereas analytic induction generalizes by abstracting (Brannen 1995, 18). The action research method stipulates the constant involvement into the real process and facilitates a smooth implementation of the program of actions whereas the evaluation method pinpoints the hitches to be polished.

The framework of the implementation of the methods was the following:

1. to gain information about the company's operations (quantitative method);
2. to study the current situation in the warehouse (quantitative and qualitative methods);

3. to conduct research on the studied subject (quantitative and qualitative methods);
4. to prepare a platform for streamlining of the designed layouts (quantitative and qualitative methods);
5. to accept the layout (qualitative and action research methods);
6. to imbed the layout into the operations (action research method);
7. to benefit from the layout (action research and evaluation methods);
8. to assess the designated layout (evaluation method).

The four methods were chosen on the basis of the defined purpose and research questions.

1.5 Scope of the study

In order to reach the main goal the research methods and the research questions described above framed and sustained the scope of the study:

1. to study the company and its current situation;
2. to examine the theory;
3. to interlace the theory with the realization of the goal: bin setup;
4. to interlace the realization of the goal with the warehouse activities and the management system.

For this purpose the whole thesis work is divided into the following parts supporting the defined scope:

1. Introduction part presenting the company, its need and the importance of the need;
2. Theory part casting a light upon the actual studied topic and the aspects related to it;
3. Implementation part carrying out the actual work stage by stage on the basis of the current situation and the studied theory as well as completion after a mutual agreement with the company;

4. Recommendation part raising ideas to improve the achieved situation and showing more benefits by connecting the achieved goal with the interlaced solutions.

The actual results and the realization of the set goal are presented in the part “Results”. The evaluation of the work is stated in the chapter “Analysis”.

2 Main part. Theory

The implementation of the bin location setup, its perspective practical use and interrelation with the operations happening in the warehouse are supported with the material covering the theoretical scope of the topic in the Main part of the thesis work.

The term “warehousing” and its functions are defined first to show their correlation with the system of the bins. Secondly, definitions of the “bin” are clarified as well as an insight into the realization of the bin system is provided for all stages from the planning stage to the stage of launching. The possible nature of the bin system and its realization in terms of allocations of products are described as well as its further incorporation to the warehousing operations including the incorporation to the warehouse management system level.

2.1 Warehousing and inventory

Warehousing is a nodal point in logistics referring to storage and material-handling activities. According to Emmett it is an integral part of the supply/demand chain/pipeline infrastructure (Emmett 2005, 1). It ensures a smooth and immediate transfer of products from production to the customers by storing finished/unfinished inventory in order to respond quickly to an uncertain but estimated demand. Hence, it enables to reduce the overall logistics costs by managing the coordination between the demand and supply as well as it enables to improve the level of customer service by supplying the products accordingly. Moreover, warehousing carries responsibilities for the inventory including its status, disposition, and condition.

Warehousing operations stipulate costs for expensive areas and buildings, labour and energy. At the same time they are required to be in accordance with the Just-In-Time concept, efficient consumer response and quick response. Hence, any company running a warehouse always strives to minimize the amount of stock held and maximize the speed of its throughput (Richards 2011, 8).

Warehousing includes products movement or material handling, inventory storage and information transfer. Long-term storage is not the goal of a warehouse, the goal is to improve the inventory turns through improvements at all levels of operations such as receiving and put-away, order filling and order picking, cross-docking and shipping (Farahani, Rezapour & Kardar 2011, 31-32.).

Regarding warehouse functions it is possible to point out the following ones: storage, processing, protection, risk bearing, financing, grading/branding and transportation. Nevertheless, it is beyond argument that the most trivial and basic storage function of any warehouse is inventory accumulation over a period of time, or simply, storage. However, from Emmett's point of view, warehouses should pay more attention to one function: sorting instead of storing products (2005, 2). In both circumstances warehouses are always focused on keeping and moving its products. As for the storage of any inventory in warehouses, there are always certain locations and different inventories are stored during different timespans depending on the storage purposes. In addition, as for the inventory turns, the circulation happens through identification during receiving and shipping and through distribution between those different locations. It is obvious that the functions of any warehouse can respectively affect its layout and structure (Farahani, Rezapour & Kardar 2011, 32).

Warehousing and its management are indivisible. Warehousing can not function well without operational day-to-day management as well as management involved in the longer strategic aspects of the business. Warehousing is a core in supply chain management and it concerns production, products, suppliers, customers and all the associated product volumes and throughputs (Emmett 2005, 6). Indeed, warehousing concerns many aspects and it should be managed effectively. Every single possible point to improve should be considered in order to minimize overall costs and improve the efficiency of the operations of handling the inventory.

The definition of the "inventory" needs to be reviewed as well. All organizations keep inventory. "Inventory" includes a company's raw materials, work in process, the supplies used in operations, and finished goods (Muller 2002, 1).

Keeping inventory is both important and expensive. It is needed in order to decouple supply and demand, to respond to the demand at any time, to anticipate it and to provide service to customers (Emmett 2005, 36). However, it is always expensive because the costs of capital, warehousing, protection, deterioration, loss, insurance, package, and administration make stocks expensive. It can absorb 25%- 40% of the logistics costs and represent a significant proportion of the total assets of an organization (Farahani, Rezapour & Kardar 2011, 181). That is why effective inventory management is crucial because it can decrease carrying cost and increase customer satisfaction at the same time (Farahani, Rezapour & Kardar 2011, 188).

In terms of inventory the following rule works well: the faster the inventory turns, the greater will be the profitability. Thus, one of the main aspects to be considered in inventory management is determining the products to stock and the location in which to stock them.

It is obvious that a proper bin location setup plays an important role in warehousing and for the inventory itself by facilitating warehouse functions such as storing and moving the identified inventory from and to the designated locations. That is why a bin location setup defining locations for products is a vital platform for a fast and healthy circulation of the inventory in any warehouse.

2.2 Bins setup

2.2.1 Bin location

There are different definitions of what a bin as a term implies. According to Murray (2012, 58) a storage bin is the smallest unit of storage in a warehouse. There is no set size for a storage bin and its size can vary between companies, warehouses and even within the same storage type. Another definition frames the following term of it: a bin location is a location name or, in other words, an address of where the products are placed. It can be a location on a shelf or a location on a carousel (How to create BIN Locations in a warehouse and how Contalog simplifies product search using it?, introduction).

All item movements are carried out particularly at the bin level. Product movements can be performed manually, when a product is reallocated within the warehouse or automatically by a program as a result of bin replenishment (Internal warehouse processes 2009, 2). Bin locations are actively used in inventory management systems to define the location with a product stored in it and to monitor the circulation of the products in the warehouse irrespective of whether it is done manually or automatically.

Bin locations clear the confusion in finding a product by giving its exact place of storage in the warehouse. Creating clear and straightforward locations within a warehouse is an important aspect for further dealing with products. That is why location names or bin names are crucial for both placing products and retrieving them in the least possible time (How to create BIN Locations in a warehouse and how Contalog simplifies product search using it?, introduction). It is important to take many factors into account in arranging the bin system in a warehouse. Such factors are, for example, the size of the warehouse, the number of shelves, product characteristics as well as the future development of the company's business (possible growth and expansion).

2.2.2 Creating inventory location bins

A bin system for locating goods can be established by creating a system that identifies the location of each item in the warehouse soon after the layout of the warehouse is established (Viale 1996, 81). The space in the warehouse should be used at its maximum. It is important to give a location name to every single physical storage space in it though at the moment some places can be unused. It is also important to think about possible future changes such as replacements of the racks, modernizations, expansions that can affect the bin system and hinder the bin allocation. It is easier and more cost-effective to set the most applicable bin location in the beginning that can increase the speed of operations and ease of use under the current circumstances and possible future ones.

Every location name should be unique and labeled. Labeling should be done in such a way that it contains the full name of the location and has arrows directing the location as well. If there are different segments or rooms in the warehouse it is good to distinguish them as separate zones. Each zone name should be abbreviated, for example, with a single symbol (a letter or a number) and should be mentioned in the labels containing the full location name (How to create BIN Locations in a warehouse and how Contalog simplifies product search using it?, how to create inventory location names).

2.2.3 Zones

Defining zones is the first step to divide a warehouse into smaller parts in order to pin down the needed location faster and easier in the future. It is often possible to split a storage area into zones as well as the whole entire area which can include, for example, dispatching, packing, manufacturing areas and an office area.

Figure 3. Zones (adapted from How to create BIN Locations in a warehouse and how Contalog simplifies product search using it)

In the example (see Figure 3), the total area has four zones and every zone has its number. However, there are other options to name zones, for example, using letters. Letters can designate the directions zones face. In this case, the abbreviation can be as follows East – E, West – W, North – N, South – S (How to create BIN Locations in a warehouse and how Contalog simplifies product search using it?, step 1).

If the warehouse is moderate in size and does not have certain specified areas it is better to omit the division of zones. This can help to create shorter and still precise names for locations.

2.2.4 Segregating zones into sections

A storage space with a certain number of racks can be easily divided by labeling each row of shelves or aisle as a section using alphabets or numbers. While setting up alphanumeric locations it is recommended to use the number “zero” in all numbers less than ten, for example, 01, 02, 03. It allows the system to read alphanumerical locations accurately if the number of the racks exceeds ten (Thayer 2017). Ideally, it is good to label sections clockwise – Left to Right. The labelling process is good to start with choosing the shelf that is the nearest to the entrance of the zone (How to create BIN Locations in a warehouse and how Contalog simplifies product search using it?, step 2).

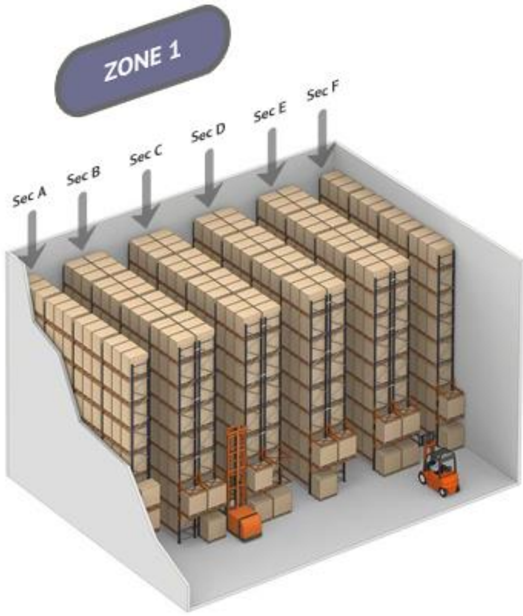


Figure 4. Sections (adapted from How to create BIN Locations in a warehouse and how Contalog simplifies product search using it)

In the Figure 4, every section defines a separate row with a Latin letter and if the section's name contains only one letter, it implies that the total number of the sections can not exceed 26 as the total number of the Latin letters is 26. To extend the number of the sections it is recommended to use double letters or double numbers. In case of double letters it is possible to achieve 675 configurations and allocate the corresponding number of sections and in case of double numbers the amount of sections can be raised up to 100 configurations.

2.2.5 The exact location of a bin

The exact location of a product in the warehouse is the key agenda to enable the easy operations during put-away, replenishment and picking processes. In order to define the exact location or a bin, it is important to divide the whole shelf row into vertical levels depending on the beams and then into horizontal levels or floors.

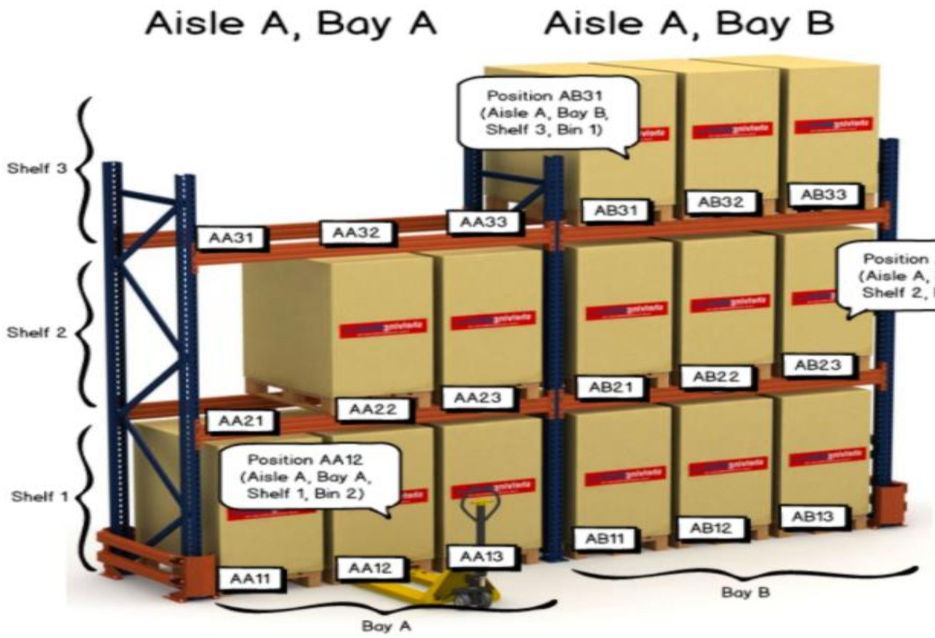


Figure 5. Exact location (adapted from Setting up bin locations 2018)

In the Figure 5 every level is divided into smaller segments to differentiate the exact and more detailed location of the product from the top to the bottom of the shelf and from the left to the right.

Shelves are recommended to number from the bottom as in case of adding extra levels to the top of the shelves there is no need to relabel them. Otherwise, if done the other way around with the top shelf given the number one and the bottom shelf being number X, the situation of adding an extra shelf to the top will hinder the designated order and will result in having shelf number X+1 on the top of the shelf number one (Thayer 2017).

2.2.6 Labeling

Labeling should be easy to spot and easy to read on the racks by both employees and technical devices such as barcode readers and at the same time it should be managed effectively for arranging the routes for handling products in bins.

The two most common ways of labeling racks are serpentine and standard. In fact, some companies prefer serpentine system. The reason is the ease and rationality of using the serpentine method during the process of picking the items from the shelves. In the serpentine method a picker provided with a picklist that is in order by location moves gradually up and down the aisle or the row and collects products for several orders without having to double back or skip around the pick list (Thayer 2017). So, it gives a more organized and efficient route for pickers to follow:

Aisle 01

Unit AA | Unit AB | Unit AC

Unit AF | Unit AE | Unit AD

Aisle 02

Unit BA | Unit BB | Unit BC

Unit BF | Unit BE | Unit BD

Aisle 3

Figure 6. Serpentine method (Thayer 2017)

In the standard system workers move along one side of the row skipping the products on the other side of the same row and go back along the same row to complete picking of the skipped products before the next row (Thayer 2017). The following example demonstrates the realization of the standard system:

Aisle 01

Unit AA | Unit AB | Unit AC

Unit AA | Unit AB | Unit AC

Aisle 02

Unit BA | Unit BB | Unit BC

Unit BA | Unit BB | Unit BC

Aisle 3

Figure 7. Standard method (Thayer 2017)

The advantage of the serpentine method is obvious in order to do picking in aisles between two rows at the same time. This enables workers to work faster and spend less energy on that in case if normally a picklist demands covering products from all the rows.

Another good point to consider in labeling is choosing the right position of the labels on the racks. Every row and racks levels should be marked, so that every worker can easily see the labels and navigate himself or herself in the warehouse. In racking systems a bottom rack does not have a crossbeam. This leads to placing two labels on the first crossbeam at once: one for the bottom rack position and one for the rack above. Employing this method of bin or rack location labeling it is good to include a visual arrow indicating whether the label represents the location below or above the crossbeam to eliminate the possible confusion of levels and racks in the warehouse (Pawlowski 2016).

2.2.7 Bin location system type

Once a system for the overall location of products has been established it must be further refined by choosing one of two basic ways of assigning locations for items being stored. The first method is called the fixed location system and the second one is the floating location system.

1. Fixed location system.

In the fixed location system stockkeeping units or SKUs are assigned permanent locations. No other items can be stored there. This method does not meet the objective of full utilization but it makes it easy to remember in what area items are stored. As a result, products can be located and retrieved faster. This system also requires less information processing. Obviously, it can not be implemented in all possible situations and should be considered only in those situations where space is not an issue.

2. Floating location system.

In the floating location system a product is stored in a random fashion based on space availability. In this system SKUs can be stored in several locations. This type of system relies on computer systems to keep track of the physical locations of items. The cost of the computer system is offset by better space utilization and faster access retrieval (Viale 1996, 81).

2.3 Bins setup related activities

The arrangement of bins is directly connected with all the processes dealing with the locations of products starting from receiving to picking and tracking changes in the stock or, in other words, with the warehousing operations concerning the movement of inventory. Below, there is a diagram that shows the costs of warehouse activities with their relationships:

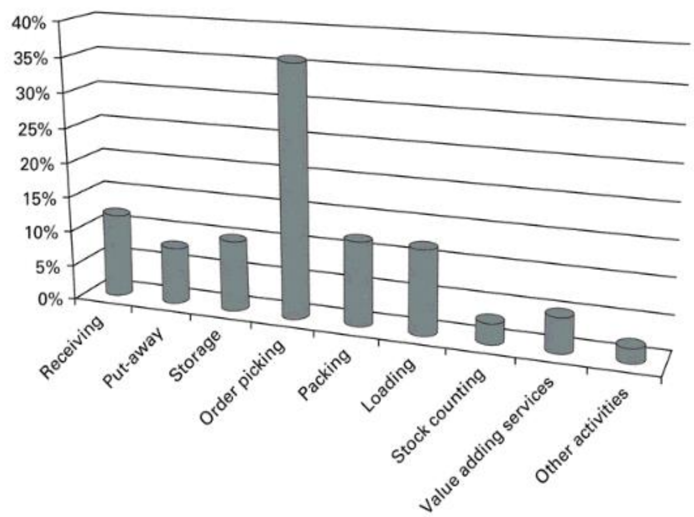


Figure 8. Warehouse activities as a percentage of total costs (Richards 2011, 44)

In the Figure 8 it is clearly seen that order picking that happens between the rows and aisles consumes much money and it goes without saying that it is directly connected with the navigation among the bins. That is why a well-arranged bin location setup can improve order picking process. At the same time bin location realization can be integrated with the technologies and systems in a warehouse and can enable the improvement of the very process as well as other processes happening in the warehouse. Thus, bin setup can be a firm base-line and an integral part for the implementation of the arrangement of the very products and the implementation of technologies to increase the benefits of the set bins.

In the next sub-chapters barcoding and arrangement of products are studied in order to enable to check their compatibility in the Implementation part, "Recommendations". The reason for their pick-up for further studies and consideration is a possible impact of barcoding on receiving, put-away, storage and order-picking processes and an impact of the product arrangement on put-away and order-picking processes in the warehouse.

2.3.1 Barcode system

Barcoding can be an effective add-in into the warehouse management that can allow to store, locate and track inventory quickly and be an intrinsic part for the warehouse management system along with other identification systems including logistic labels and smart tags based on RFID.

A bar code is an optical conversion of a numerical or alphanumerical code which is used to identify a package or a product. This optical conversion is represented by means of an alternating sequence of vertical bars and spaces (Gianpaolo 2013, 227).

A barcode usually contains an item number for a specific stock keeping unit and can also have other information such as a purchase or sales order number, warehouse and bin location or batch number. More elaborated two dimensional barcodes can be used to represent in depth product history and traceability information (Distribution Barcoding to Manage Your Inventory 2017).

When a barcoding system interfaces with the enterprise resource planning system of the company it offers advantages in terms of straight feeding the system with the location and numbers of the arrived product as well as picking the desired amount of items from the designated location.

Other advantages include the points that barcoding allows to cross-dock inventory for rapid shipment while dealing with items with long lead-times and customers waiting to receive those items as well as it helps to do bin-to bin faster and more accurate.

To implement operations with barcoding it is needed to have a good completed set-up of all the bins in the warehouse including an arrangement of barcodes labeled, for example, on the racks referring to the location and barcodes on the products or pallets indicating the product itself. Thus, barcoding can improve the operations during put-away and picking by scanning the products to define, denominate or vacate a product’s location and improve the operations during receiving and storage by scanning the products to monitor their circulation in the warehouse.

2.3.2 Allocation of the products in the bins

The allocation of the inventory can be based on a locator system that gives guidance in setting up a system of putting items where they will do the most good for the company by providing with the knowledge of:

- three key stock locator systems (which relate to the overall organization of SKUs within a facility and their impact on space planning);
- item placement theories dealing with the specific arrangement of products within an area of the warehouse;
- some practical methods of attaching addresses to stock items and how to tie an item number to its location address.

The purpose of a material locator system is to create procedures that help to track product movements (Muller 2002, 47). Though, at the same time every locator system works differently and is focused on maximizing whether, for example, use of space or equipment, flexibility or accessibility.

The first type is a memory system that is based on the human recall. It brings simplicity, relative freedom from paperwork or data entry and maximum utilization of all available space (ibid., 49).

In the fixed location system the honeycomb concept appears with a dedicated location for a certain product that simplifies the process of finding a product but that implies the usage of the total cubic space of all possible SKUs (Muller 2002, 52-53.).

The next type is a zoning system. It differentiates all the inventory according to the zones they belong or suit because of certain characteristics and at the same time it adds the complexity in planning and honeycombing (ibid., 56).

The fourth type is called a random locator system. It is totally relied on an SKU identifier defining the location bin it belongs to and is stored in. As a result, they give flexibility and good space utilization by adding complexity of constant data updating (ibid., 57).

The mentioned above allocation systems demonstrate the common view of different perspectives and can be blended into a combination system (ibid., 58).

The more precise allocation types are displayed by narrowing the focus of how the product should be laid out within any particular location system. On such a basis the allocation of products within the storage zone of a warehouse can be random or based on dedicated, class-based (ABC), affinity-based or family grouping and popularity-based strategies.

The main principle of the random storage is to fill available bins with incoming items randomly. As a result high space utilization is reached but the material handling cost and travel distance rise as well as a strong need in a good automated WMS rises that can keep track of the locations assigned to the products (Smyk 2018, 29).

The next type, the dedicated storage allocation type, gives a fixed location bin to an item. A drawback here is that the locations stay reserved even for the items that are not currently in stock. Consequently, the space utilization is the lowest among all allocation strategies leading to the high warehouse rent costs (De Koster, Le-Duc & Roodbergen. 2007, 11). Though, it is the easiest method to implement, no high-tech is needed, pickers can memorize locations. Finally, it typically reduces picking time and material handling costs (Smyk 2018, 29).

The class-based allocation is a combination of the random and dedicated allocation strategies together. Inventory is divided into classes based on some criteria: demand, value or size. Every class is assigned a certain zone of storage location where the random strategy is valid. In the approach Pareto's distribution is used. More frequently demanded items are commonly defined as A-class items and less frequently requested items as B-class items and C-class items (De Koster, Le-Duc & Roodbergen. 2007, 12). Items with higher demand are placed next to the inbound and outbound areas facilitating flexibility. In order to place incoming shipments appropriately in the separated dedicated zones of the classes, vacant locations are offered demanding more space with the amount of the classes (Smyk 2018, 29).

In the affinity-based or family grouping items which are often ordered together are placed close to each other, so that the affinity of several items demanded together, for instance, in the same customer order or within the same time period is implemented. Evidently, the grouping of the items can be aligned with some of the previously mentioned allocation strategies. Frazelle performed a simulation study and confirmed that affinity-based allocation can potentially decrease the number of the required pickings by 30-40%. The restrictions are a challenge to deal with possible millions of pairs of products and a challenge to deal with product characteristics such as safety issues, like flammability, product fragility, shape or weight which limit the choice of storage allocation policy (Smyk 2018, 37).

The popularity-based strategy distributes products in a warehouse corresponding to their turnover, the number of storage and picking requests per item or the amount of the picks per items. The items with the largest sales volumes are placed at the most reachable locations, typically next to the packing and shipping area. Items with the low demand are assigned towards the back of the storage. The main drawback is that the demand fluctuates constantly over time and the variety of the popular items alters frequently. Thus, this leads to the unbalanced utilization of the warehouse and aisle congestions. Though, under certain conditions the strategy can be optimal and can benefit a warehouse in the reduction of travel time and distance (Smyk 2018, 29).

The right choice of an allocation strategy or, in other words, the right implementation of the bins for the products can increase the overall efficiency of the warehouse activities and should be considered after the system of the bins is defined in the warehouse.

2.4 Inventory management system

Paper-based inventory management systems can fulfil a need and manage stock accurately if managed well. Though, in order to stay more competitive companies need to have real-time inventory management software that can, for example, help to deal with managing the products in the very bins (stock visibility and traceability, accurate stock, reduction in mispicks and automatic replenishments) (Richards 2011, 137-139).

There are three different types of software offering functionality for managing warehouse operations:

- Warehouse management systems (WMSs) (including connections with SCM and ERP);
- Supply chain management (SCM) suites (including connections with ERP);
- Enterprise resource planning (ERP) suites (such as SAP including ERP, CRM, SCM and others).

The first type, a WMS application, is a stand-alone solution with the functionality for controlling inventory including expiration date tracking and cycle counting and the functionality for streamlining warehouse operations including slotting, receiving, put-away, picking, packing and shipping. Typically, it does not cover other supply chain operations, though some systems offer a handful of transportation management capabilities such as an integration with the shipment tracking systems of major parcel carriers (Hedges, WMS, SCM or ERP: Which Is best for 3PLs).

The next type, SCM, includes warehouse management applications as standard offerings alongside other supply chain planning and execution applications, such as demand planning and transportation management. An integrated SCM suite allows the holistic management of an entire supply chain, whereas WMS systems only cover warehousing (Hedges, WMS, SCM or ERP: Which Is best for 3PLs).

The third type, ERP suite, includes the core software applications for managing the processes across the enterprise including human resources, customer relationship management, SCM and accounting. ERP systems can enable greater visibility into business processes, tighter operational integration and better free information flow between disparate software applications as well as between research and development, marketing and logistics departments (Hedges, WMS, SCM or ERP: Which Is best for 3PLs).

In order to choose the right inventory management system it is important to understand the company strategy, ensure that the specific needs are met by selecting the solution that best matches the business objectives.

For any system the significant point is to define the ability to interface with other systems, to be modular and scalable, accessible, to provide the ease of operations, to present the standard system, to meet specific needs, to be capable of supporting warehouse best practice and reporting capabilities (Richards 2011, 143-145.). So, when the needs are identified the search for the right software becomes narrower between a WMS, SCM and ERP.

3 Main part. Implementation

The Implementation part gives the insight into the actual work done in Mattokymppi warehouse and shows all the steps on the way to accomplishing the bin setup on the basis of the theoretical framework, the observation of the warehouse and the current situation.

The chapter discusses the situation from the start as well as the steps of setting the bin system supported by figures and explanations. The warehouse is still in the equipping phase but the expected plan of its completed version is certain and assured. That is why it is possible to show the expected final result of the bin system at the end of this part.

3.1 Mattokymppi. The situation from the start

Mattokymppi is a Finnish company providing its customers with different carpets suiting their individual needs. It emulates in the market and strives for improving its service and logistics including warehouse operations.

In the beginning of 2018 Mattokymppi moved its warehouse to Seppälänkangas, Jyväskylä and started equipping the space with the static racks. At the moment of the actual work the warehouse was less than half equipped and still waited for the inventory to be located in the racks that had already been put in place:

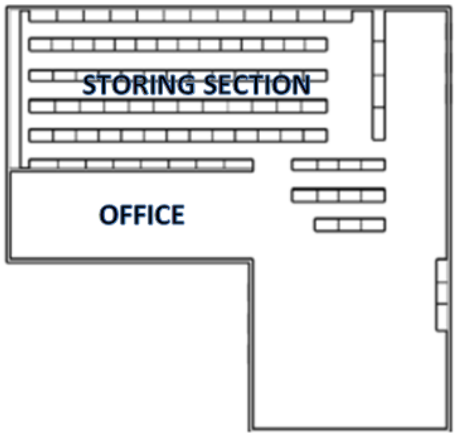


Figure 9. The current situation of Mattokymppi warehouse in the beginning

The warehouse needed to set the bins in order to manage the products circulation effectively by assigning the addresses to every storage location. The bin setup was needed with the purpose to define all storage locations needed for placing the arriving products in the designated bins, picking the products from the designated locations, managing the available and occupied space and products in the warehouse as well as navigating the workers trying to find a certain product or location in the warehouse.

The situation from the beginning required the consideration of certain points related to the actual situation and its challenges demanding to take into account. The warehouse had a rough plan for locating the upcoming racks and that is why it could not have a certain and final arrangement of the lacking bins. The products arriving gradually filled the undefined bins and were reshuffled if needed.

The challenge at the very step was to anticipate the future layout and make the arrangement of the bins to be flexible for the possible changes of the anticipated layout. In addition, it had to be flexible for possible future changes in case of modernization and expansion of the warehouse.

The need to feed the system existed already from the beginning. The feeding was done continuously and updated every now and then during most of the visits to the company as soon as the bin setup started being completed.

3.2 Mattokymppi warehouse structure

The warehouse has about 2500 square meters totally and about 2000 square meters of storing capacity. The warehouse has static warehouse systems such as conventional racks and it is divided into three actual zones: an office-section, tailor-section and storing space including the receiving, packing and shipping areas accordingly. Its inbound and outbound areas form a curved I-shaped warehouse product flow:

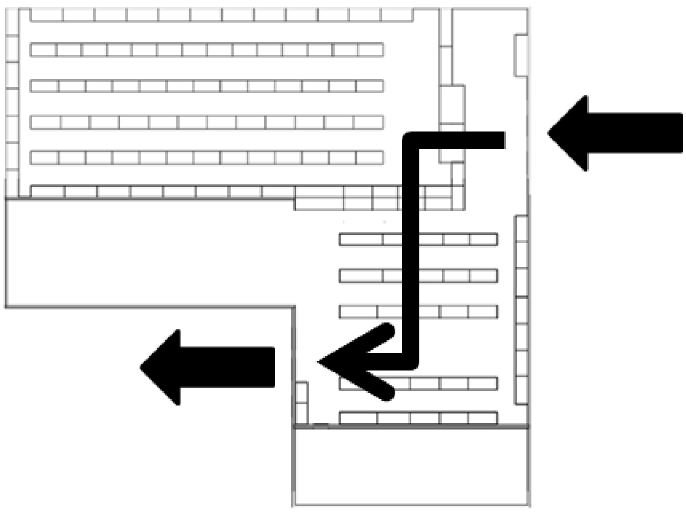


Figure 10. Mattokymppi product flow

It is important to notice that the warehouse was being equipped during the spring/autumn period continuously. The shown Figure 10 depicts the actual current situation of the warehouse.

During the process of setting the bins an AutoCad model of the warehouse was built and used as a sample for marking the anticipated locations of the upcoming rows that bring X amount of the future bins. With the help of the AutoCad model it was possible to find the optimum locations for the expected rows together with the manager of Mattokymppi. Due to the fact that the racks belonged to one type of the static racks and had the same width it was possible to estimate their number as well.

The built model in AutoCad presents the warehouse model in the real life scale with the surface utilization rate that is equal about 457 m2 currently (Gianpaolo 2013, 214) and with the following basic dimensions:

- warehouse length – 52,5 m;
- warehouse width – 70 m;
- warehouse height – 7 m;
- row width – 1,2 m;
- clearance – 2,4 m.

The dimensions are shown in the scheme in Figure 11:

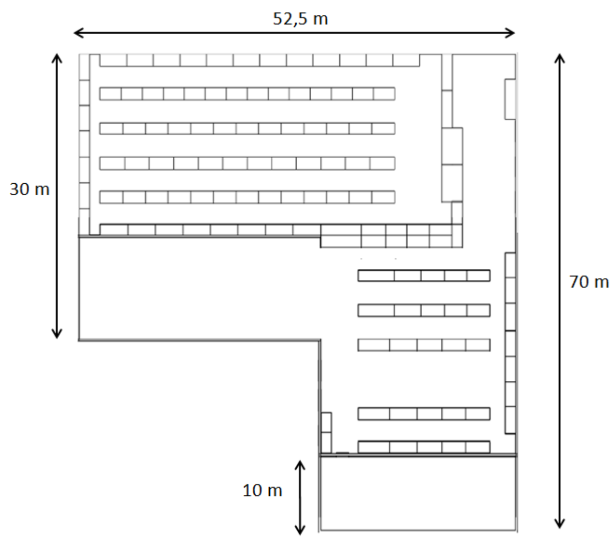


Figure 11. Warehouse scheme with the dimensions

The dimensions were used for building the model in AutoCad (see Figure 12) that served as the template for marking the expected designated bins in the future.

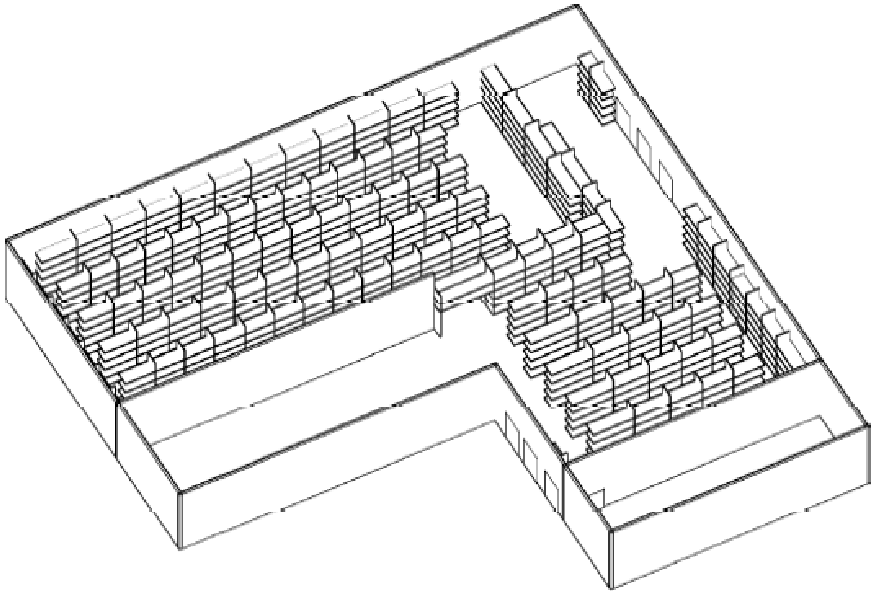


Figure 12. AutoCad scheme of the anticipated ready warehouse

Currently, the storing capacity contains 16 intact rows and 1 row consisting of two parts (row Z) with the following amount of the bins shown in Table 1:

Table 1. Bins and sections availability

Row's name:	Number of the sections in the row:	Number of the bins in the row:	Row's name:	Number of the sections in the row:	Number of the bins in the row:
Row A	12	52	Row J	5	28
Row B	14	115	Row L	5	22
Row C	13	64	Row S	7	18
Row D	12	68	Row V	2	6
Row E	13	125	Row W	7	37
Row F	14	64	Row X	4	22
Row G	5	21	Row Y	4	12

Row H	5	26	Row Z	9	33
Row I	5	26			

At the moment the warehouse has a total of 739 arranged bins serving as locations for finished products and semi-finished rolls of carpets for tailoring.

As long as the warehouse is moderate in size, the areas for receiving, packing and consolidating the products are not big in size respectively. The receiving area has about 100 square meters for unloading the goods and putting them up before being placed to the dedicated bins. The packing and shipping areas have around 50 square meters and do have a couple of independent bins located above the tables that are used for packing and consolidating the orders in the packing area, so that the utilization of space can serve at its maximum as a room for packing and storing at the same time. The packaging material is located in the same area and does not occupy any meaningful space.

In the warehouse all the bins serve for storing the finished and semi-finished products. However, there are shelves in the storing area that are used only for either finished or semi-finished or mixed products. Those shelves for both products are located in the same zone for storing and in both parts of it. That is why it is not possible to separate the areas for storing the products according to the type.

On the basis that the warehouse does not contain many bins, does not occupy plenty of space and does not handle very different types of products it does not have any division for areas as there is no need to define different areas in the storing zone.
As for the storing area in general, the following characteristics and dimensions can be found in Table 2:

Table 2. Storing area characteristics

Products	Area, m2	Capacity, bins
Finished products: carpets and rugs.	1154	630

Semi-finished products: carpet rolls used for tailoring according to the individual clients' needs.	846	109
Products in total	2000	739

It is important to notice that as long as row K is not placed in the warehouse by the official completion of the thesis work, the useful space utilization of that row is not taken into consideration in Table 2.

3.3 Mattokymppi wholesaler. Bins location

In the warehouse there are three zones defined: the office, tailoring and storing zones. In the storing zone there are no specific areas defined as long as the warehouse area is moderate in size and there is no need for that. That is why the possible division of the storage zone into smaller areas will bring unnecessary complicated aspects into the usage of the bins such as more complicated navigation.

On the basis of the interview with the warehouse manager it was clarified that all the products were stored in the warehouse based ion being collected for certain customers and a collection is usually situated within a row or an aisle. The other arrangement of carpets is according to their quality and sizes. A new arrangement was not sought by the company and that is why it was suggested as a recommendation only.

In the new warehouse there was a need to arrange the bins and to feed the system with the products located in the designated bins. That is why the other improvements were only recommended.

The agreed arrangement is the following: the bins are classified with the help of the standard rule and its row and level division. There are rows numerated in the alphabetical order according to their positions: the first type of the rows is horizontal (based on the angle of the scheme drawn) and starts with row A, the other type of the rows is vertical and starts with row V.

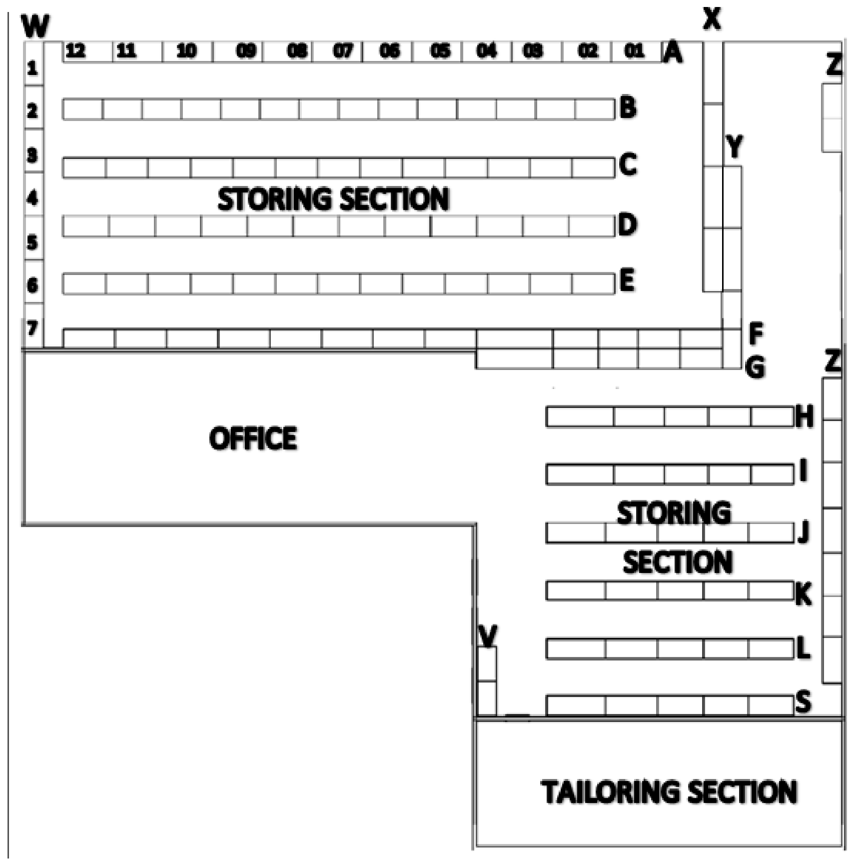


Figure 13. Scheme of the ready warehouse

In the Figure 13 it is possible to notice that row S falls out of the assigned logical order. The explanation is so that the bin location setup started far long ago when more than half of the shelves were still absent in the warehouse and in order to be flexible and be ready for a different number of the shelves than for the anticipated number it was agreed to use S-letter for the shelf being already located in the end of the warehouse next to the wall. The usage of S letter derives from the Finnish word *seinä* meaning a wall in order to make it easy for the warehouse workers to remember it. In such a case it was possible to stick to the assigned order of the upcoming horizontal shelves to be designated further on from letter A to L without being unsure of meeting the logical match with the very shelf with the name in question. Giving the name to row S enabled straight feeding to the system and enabled the designation of the products occupying the bins in row S in the beginning of the work.

In the warehouse there are five vertical rows of shelves and that is why five last letters were used to denote them among the horizontal ones: V, W, X, Y and Z. The designation of the vertical rows was challenging as the number of them was not certain in the beginning. That is why the work started with the horizontal shelves because of their availability. By the time when labeling of the horizontal shelves had been finished, the vertical shelves were already placed in the warehouse. As a result, it enabled to anticipate a more exact picture of the possible changed situation in compliance with the warehouse team and the manager.

Thereby, in case of moderate changes it is planned to use the rest of the letters in the alphabetical order for new horizontal rows or to expand the number of the sections in the vertical or horizontal rows for adding new sections without making changes in the allocation of the rows.

It is important to notice that as long as it is not anticipated to have new other vertical rows in the storing zone and as long as the warehouse does not have sufficient space to locate new other vertical rows in the defined storing zone there is no chance for adding extra number of them whereas adding sections to the existed ones. In case of vast changes and growth of the warehouse it is planned to start dividing zones in the warehouse that are absent currently.

Numbering of the sections of the rows starts from the right because the receiving area is on the right side of the scheme and because the entrance passage from the packing and consolidating area leading to the upper warehouse area also reveals the shelves from the right side at first. That is the reason that explains the direction of the section numbering.

Altogether, it is expected to have 18 rows and that is why there is an agreed and accepted decision to use the Latin letters for denoting the rows.

As for the levels, there are mostly four levels, though in some cases it is possible to find five, six and seven levels in the sections. All the levels start from the bottom. This allows the shelves to add possible extra levels to the top level without making changes to the current level system.

From the practical point of view, it is important to distinguish the left and right sides of the shelves due to the different products occupying them: some rolls of the carpets and rugs are small in size: they can occupy half space of the width of the shelves. The same or different products are placed on different sides of the same shelf level in the same section, either on the left or right side. Consequently, the bins can be differentiated from the side location. For denoting the side, the following letters were used: O meaning the right side (oikealla) and V meaning the left side (vasemmalla).

As a result, the bin location defines the row, section of the row, level and side of the shelf. This order defines the names for all the locations for all the products in the warehouse.

Some examples of the bins that are formed as it was described above: B10.3.V – the bin is in the B row, in the tenth section of the row (location between the beams), in the third level or floor starting from the ground and on the left side from the direction of numbering the sections of the row between the beams; F07.5 – the bin is in the F row, in the seventh section of the row (location between the beams) and in the fifth level or floor starting from the ground where the products occupy the whole level of the section of the row.

The realization of the bin location setup in Mattokymppi can be seen in Figures 14, 15 and 16:

Figure 14. Bin location setup. Rows

Figure 15. Bin location setup. Rows, sections and bins

Figure 16. Bin location setup. Bins

As a result, the bins were designated and marked in the warehouse. The stickers designate the locations primarily but they also help to navigate the workers in the warehouse. For example, in Figure 14 the stickers do not point the very bins and are used for the navigation only.

3.4 SunManager

SunManager is chosen by the company as the software to deal the warehouse management in Mattokymppi. According to its characteristics it is identified as an ERP and CRM system.

The software designs and implements business solutions in close cooperation with the customer to provide a solution that meets the customer's needs. Products are largely integrated with existing client software. The customer database and service management can help track billing and improve overall customer service. With SunManager software, it is possible to do both paper and electronic invoices.

The software is scalable according to the needs of the business and is seamlessly integrated with other Sunsun products. More than that, it can be connected to systems supplied by a third party. The software has the following modules: customer relationship management (CRM), product management, warehouse management, billing and calculations, FinVoice net invoices, bidding, subscriptions, work orders, purchase orders, ship management, service contracts, calendar, appointments, catalog, extranet and customer communication (sms and email).

The software can be combined with the inventory management or a product catalog. Barcode hardware, accessories and innovative products can be used as well in order to build a solution or service package that suit customers' needs (SunManager - monipuolinen ERP/CRM ohjelmisto).

As for inventory management, SunManager offers SunManager ERP system, warehouse management and tracking systems that can be implemented together with barcode solutions (Tuotteet ja ratkaisut).

Figure 17. SunManager logo (SunManager - monipuolinen ERP/CRM ohjelmisto)

Figure 18. SunManager software main page

SunManager deals with information concerning every single product and allows a company to check the availability and the location of products. In the software products can be divided by groups denoting the brand or the producer of a product group.

3.5 Mattokymppi wholesaler. Bins location feeding

Mattokymppi uses SunManager program (Sunsun) to monitor, for example, the balance of the account, the realization of customers' orders, purchases from the factories. The same program is used for feeding the system with the bins location and the products occupying those bins. The information about the products location is planned to be used for more effective put-away, replenishment and picking processes.

Feeding the system started with gathering the information about the products occupying the bins (see the Figure 19):

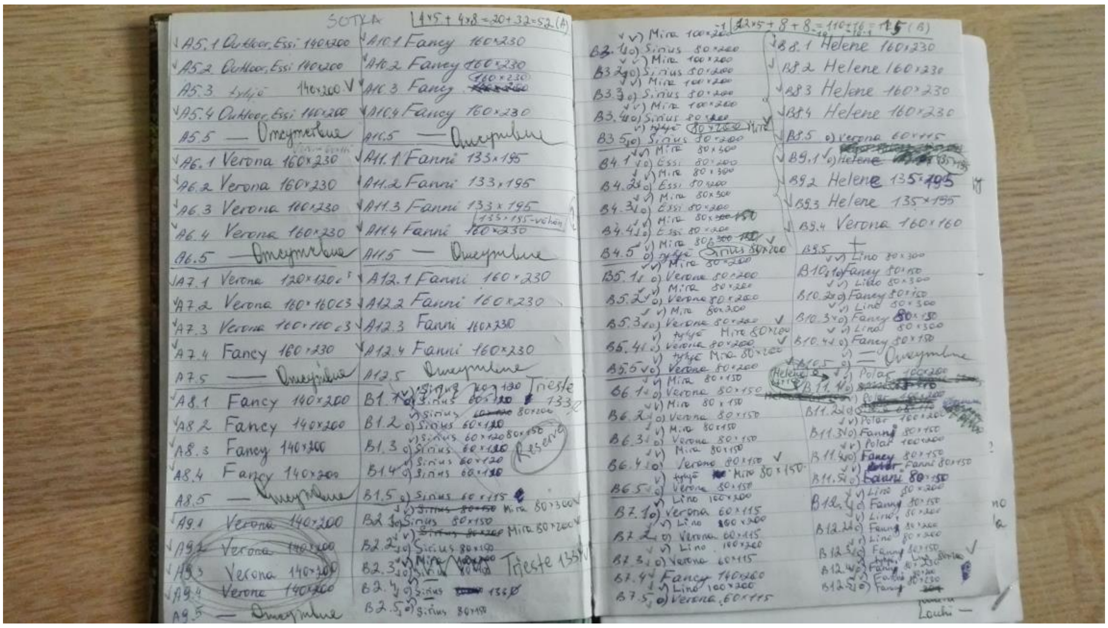


Figure 19. The process of gathering the information about the products locations

The next stage was feeding the system with the collected information by adding the bin location to every single product according to its name and size in the Inventaario tab (see Figure 20 and 21):

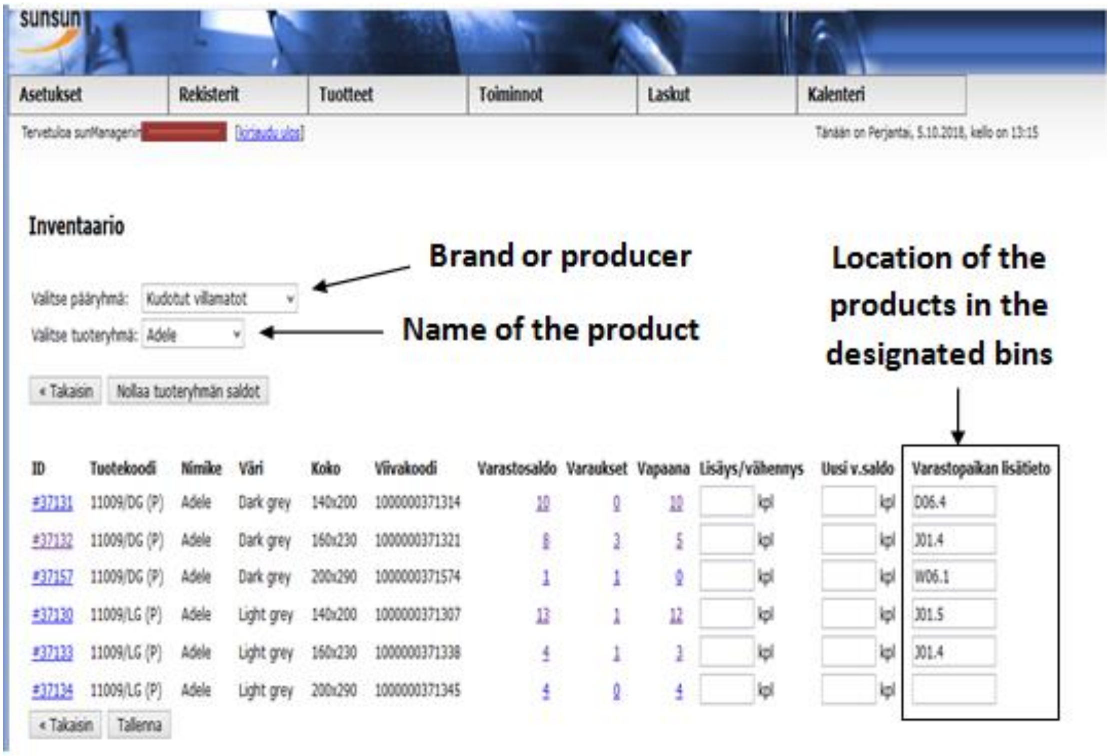
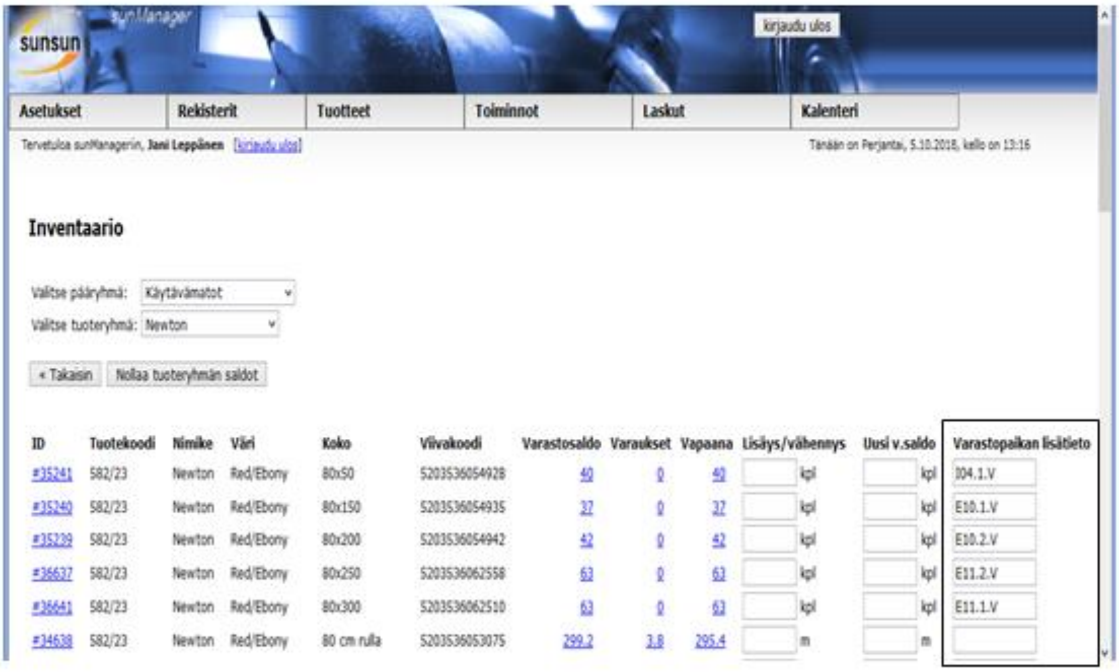
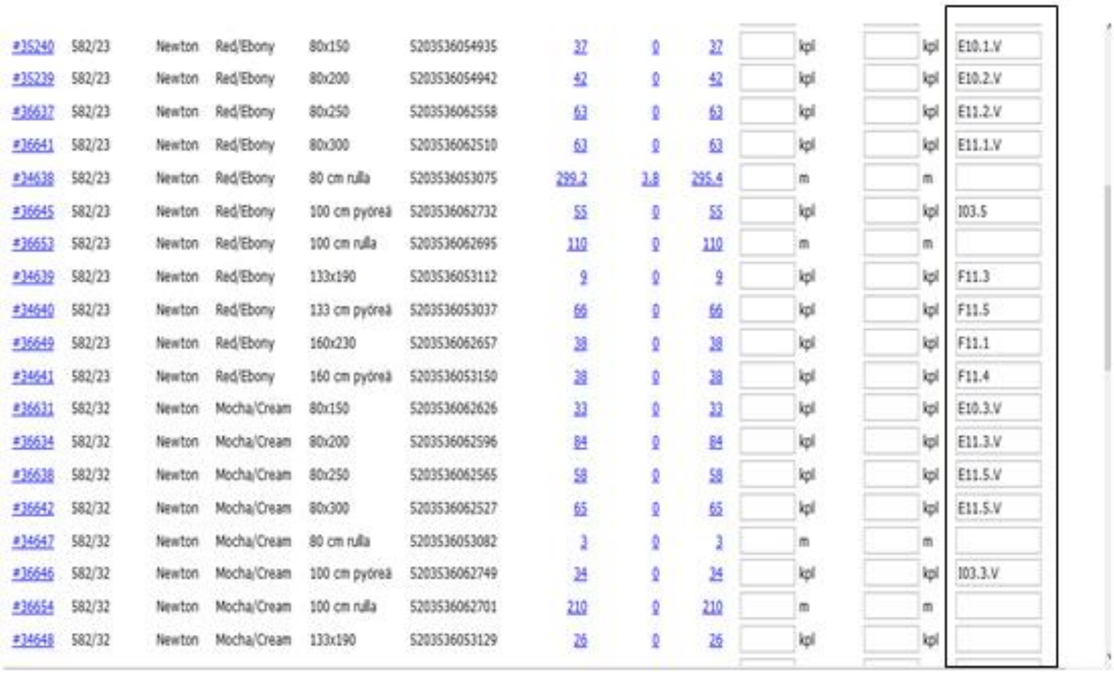


Figure 20. Feeding in SunManager. Example #1



ID	Tuotekoodi	Nimike	Väri	Koko	Viivakoodi	Varastosaldo	Varaukset	Vapaana	Lisäys/vähennys		Uusi v.saldo		Varastopaikan lisätieto
#35241	582/23	Newton	Red/Ebony	80x50	5203536054928	40	0	40		kpl		kpl	I04.1.V
#35240	582/23	Newton	Red/Ebony	80x150	5203536054935	37	0	37		kpl		kpl	E10.1.V
#35239	582/23	Newton	Red/Ebony	80x200	5203536054942	42	0	42		kpl		kpl	E10.2.V
#36637	582/23	Newton	Red/Ebony	80x250	5203536062558	63	0	63		kpl		kpl	E11.2.V
#36641	582/23	Newton	Red/Ebony	80x300	5203536062510	63	0	63		kpl		kpl	E11.1.V
#34638	582/23	Newton	Red/Ebony	80 cm rulla	5203536053075	299.2	3.8	295.4		m		m	

Figure 21. Feeding in SunManager. Example #2



#35240	582/23	Newton	Red/Ebony	80x150	5203536054935	37	0	37		kpl		kpl	E10.1.V
#35239	582/23	Newton	Red/Ebony	80x200	5203536054942	42	0	42		kpl		kpl	E10.2.V
#36637	582/23	Newton	Red/Ebony	80x250	5203536062558	63	0	63		kpl		kpl	E11.2.V
#36641	582/23	Newton	Red/Ebony	80x300	5203536062510	63	0	63		kpl		kpl	E11.1.V
#34638	582/23	Newton	Red/Ebony	80 cm rulla	5203536053075	299.2	3.8	295.4		m		m	
#36645	582/23	Newton	Red/Ebony	100 cm pyöreä	5203536062732	55	0	55		kpl		kpl	I03.5
#36653	582/23	Newton	Red/Ebony	100 cm rulla	5203536062695	110	0	110		m		m	
#34639	582/23	Newton	Red/Ebony	133x190	5203536053112	9	0	9		kpl		kpl	F11.3
#34640	582/23	Newton	Red/Ebony	133 cm pyöreä	5203536053037	66	0	66		kpl		kpl	F11.5
#36649	582/23	Newton	Red/Ebony	160x230	5203536062657	38	0	38		kpl		kpl	F11.1
#34641	582/23	Newton	Red/Ebony	160 cm pyöreä	5203536053150	38	0	38		kpl		kpl	F11.4
#36631	582/32	Newton	Mocha/Cream	80x150	5203536062626	33	0	33		kpl		kpl	E10.3.V
#36634	582/32	Newton	Mocha/Cream	80x200	5203536062596	84	0	84		kpl		kpl	E11.3.V
#36638	582/32	Newton	Mocha/Cream	80x250	5203536062565	58	0	58		kpl		kpl	E11.5.V
#36642	582/32	Newton	Mocha/Cream	80x300	5203536062527	65	0	65		kpl		kpl	E11.5.V
#34647	582/32	Newton	Mocha/Cream	80 cm rulla	5203536053082	3	0	3		m		m	
#36646	582/32	Newton	Mocha/Cream	100 cm pyöreä	5203536062749	34	0	34		kpl		kpl	I03.3.V
#36654	582/32	Newton	Mocha/Cream	100 cm rulla	5203536062701	210	0	210		m		m	
#34648	582/32	Newton	Mocha/Cream	133x190	5203536053129	26	0	26		kpl		kpl	

Figure 22. Feeding in SunManager. Example #3

After feeding the system, constant updating of the information has been done with the purpose to eliminate the risks of wrong database in the system on the ground that the products locations are changed once in a while. It is planned in the future that the warehouse workers will be responsible for updating the products addresses on their own in the warehouse after every change of the locations of any products.

4 Recommendations

In the next subchapters implementation of barcode readers and a consideration of allocations of products were explicated and reviewed.

4.1 Barcoding

Barcoding is considered as a recommendation to the company Mattokymppi with affinity-based arrangement of the products in the storing facility where the put-away and picking processes are done and tracked manually. All the work that is done up to now is a good foundation for further improvement of warehouse operations such as implementing barcoding. Barcoding is connected to the bin setup and can improve the efficiency of the warehouse operations.

It is important to bear in mind the following sentence: “if a barcode system is hard to use; then it will not be used correctly, and the barcode labels will just end up as stickers on pallet racking”. That is the reason why many manufacturers still prefer to track operations manually and even after purchasing an “inventory solution” software (How to Barcode Your Warehouse).

That is why barcoding system should be effective through the arrangement of the bins that should be easy to understand and follow by all the workers in the warehouse. In the company the bin setup was mutually chosen to be standard with the division of the rows and the levels. The workers easily navigate themselves within the storing area. Moreover, there is a map/scheme of the division of the warehouse for providing an overall picture with all the bins.

Every location should be labeled and should be easy to scan. As long as the warehouse of Mattokymppi is small all the workers complete their work well and do not meet serious challenges there is no actual need to invest much money into high-tech technologies. What is recommended is to implement a portable barcode scanner with short range scanner that can read barcodes fixed on the racks within the first level. As a result a gained degree of accuracy can have profound and far-reaching effects on business (Integrated barcode technology for ERP).

Many scanners have the option of adding ERP software applications to the device, making it possible to connect the platform directly during an inventory count or when tracking an item's production (Imprint Enterprises). More than that, current warehouse software SunManager gives the possibility to integrate barcoding into the system.

Completing bin-to-bin transfer can be done easier and faster with barcode scanners, too. For example, using a barcode scanner that is integrated into WMS, all the warehouse operations can be easily tracked right from the production floor (tailoring section) or warehouse (storing area itself). In this case the key information of a product is only needed to be scanned and WMS is updated directly from the scanner. Marking the stock code of the product to be transferred and the amount of items from a certain bin to a goal bin can be recorded directly in the system.

Data can be captured using barcode scanners, touch-screen computers and can be directly integrated with scales, flow meters, analytical testing equipment and other plant equipment.

Eventually, barcode software updates ERP Purchase Orders, Job Receipts, Inter-Warehouse Transfers, Bin-to-Bin Transfer, Sales Orders and other stock and quality related information from the manufacturing floor and the warehouse (TransLution).

Apparently, implementing a barcoding system interfaced to the enterprise resource planning system of the company can feed the system directly with all the changes connected to the location and movement of products including cross-docking inventory excluding manual time-consuming feeding.

Though, the drawback here is that SunManager is mainly a customer oriented program and does not give all the possible options to deal with the circulation of the products in the warehouse. Nevertheless, using a barcode scanner is recommended as it can help to manage the inventory more effectively with the current software in terms of product management including receiving, bin-to-bin transfer, picking and tracking as long as Mattokymppi does not require vast innovations in the its inventory management and there is no need to change the software at the moment in order to use barcoding at its most.

4.2 Allocation

Mattokymppi implements affinity-based allocation aligned with dedicated filling to allocate the products. According to the information given by the company, all the products are stored in the warehouse based on being collected for certain customers and a collection is usually situated within a row or an aisle. At the same time the company allocates its products according to their quality and sizes. The chosen allocation commitment ensures that the distance travelled between picks is decreased and productivity is increased as long as one customer's order can be easily found within a row or an aisle. The practical drawback seen in the warehouse is that some of the bins tend to be empty due to the chosen dedicated storage type within one family product and that the same product can be separated by other products and be located within some meter(s) from the same product. Due to these facts, the warehouse workers try to increase the space utilization by changing the location of products occasionally with marking a new dedicated bin for the very product with the changed location. Consequently, it affects the productivity and increases the probability of making mistakes in bin-to-bin transfer.

During the bin setup creation phase the company integrated the bin location feeding into the SunManager program and ordered feeding. Currently, the allocation of the products with their dedicated bins has been completed, so that the location of the products can be observed in the system. The workers have access to the system to edit the location at any time if needed.

As a recommendation in order to minimize the probability of changing the fixed locations of the products in the new warehouse that tends to happen periodically and to minimize the handling costs by decreasing picking routes, the matter of changing the allocation type within the family product can be considered. For these purposes the popularity-based strategy within the family product can be introduced and put into practice that can assure short access route to the products with high turnover rate. On the other hand, it increases the space utilization as the bins close to the inbound and outbound areas or to the depot within every product family tend to be filled according to the fluctuations or trends of the demand of the products. Though, as long as those trends of the permanent products fluctuate in a stable manner during the year and stay predictable according to the given information by the company, it is possible to dedicate a certain number of the bins for the popular products. Especially, keeping in mind that currently the company implements the dedicated products arrangement and allocates the certain bins for the certain products it gets obvious that the company can have empty bins once in a while. Thus, the recommended solution for increasing the usage of the bins can be done with the change of the allocation substrategy in favour of affinity-based/family allocation aligned with popularity-based filling to allocate the products.

5 Results

During the period from April to October of 2018 in the warehouse of Mattokymppi there has been carried out the realization of the bin location setup. The goal that was set in the beginning of the implementation of the work is at the final stage of its completion at the moment. The obstacle for completing the whole work up to now is the unavailability of all the shelves for marking the bins. It is important to note that the work of arranging the location of the bins will be continued in the autumn period of 2018 until its complete realization.

To sum up the main goal that was stated as *managing the bins at Mattokymppi warehouse in the most effective and practical way* is achieving successfully. Effective usage of the bins includes easier, faster and more accurate put-away and picking, simple navigation, program integration and ease of the expansion of the system of the designated bins.

To achieve the main goal and support the final result, the following arrangements have been done:

1. bin location setup;
2. bin location labeling;
3. system feeding.

The very arrangements that have been done in the warehouse of Mattokymppi have generated the real value to the company by benefiting it with the set bin system that is ready to be used further on for managing the bins enabling dealing with the products occupying the designated bins as well as the available and occupied space in the warehouse.

During the implementation phase of the thesis work, the other aspects related to the usage of the bins have been covered in the part Recommendations and strengthened the perspectives in the very field accordingly for the both parties involved into the process:

1. allocation sustaining the implementation of the bins;
2. barcode technologies supporting the implementation of the bins.

As a result, the outcomes have brought the value to the both parties involved into the process: the warehouse of Mattokymppi received the result displayed in the availability of the system of the bins for further coordinating and managing their saturation and the author of the thesis work has mastered the skills in the field of distributing warehouse facilities in terms of bins and their utilization.

The work has been done continuously:

1. remotely while gaining the theoretical background concerning the studied topic and while building the AutoCad scheme of the system of the bins;
2. on site while carrying out the realization of the bin setup.

6 Analysis

The actual result of the implementation of the bin location setup is integrated into the system SunManager and interlaced with the warehouse operations in Mattokymppi concerning the movement of the products. Updating of the information and feeding the system can also be carried out by the warehouse workers from now on and the processes such as put-away and picking are supported with the dedicated product location information.

As a result, the quality of the work satisfies the needs and meets the expectations as the outcome shows active managing the newly set bins and their saturation by the workers that happens in the warehouse without challenges and misunderstandings.

The analysis is embodied on the basis of achieving the following points:

1. bin setup bringing faster and more accurate put-away, picking and simple navigation;
2. achieving the program integration with the bin setup;
3. assuring the ease of the potential expansion of the system of the designated bins.

Based on the given points the completed work in Mattokymppi is defined and analyzed. The analysis has been done with the help of the evaluative criteria that assess the given performance of the set bin layout from a foreseen goal-related point of view and an unforeseen goal-free one. On the basis of the evaluative method the given points for analysis are evaluated:

1. the goal such as bin setup bringing faster and more accurate put-away, picking and simple navigation is achieved well: the set bin system is actively used by the workers for locating and picking the products increasing faster reaching the needed locations or products due to easy and simple decoding of the bins and easy and simple navigation to the desired places;
2. the program integration with the set bin setup is carried out well: the set bin system is actively and willingly used by the very workers for managing the updates concerning the movement of the products in system SunManager to

keep track of the available products occupying the dedicated bins in the warehouse of Mattokymppi;

3. the ease of the potential expansion of the system of the arranged bins is taken into consideration: the set bins enable adding extra rows as well as extra vertical and horizontal levels in the rows in the warehouse in case of the minor storage expansion or adding extra zones in case of vast changes.

Eventually, the strong points in the whole realization of the bins are the following:

1. improvements in the put-away and picking processes as well as in managing the saturated and empty bins and the products' availability;
2. easy navigation.

The weak points are the following:

1. lack of possibility to connect the set bins with barcode technologies because of the company's prospective plans and needs for the nearest future;
2. absence of the possibility to carry out the new allocation strategy.

7 Conclusion

The topic of the thesis *Bin location setup* deserves attention by companies as the realization of the bins serves as a foundation for all the operations happening in any warehouse. As long as two main functions of any warehouse are storing and product circulation it is obvious that denoting the addresses of the bins is crucial and will be used further for managing put-away, storage and picking by a company. That is why the implementation of the bin location setup takes attention in the thesis work, shows the connection with the operations happening in the warehouse and points out bin-related aspects for increasing the efficiency in the warehouse.

During the whole setup phase different possibilities for managing bins have been studied and covered including the effect of their implementation in terms of the future warehouse operations.

For carrying out the thesis work the theory concerning the topic was studied thoroughly as well as the knowledge gained from the studies were taken into use, especially the studied course Materials Handling and Warehousing contributed to accomplish the work by giving the prospective to look at the task and challenges to solve. More than that, the work was supported by the manager of Mattokymppi who guided and monitored the work processes. The work was also done on the mutual basis with the workers who affected the working process as well.

As a result, it has been possible to reach the goal that satisfies both of the parties involved into the process: the company Mattokymppi with its representatives and the work designer. It is rewarding to see that the result brought into the use is being used actively and willingly by the workers and that this result brings the values to the company in terms of efficient put-away, picking, navigation and the integration of the bins with the system for better managing the products' movements.

Carrying out the process step by step faced points to consider and gave better understanding of the warehouse operations and their connection to the bin system.

The very chance to work with the real company operating on the territory of Finland was a tremendous learning opportunity contributing to the professional reinforcement of the knowledge of the designer in warehousing and converting it into skills. The work increased the understanding about warehousing and increased the personal interest of the designer towards the topic.

8 Bibliography

Brannen, J. 1995. Mixing Methods: Qualitative and Quantitative Research. USA, NY: Routledge.

Calidoni-Lundberg, F. 2006. Evaluation: definitions, methods and models. An ITPS framework. Swedish Institute For Growth Policy Studies. Accessed 23.09.2018. Retrieved from http://www.tillvaxtanalys.se/download/18.1af15a1f152a3475a818975/1454505626167/Evaluation+definitions+methods+and+models-06.pdf

DeFranzo, S. E. 2011. What's the difference between qualitative and quantitative research? Page on Snap Survey Software and Research expertise webpage. Accessed on 27 October 2018. Retrieved from https://www.snapsurveys.com/blog/qualitative-vs-quantitative-research/

De Koster, R., Le-Duc, T., Roodbergen, K. 2007. Design and control of warehouse order picking: A literature review. *European Journal of Operational Research,* 1, 1-30.

Distribution Barcoding to Manage Your Inventory. 2017. Page on Unleashed inventory management team's website. Accessed 24.08.2018. Retrieved from https://www.unleashedsoftware.com/blog/distribution-barcoding-managing-inventory-receipt-fulfilment

Emmett, S. 2005. Excellence in Warehouse Management. How to Minimise Costs and Maximise Value. England, Chichister: John Wiley & Sons Ltd.

Farahani, R.Z., Rezapour, S., Kardar, L. 2011. Logistics Operations and Management: Concepts and Models. USA: Elsevier.

Gianpaolo, G. 2013. Introduction to Logistics Systems Management. United Kingdom: John Wiley & Sons Ltd.

Hedges, L. WMS, SCM or ERP: Which Is best for 3PLs? Page on software advice website. Accessed on 18 September 2018. Retrieved from https://www.softwareadvice.com/resources/wms-scm-erp-which-is-best-for-3pls/

How to Barcode Your Warehouse. Page on DataNinja. Accessed on 7 September 2018. Retrieved from https://www.dataninja.com/how-to-barcode-your-warehouse/

How to create BIN Locations in a warehouse and how Contalog simplifies product search using it? Page on Omni channel Digital Commerce platform. Accessed on 10 May 2018. Retrieved from https://www.contalog.com/blog/how-to-name-inventory-location/

Imprint Enterprises. Page on the official webpage of the company providing barcode, RFID and labeling solutions. Accessed on 8 April 2018. Retrieved from https://www.imprint-e.com/

Integrated barcode technology for ERP. Page on WorkWise software. Accessed on 7 September 2018. Retrieved from https://www.workwisellc.com/integrated-barcode-technology-erp/

Internal warehouse processes. 2009. Page on Microsoft Official Training Materials for Microsoft Dynamics. Accessed on 30 September 2018. Retrieved from https://www.cbsi-corp.com/wp-content/uploads/2012/02/NA2009_04_Internal_Whse_Process.pdf

Khandker, S. R. 2009. Handbook on Impact Evaluation: Quantitative Methods and Practices. USA: The World Bank.

Mattokymppi. Page on the official webpage of the company. Accessed on 15 April 2018. Retrieved from https://www.mattokymppi.fi/

Merriam, S. B., Tisdell E. J. 2016. Qualitative Research: A Guide to Design and Implementation. USA: Jossey-Bass.

Muller, M. 2002. Essentials of Inventory Management. USA, NY: AMACOM.

Murray, M. 2012. Warehouse Management with SAP ERP. Functionality and technical configuration. Boston (MA): Galileo Press Inc.

O'Brien, R. 1998. An Overview of the Methodological Approach of Action Research. University of Toronto: Faculty of Information Studies. Accessed 23.09.2018. Retrieved from http://www.web.ca/~robrien/papers/arfinal.html#_Toc26184651

Pawlowski, R. 2016. How to Set Up Bin and Rack Locations for Successful Warehouse Management. Accessed 17.08.2018. Retrieved from https://intellitrack.net/how-to-set-up-bin-and-rack-locations-for-successful-warehouse-management/

Richards, G. 2011. *Warehouse Management* [A complete guide to improving efficiency and efficiency and minimizing costs in the modern warehouse]. London: Kogan Page Limited.

Setting up bin locations. 2018. Page on Jazva automation software. Accessed on 12 May 2018. Retrieved from https://help.jazva.com/hc/en-us/articles/210263263-Setting-Up-Bin-Locations

Smyk, V. 2018. Minimizing order picking distance through the storage allocation policy. Accessed on 16 September 2018. Retrieved from http://www.theseus.fi/bitstream/handle/10024/141838/Minimizing%20order%20picking%20distance%20through%20the%20storage%20allocation%20policy.pdf?sequence=1

SunManager - monipuolinen ERP/CRM ohjelmisto. Page on SunManager software. Accessed on 29 July 2018. Retrieved from http://www.sunsun.fi/?s=tuotteet&tag=sunmanager

Thayer, A. 2017. Label Your Locations to Avoid Costly Mistakes. Page on SkuVault, a world-class WMS. Accessed on 12 May 2018. Retrieved from https://www.skuvault.com/blog/warehouse-locations-labeling-mistakes

TransLution. Page on TransLution software webpage. Accessed on 10 September 2018. Retrieved from https://www.translutionsoftware.com/

Tuotteet ja ratkaisut. Page on SunManager software. Accessed on 29 July 2018. Retrieved from http://www.sunsun.fi/?s=tuotteet&tag=sunmanager

Viale, J. David. 1996. Inventory Management: From Warehouse to Distribution Center. USA: Course Technology Crisp.