An Information System Proposal for Determining of Material Picking Route and Picking Box Quantity in Warehouse

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***Abstract*—** The primary focus of lean thinking is to prevent waste. Overproduction, unnecessary transportation, unnecessary movement, unnecessary waiting, unnecessary processing, excess inventory and errors are defined as 7 wastes. It is aimed to prevent waste by finding the number of picking boxes along with the shortest path in the warehouse of the personnel who will pick the materials to be sold or produced in the warehouse. Within the scope of the study, an information system design was made to find the shortest path in warehouse activities and to determine the number of picking boxes and their in-box sequences. It is expected that the information system to be developed will reduce the company's losses due to unnecessary movements and provide a competitive advantage.

***Keywords*—**Information System, Warehouse Management, Determining of Material Picking Route, Determining of Material Picking Box Quantity

1. INTRODUCTION

Businesses focus on reducing product costs in order to make improvements on the product price in the competitive environment. Keeping the storage and material transfer movements at a minimum level reduces the product cost and this provides a competitive advantage to the enterprises.

One of the main activities of warehouse management is the preparation and delivery of raw materials, parts, semi-materials and products for production or sale. Considering all the costs related to warehouse operations, material Picking activities constitute 55%-65% of them [1]. Fast and correct material preparation activities for production line or customers not only prevent the production line or customer from waiting for materials, but also ensure efficient use of the workforce in the warehouse.

The main activities in a warehouse are the storage (stocking) of the material in suitable conditions and its transportation (handling) from one point to another point. For the preparation of raw materials, parts, semi-materials and products for production or sale from the warehouse, which is one of the handling operations, the picking activity of materials in the warehouse stock areas comes first in the warehouse activities. This proses constitutes the largest part of the storage activities. Improvements to be made regarding the picking of materials will directly affect the entire activity as a major improvement.

In this study is presented the design of an information system called Material Picking Information System, which is planned to be developed for improvement the material picking route from the warehouse and determining the number of picking boxes needed before the picking activity. With the designed information system, it is expected that the losses of the enterprise due to

unnecessary movements will decrease and it will provide a competitive advantage.

2. CONCEPTIONAL FRAMEWORK

2.1. Role of Information System in Plant

An information system is a system that takes data sources as inputs, processes them, and produces information products as outputs. In this case, while the information system achieves this, the question arises "What elements and activities does it include?" [2].

Successful management of information systems and technologies provides great opportunities and advantages for businesses. Shortening of the product development period and rapid introduction of the new product to the market, expanding the market, increasing the product range, decreasing the costs, adapting quickly to the changing economic conditions, and meeting the changing customer demands and requirements accurately and on time can be given as examples [3].

Information systems have been one of the main functional areas in businesses as important as accounting, finance, marketing or human resources [2].

2.2. Warehouse Management

Storage problems are generally grouped as warehouse design and warehouse operations in the literature [4]. Warehouse design includes overall structure, sizing and dimensioning, department layout, equipment selection, and operation strategy. And warehouse operation includes receiving and shipping, storage and order picking.

As an example of warehouse problems; classical discrete optimization problems are expressed as traveling salesman problem (TSP) and box packing problem (BPP). These two problems are easy to formulate, but difficult to solve. BPP is often used to decide the position of materials in the warehouse or on the pallet. The most labor-intensive activity in the warehouse is order picking. There are many studies on order picking policies in the literature [5].

As an example of order picking algorithms, Armstrong, Cook, and Saipe (1979) developed an order picking algorithm that minimizes the total picking time with a mixed integer linear programming model [6]. They used artificial orders for exact programming. They have considered field picking operations for the distribution center. There are also studies in the literature that emphasize the usefulness of the heuristic algorithm in picking material from the warehouse [7],[8],[9]. Researchers aimed to minimize the total material picking route. Ratliff and Rosenthal (1983) presented a picking route algorithm that minimizes picking time for a warehouse system with two cross aisles, front and back [10]. They developed a robust procedure for determining a picking route using a simple step structure. Tsai, Liou, and Huang (2008) consider not only the lap distance but also the early and late penalty costs in the models they propose on the picking of different material lots [11].

In 2016, Lin, Kang, Hou, and Cheng proposed a model that combines order grouping and order picking route in the same model. They developed a model for order grouping and order picking using the Particle Swarm Optimization (PSO) algorithm [12]. Erdoğan (2017) developed an MS Excel VBA Macro based on the large neighborhood search heuristic algorithm. This study helps to decide the quantity of the box type and the algorithm to put them in the designated boxes [13].

As can be seen in the literature, efforts to find the best solution still keep going and businesses continue to seek optimum solutions to gain competitive advantage.

3. METHOD

3.1. Definition of the Problem and System Expectations

In a warehouse system with parallel aisles and starting and ending points in the same location, the activities of preparing raw materials, parts, semi-finished products and finished products for production or sale, defined as stock materials, are among the daily routine tasks. In these routine activities carried out, the determination of the picking route is made based on the intuition and experience of the personnel. For this reason, there is time loss and wastage in the routine processes carried out in the warehouse. At the same time, due to the inability of the personnel to determine the exact amount and dimensions of the picking box they need at the beginning of activity, the process of taking or replacing a new picking box occurs by returning to the starting point many times. These repetitive processes increase the time and labor losses of the enterprise. In this study, in order to minimize the mentioned losses, the shortest possible routing, solving the problem of determining the rectangular box type and quantity required in packaging and the development of the simulation including the placement of the material in the box presenting the warehouse personnel including a data flow diagram has been developed an information system design before starting the material picking activity from the warehouse.

3.2. Description of Current System and Limitations

The storage system (warehouse) has a width of 26 m and a length of 16 m. There are 5 parallel aisles and 4 aisles perpendicular to these aisles and 72 defined stock locations in the warehouse. Each warehouse consists of 6 floors and the warehouse has a total height of 5 m. Warehouse corridors are 2 m wide. The width of the stock areas is 2x2 m. As for the coding of stock locations, the first subscript indicates the column number, while the second subscript represents the shelf row number, as shown in Figure 1.

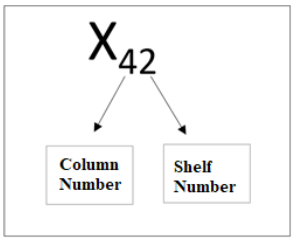


Figure 1. Stock Address Coding

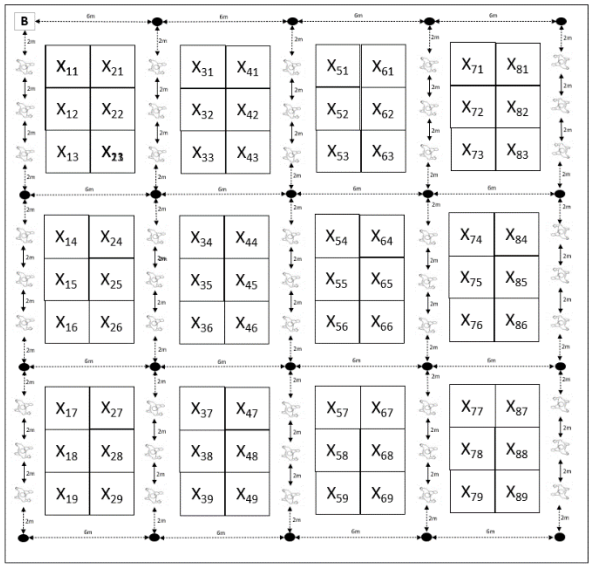


Figure 2. Warehouse Map

As can be seen in Figure 2, X_{42} is located on the 2. shelf of the 4th column.

In the warehouse system, the shortest material picking route, number of picking boxes and in box placement simulation are planned to work according to 20 kinds of materials to be picking from stock areas. The reason for this is to prevent the prolongation of the solution time based on the MS Excel Solver infrastructure to be used in the solution. It is thought that this variety and solution time can be increased in different software infrastructures. In the infrastructure of the system to be created, there will be 72 types of materials at each stock address.

The personnel who will start picking materials from the starting point (B) will return to point (B) after the picking.

By running the information system, the required number of boxes, the contents of the box and how it will be placed will be presented to the warehouse personnel with simulation.

The materials and quantities in the picking list will be made into a connected lot and the picking will be carried out. In other words, it is requested that all quantities of a material to be picked are contained in a single box.

Picking box sizes are standard and 3 types. They are respectively in width, length and height 0.40m. x 0.60m. x 0.28m., 0.60m. x 0.80m. x 0.32m. and 0.61m. x 0.81m. x 0.52m. Materials that do not fit in any picking box are transported on pallets. The number of picking boxes are 5 for each size and 15 in total. Models of Picking boxes are given in Figure 3.

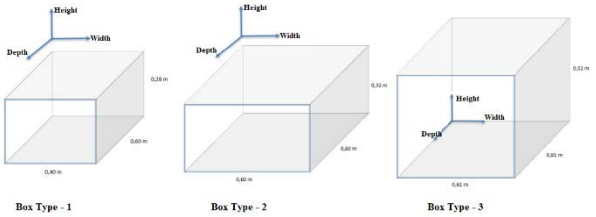


Figure 3. Picking Boxes Types (Container Types)

Data Flow Diagrams (DFD), were used in the development of the information system.

DFD is a very popular tool used in structural system development and provides a graphical representation of the system. With DFD, it is possible to describe any complex system using 4 symbols [14].

3.3. Creating Context Diagram

Considering the limitations and expectations of the system, the Context Diagram was created as in Figure 4. Inputs of Material Picking Information System; transport box types (container types) information, warehouse address and distance between addresses, material stock address information, material size information, sequence information according to pieces, the required transport box and in-box layout calculation request, 3D in-box layout request and report are requests.

Outputs of Material Picking Information System; It consists of the order of picking the materials from the stock places, the number of boxes, the 3D in-box layout list and other reports that give the shortest path. Warehouse supervisors and warehouse operators constitute the external units. The warehouse supervisor is the administrative officer of the warehouse activities and is in the managerial position. Planning and organizing the

activities during the day are among the primary responsibilities of the warehouse supervisor. Warehouse operators are employees who actually carry out the activities with the plan they received from the warehouse supervisor.

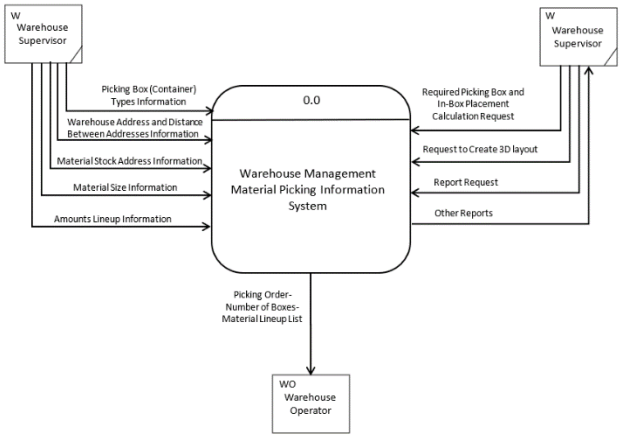


Figure 4. Context Diagram

3.4. Creating 0-Level Data Flow Diagram

0-Level Data Flow Diagram was created as in Figure 5. There are 9 processes and 9 datastores in the system.

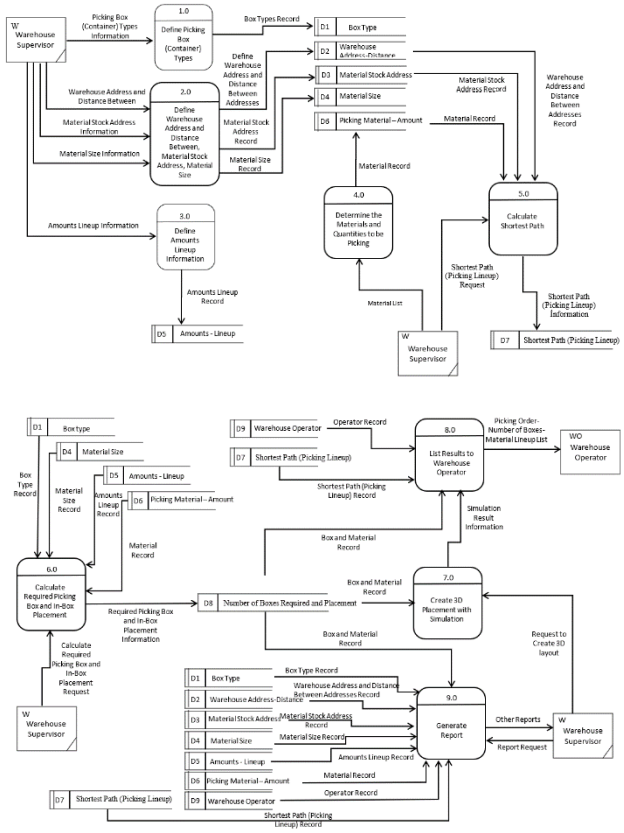


Figure 5. 0-Level Data Flow Diagram

2.0 Process sublevel diagram given in Figure 6.

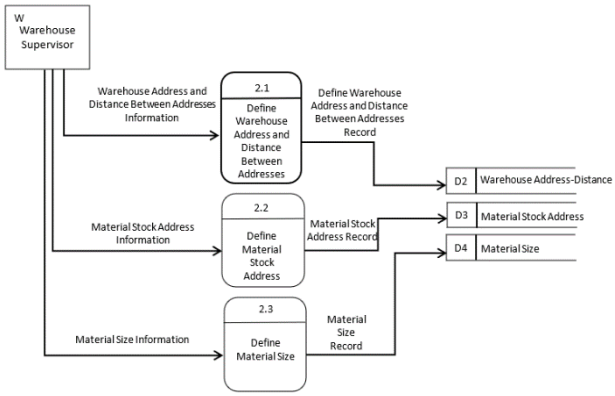


Figure 6. 2.0 Process Sublevel Diagram

3.5. Creating System Data Store

In order to provide information entry to the 6 datastores in the system, an interface was designed and the system defined the transport box type (container type) information, material stock address information, material size information, warehouse address-distance information, box sequence information and warehouse operator information.

3.6. Some Information System Results

The materials and quantities in Table 1 were chosen as examples for the calculation of the number of picking boxes and the arrangement within the box.

Material	Picking Amount
STK-882-C1-DE5944	8
STK-721-B4-GY2652	12
STK-500-A4-AB3817	9
STK-323-B1-GY8424	10
STK-967-C5-RT7031	10
STK-100-B2-DE3240	2
STK-240-B9-AN4800	10
STK-208-A7-AC5790	10
STK-684-A3-FT1640	6
STK-232-C5-AC2271	2

Chart 1. Materials and Picking Amounts List

When the Material Picking Information System is run to find the shortest path in the material picking route, the material picking lineup result in Figure 7. is obtained.

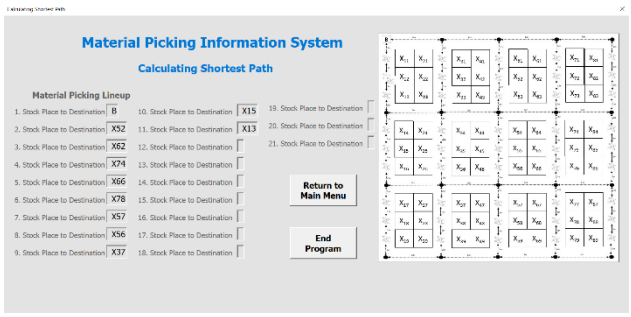


Figure 7. Example Shortest Path Screen Output

Considering the amount of materials, the Material Picking Information System was run to find the number of Picking boxes needed and the result in Figure 8. was found.

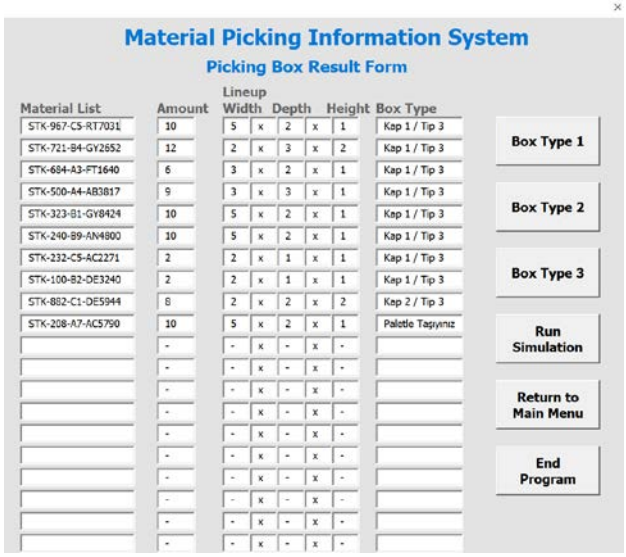


Figure 8. Screen Output of Number and Type of Picking Boxes Required

In-box layout image as a result of the 3D supported simulation created by the Material Picking Information System for the sample collection list is given in Figure 9.

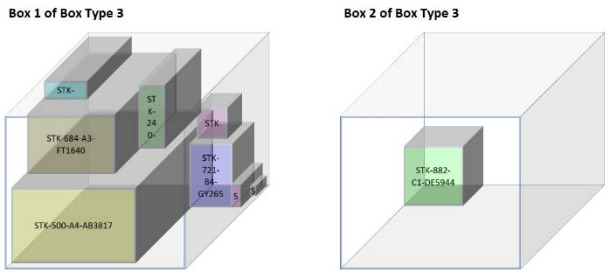


Figure 9. In-Box Placement Screen Output

4. CONCLUSION

Many businesses are focused on their costs because they cannot increase their product prices in order to maintain the economy in their business. It can be aimed to reduce costs by reducing the losses in the activities of preparing raw materials, parts, semi-materials or products for production or sale in warehouses. In this study, an information system analysis and design, which is planned to be developed, was created in order to establish the shortest material picking route and to determine the number of materials picking boxes.

As the final of the ongoing work, it is planned to complete the information system and present a two-stage result to the users.

This study is aimed to increase productivity by reaching an optimum or near-optimal result through the Material Picking Information System, which was designed with a systematic approach to material picking operations that were previously carried out based on employee experience and intuition.

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