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Warehouse Management for Improved Efficiency in A Small Warehouse

M. Srikanth Yadav[1], Y. Eswara Rao[2], P. Sudhakar[3], Allada Aparna[4]

[1]*Assoc. Professor & Head, Dept. of CSE, R. K. College of Engineering, A.P., India.*
[2]*Professor, Dept. of Civil Engineering, V.R .Siddhartha Engineering College, A.P., India.*
[3]*Asst. Professor, Dept. of I.T, R. K. College of Engineering, A.P., India.*
[4]*Asst.Professor, Dept. of I.T, Andhra Loyola Institute of Engineering, and Technology, A.P., India.*

Abstract **- Recently new innovative warehouse layouts are suggested that do not follow usual restrictions of ubiquitous traditional designs. One of them, called fishbone layout, showed potential to reduce travel distances in unit-load warehouses by more then 20%. In manual-pick order-picking systems with case and item picking from multiple locations different routing policies are used. Small warehouses generally have different needs than large warehouses. They usually do not have warehouse management systems that are data intensive and involve high capital investment. Operational procedures are more nebulous and management control is less rigid. Because of the difference in operational approach, different measures are needed in order to enhance productivity. The study presented here considers arrangement and management policies to improve the order picking procedure in the existing company warehouse. The main objective was to reduce the overall picking time that is quite high due to the lack of proper management and the nature of the stored items. The first stage was to register the situation in the warehouse. The second stage involved the analysis of the obtained data, to identify promising modifications and quantify the benefits of adopting them. The proposed modifications were based on policies and methodologies suggested in the literature.**

Keywords **- Inventory control, order picking, order batching, heuristic, small warehouse.**

I. INTRODUCTION

It is well known that logistic costs have important influence on final successfulness of any company. According to the Logistics Cost and Service 2007 study [1], in western countries these costs represent almost 10% of sales. Warehousing, along with transportation and inventory carrying, is one of the three major drivers of total logistics cost, with 21% in US and 37% in EU. Order-picking process, defined as the process of retrieving items from storage locations in response to a specific customer request is the most laborious and the most costly activity in a typical warehouse, with up to 55% of warehouse total operating costs (Tompkins et al. [2]). With a direct link with speed of delivery, it influences service level too. Order picking (OP) appears as one of the most significant activities in a warehouse. The picking tasks may contribute by over 65% in the warehouse operating costs.

In fact, the retrieval cost exceeds by far the storage cost of any given item (Coyle et al., 1996). The factors affecting the efficiency of OP typically include the product demand, the warehouse layout, the location of the items, the picking method in combination with the routing methods, the experience of the employees, and the extent of automation (Gattorna, 1997). Note that the high cost associated with the automation of the procedure forces the majority of companies to use manual operation, usually at the expense of efficiency and time. Small warehouses are usually quite distinct from large warehouses in a number of ways. First of all, typically in smaller warehouses stock-keeping unit (sku) density is quite high. Capital investment is quite low. Small warehouses usually do not invest in costly warehouse management systems, and automation is also lacking or limited. These differences necessitate different needs for the internal operations management. To be efficient, processes in small warehouses need to be carefully structured in order to meet productivity and accuracy goals.

II. REVIEW OF WAREHOUSE POLICIES RELATED TO ORDER PICKING

There is a variety of studies on methods, policies, principles and/or techniques developed to improve the overall OP procedure. The decisions usually concern policies for the picking of the product items, the routing of the pickers in the warehouse, and the storage schemes for the products in the warehouse. The research scope has been to investigate the effect of changes in these policies on the reduction of the overall OP costs and the increase of percent savings. Petersen and Gerald (2003) was the first to attempt a simultaneous evaluation of all the three policies, whereas the usual practice is to consider them separately.

2.1. Picking policies

In terms of the picking policies, Ackerman (1990) divided OP into strict, batch and zone picking and proposed policies tailored to each case. In *strict picking*, a single order is assigned during a picking tour, leading to lower service times and higher customer satisfaction. The policy is ideal when the group of the picking products is quite small and easy to be found. Drawbacks of the policy include an increase in the overall transportation time and a cost penalty. Alternatively, the *batch picking* policy assigns to a picker more than one orders during a picking tour (Gibson and Sharp, 1992; De Coster et al., 1999; Petersen, 2000). The batch scheme may bring significant reduction on the total picking time, but introduces an additional cost for monitoring and separating the orders at a later stage. *Zone picking* assigns a picker to a designated picking zone, where the picker is responsible for those products that are in his/her zone of the warehouse. This scheme decreases the chances for destructions and mistakes, but a possible delay in a zone is a threshold for the entire picking procedure for a big order. Frazelle and Apple (1994) further divided zone picking into: sequential zone, batch zone and wave OP. Petersen (2000) suggested that in the *sequential zone* scheme the order integrity is maintained, in *batch zone* the orders are batched together and each picker collects the products within a zone, and in *wave picking* a group of orders is programmed in precise time period.

2.2. Routing policies

Routing policies suggest the route for a picking tour and the picking sequence of the items on the pick list. The suggestions are based on decision-making technologies that range from simple heuristics to mathematical optimization procedures. [3] Using *mathematical programming* tools Ratliff and Rosenthal (1983) found that optimal routing reduced the travel time, but the optimal routes were quite confusing routes and difficult to implement in practice. [4] Hall (1993) and Petersen and Schmenner (1999) examined the efficiency of *heuristic routing* in minimizing the distance traveled by the picker. In practice, many warehouses use the traversal policy, where the picker must pass through the entire aisle and in order to collect the items. Petersen (1997) and Roodbergen and Koster (2001) examined the possibility of combined traversal and return routes to reduce further the travel distance.

III. INVENTORY ACCURACY

The daily process flow used by the client is represented in Figure. 1. Orders are entered by sales representatives a day in advance. In the morning, orders are printed and orders that are completely in stock – according to the book inventory levels – are picked. Between 9:30 and 11:00 AM inbound merchandise arrives and is received in the system. Order picking of complete orders is continued based on the updated book inventory levels. Finally orders are checked, packaged and shipped. As a consequence of low accuracy levels, order picking is often interrupted because of unexpected shortages. A survey of 410 manufacturing companies indicates that companies using cycle counting methods achieve higher levels of inventory record accuracy, compared to companies that use physical inventory to measure inventory record accuracy [1].

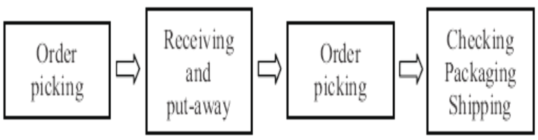

Fig. 1 Process flow

IV. INVENTORY CONTROL

Once a reasonable level of inventory accuracy is achieved, the focus can be shifted to inventory control for improvement opportunities. High backorder levels were also indicated as a problem by the client. Although better accuracy decreases the number of backorders, better inventory levels based on historical data help ensure the fill rate is improved. Inventory analysis was used to quantify and compare the amount of expected and actual inventory levels of each stock keeping unit. Once computed, these levels are translated into their associated holding costs. A base stock or order-up-to model [5] to theoretically approximate the real inventory was chosen as the most suitable statistical inventory model. The model was adapted to account for box quantities, since client orders are always in a multiple of box quantities. For the sake of the analysis, demand was assumed to follow a normal distribution. In terms of inventory holding costs, 25% of the item cost was represented to be the holding cost for a particular item in consideration. This comes from a maintenance cost of 20% and a 5% interest rate to quantify the time-value of money. The inventory model assumes an 85% fill rate, i.e. the current fill rate as indicated by the client.

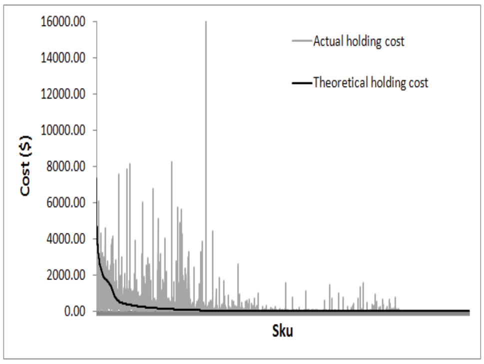

Fig. 2 Actual versus theoretical holding cost

V. DESCRIPTION OF THE STUDIED WAREHOUSE – INITIAL SITUATION

The company considered here deals with wood production and trading, and uses 6 warehouses for the finished products. Each warehouse is further divided into individual sections where different categories of products are stored. Panels, i.e. sheets of compressed wood (chipboard) account for 80% of the total product sales of the company. The panels are covered with coloured melamine to imitate the appearance of various types of wood. The panel warehouse has over 6000 codes of stored products, distributed into 4 individual sections. The study considers one of these sections, where the number of codes is around 1000. The most frequent values for the size of the panels is 3.66×1.83m, and the thickness is between 6cm and 25cm. Instead of using shelves, the products are piled one on top of the other using small chocks between the packages. Great attention is paid to the alignment of the items in each pile, to avoid sheet warping. Warping can easily occur due to the small thickness of the packages and the large load they take.

VI. MEASUREMENTS AND PROPOSED MODIFICATIONS

The time measurements were carried out twice. The first measurement (stage 1) presented the initial anarchies situation of the system. The second measurement (stage 3) showed the effect of the improvements suggested by the authors and adopted by the company. The picking procedure is divided into four phases and the time measurements concern the:

1. the *travel time* required for the picker to reach the pick point.
2. the *search time* required for the products to be found.
3. the *retrieval time* required for the products to be retrieved, and
4. the *return time* required for the picker to transport the products to the order point.

Each time measurement considered 15 order plans selected by the Traffic Office of the company in collaboration with the authors. The selected plans were representative and included a large number of products, so that the analysis of the obtained time schedules yields reasonable and reliable conclusions. The number of orders in the studied plans ranged from 5 to 17 per plan. To allow comparison between the picking times measured for items of different size, the results are presented as the measured time over the volume of the respective item, namely in minutes per cubic meter.

Stage 1: Results of the 1ST measurement series

The results of the 1st measurement series are reported on Table 1. The time required to complete the picking cycle is 5.69 min/m3. In terms of the itemized times for travel, search, retrieval and return, we observe that finding and retrieving the products are the most time-consuming procedures. The *search time is around 36%* (2.05 min/m3) of the total OP time. The percentage is quite high and reveals the need for an automated system to control and monitor the placement of the stock. Tracing the products becomes an extremely difficult and demanding procedure relaying mainly on the experience of the operator and the assistant. Many years of work in this particular position and the ability to locate the items using visual contact are decisive factors. In many cases, finding an item quickly is merely a matter of coincidence or luck. Our results include cases where locating a stocked product took over 45 minutes of searching and the product eventually failed to reach the customer on time.

Stage 2: Proposed and implemented modifications

The scope here is to reduce the time spent to reach the picking area and the packaging point. Based on the analysis of the first measurements the following were suggested to the company.

- *Introduction of a Warehouse Management System (WMS):* The use of a WMS can facilitate and speed up the tracing of the products. This is expected to reduce significantly the search time that is over a third of the total OP time.
- *Improvement of the picking policies:* After introducing a WMS, it is advisable to change the method of OP from strict to zone picking.
- *Application of optimal routing policies:* In total, the travel and return time is only around 20% of the total OP time. A techno-economical feasibility study (in the form of an ABC analysis) can quantify how much of this can really be reduced by the choice of routing policies, and provide incentives to carry out the necessary modifications.

VII. CONCLUSION

This work presents a real case study to improve the performance of order picking in an existing company warehouse. The main objective is the reduction of the overall picking time. The work is divided into three stages. The first stage is to register the situation in the warehouse with regard to the required order picking times. The total time is divided into travel, search, and retrieval and return time to allow a more detailed analysis of the situation. The analysis of the obtained data identifies promising modifications and quantifies the benefits of adopting them. In effect, the measurements indicated the need for more systematic management, storage and arrangement of the products in the warehouse, and more efficient routing. After the company approved and implemented (some of) the proposed modifications, the time measurements were repeated to see the benefits. Finally, a mean 50% reduction in the total picking times was achieved. There is still space for improvement, even given the reluctance of the company to carry out expensive modifications.

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AUTHORS PROFILE

M. Srikanth Yadav working as Assoc. Professor & Head, Department of Computer Science Engineering at R. K. College of Engineering, Affiliated to JNTUK, Kakinada, A.P., India. My research Interests includes Data warehousing and data mining, Computer Networks. He is a Life member of ISTE.

Dr. Y. Eswara rao, working as Professor, Department of Civil Engineering at V.R .Siddhartha Engineering College, Kanuru, Vijayawada, A.P., India. My research Interests are Data warehousing.

P. Sudhakar working as Asst. Professor, Department of Information Technology at R. K. College of Engineering, Affiliated to JNTUK, Kakinada, A.P., India. My research Interests are Datawarehousing and data mining.

Allada Aparna , working as Asst. Professor, Department of Information Technology at Andhra Loyola Institute Of Engineering and Technology, Vijayawada, Affiliated to JNTUK, Kakinada, A.P., India. My research Interests are Data warehousing and data mining.