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A study on the picking process time

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Abstract

The order picking activities in distribution center are mainly sorting and arrangement works classified by destinations in accordance with customer's request. The activities consist of lifting, moving, picking, putting, packing and other works basically. Also it can be classified into box picking, client picking, etc. according to the shape of products, type of process, type of picking system and so forth. In some companies, picking process consists of pre-picking and auto picking. Pre-picking refers to the work before the auto picking system classification where orders received from clients are checked and products are sorted by unit of box, pallet or auto picking unit. The auto picking (or semi auto picking) is defined as the process of sorting the pre-picking-treated products according to the units of clients, order, vehicles, etc. through the auto picking system. Although these activities are very simple and easy, every warehouse has different process for picking due to the lack of standard process. In this paper, we present a standard picking process for light weight cargo & productivity analysis for warehouse picking systems considering operational processes to compare: standard process versus ad-hoc process; conventional manual picking (e.g. manual digital picking system) versus automatic picking system.

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Keywords: Order picking process; Manual order picking systems; Distribution center; Produtivity

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1. Introduction

Recently, automation technologies and advanced information technologies have been applied to logistics industries. For example, in distribution center computer-aided picking systems (CAPS) using light to pick or automated picking systems have been used. Using these systems, workers do not need picking lists to check the items and quantities of products. It could improve productivity of workers and operational efficiencies. However due to the variety of customer demand manual work remains still a important factor. There are some limitations of the automated systems such as abnormalities, extraordinary treated product while human workers can do with flexibility. However, conventional manual operations are performed without considering cognitive aspects for instance seeking the location and counting the quantity of items. To improve accuracy and productivity of order picking systems, it is recommended which use hybrid operation of manual works and automated works.

In this paper we focus on the cognitive perspective by two ways. Firstly we analyzed manual order picking task in the perspective of physical task and cognitive task, and secondly a case study was conducted to compare productivity and efficiency of several types of the picking system in accordance with the degree of automation. We selected a distribution center with the automated picking system in place, which generally handles light-weight cargos to re-define the standard picking operation process and standard picking working hour to charge their operational target to small quantity batch production, high frequency small quantity order.

2. Picking process

2.1. Picking process in warehouse

Briefly the flow in warehouses is defined as Fig.1 that includes receiving, put away, storaging, transporting, picking, packing, shipping and etc. Receiving is the activities for taking the products and information into the warehouse. Transfer and put away include the transfer of products to storage. Order picking involves the process of selecting and gathering a right amount of the right products in accordance with customer's request. Accumulation/sortation of picked is activity that makes the picked orders in batches to individual orders to sort. Cross docking carried out when incoming products are transferred directly to the shipping docks.

Order picking systems are classified into manual and automated task. In manual system typically picker picks the products from storage racks traveling along the storage aisles in order to fulfil customer order. Parts-to-picker system includes automated storage and retrieval systems (AS/RS) that retrieve one or more unit loads and bring them to a picking station. In this station an order picker takes products on orders and the remaining items on unit loads is transferred to the storage again.

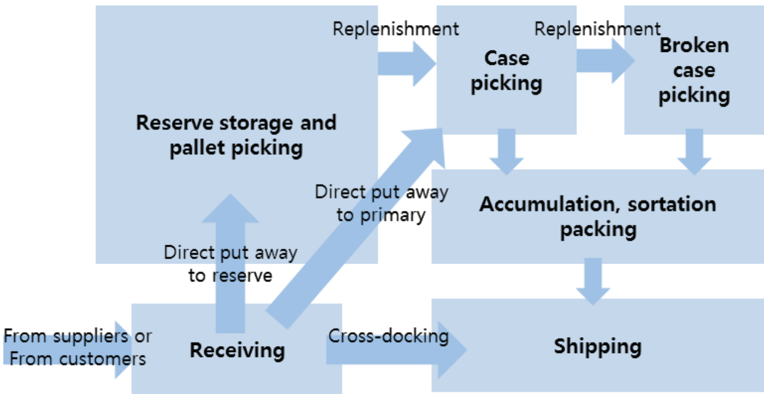


Fig. 1. Typical warehouse functions[1].

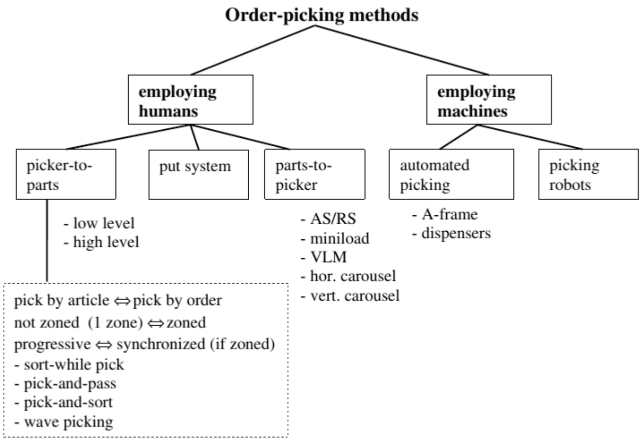


Fig. 2. Picking systems classifications [2].

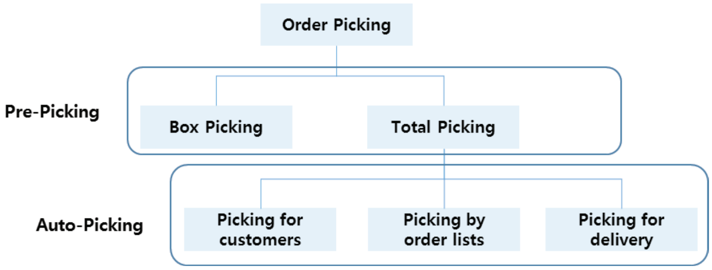


Fig. 3. classification and definition of order picking process for distribution center.

There are a lot of types of light weight cargo. In this paper we consider a typical warehouse which has two step picking process: pre-picking and auto picking. Pre-picking refers to work before the auto picking system classification. In prepacking orders received from clients are checked and products are sorted by unit of box, pallet or auto picking unit.

2.2. Manual picking process activities

Manual order picking activities in distribution center are mainly sorting and arrangement works classified by destinations in accordance with customer's request. The activities consist of lifting, moving, picking, putting, packing and other works typically. Fig. 4 shows typical manual picking process to compare physical activities and cognitive activities. Although these activities look like very simple and easy, there are some cognition activities included. For the first step pickers take order list and read it, at the same time they count the quantity of the items. Then start moving with the cart to put items in while searching for picking location. After they find the piking location they walk to the location and pick items from the storage rack identifying the items for varifying and counting the number of items. Move and picking activities are continued until all the number of products in the order list are picked. Even if one fulfils the same order the picking performance may vary depending on the picker's cognition activities. Many order picking errors occur in counting or identifying items.

Physical work	Automated activity	Human activity	Cognitive work	Automated activity	Human activity
Reading		○	Counting order quantity	○	
Stand in front of the cart		○			○
Walking		○	Searching for picking location	○	○
Handling product (Bending, retrieving items, grasping, pushing, etc.)		○	Counting the number of items	○	
			Identifying characteristics of the items		○
marking	Not needed		Check remaining works	○	

Fig. 4. The activities by human or digit system.

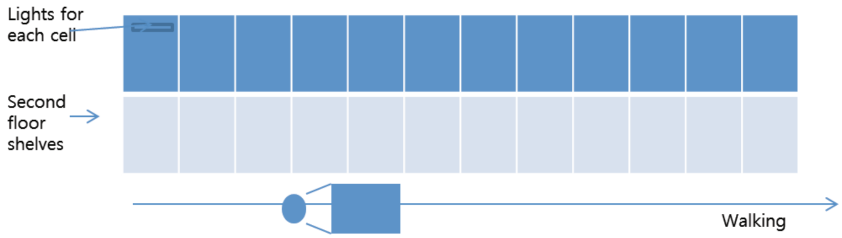


Fig. 5. experiment environment.

3. Comparison of picking process time

3.1. Experiments

We have made an experiment for comparing two different types of picking process. One is the typical manual order picking process and the other is manual picking process with digit system where digital mark help pickers search for locations and amount of the items on the storage or shelves. The picking system with digital mark provides efficiencies to some tasks for workers such as searching for picking items, counting the quantity of items and checking remaining works. Fig. 5 shows test environment. The data was collected in the laboratory with 24 items of products. In manual picking scenarios, pickers pull the cart and pick the products in the order list, in the case of digital light system scenarios pickers pull the cart and pick the products where LED lights are flicking with picking amount. The length of the shelves is 17.2m and the first floor shelves is 56 centimeters above from the floor, height of each shelf is 56cm. Fifteen non-experienced pickers participated in the experiment.

3.2. Results

The analysis includes the task time of two different picking systems with 15 pickers. The order list consists of 10 types of products and the total amount is 29 items. Table 1 shows average and standard deviation of the picking time. For manual picking system, average task time is 159 seconds and in case of digit picking system the average is less than manual system, 87 seconds. Compared to the standard deviation manual system has high variations depending on the pickers, but in case of digit system the difference is smaller. It is considered that the device helping cognition activities affect the decrease of the fluctuation of picking time as well as the reduction of task time for picking. Fig 6 shows the different shape of graphic chart for two picking system's task time.

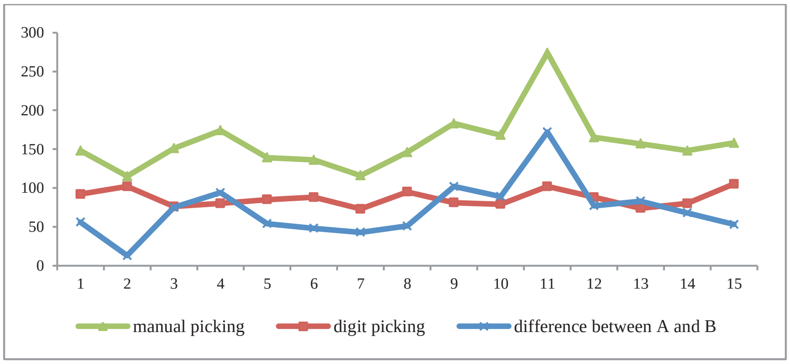


Fig. 6. Picking time of manual and digit system.

Table 1. the results of the experiment.

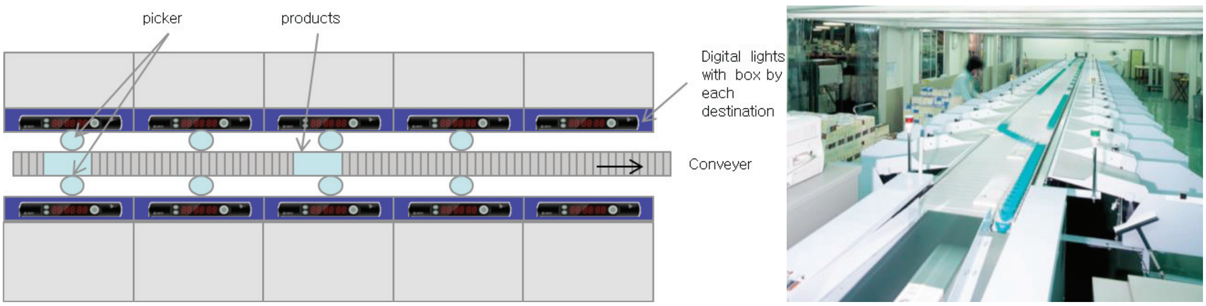
	manual picking(A)	digit picking(B)	difference between A and B
average	159	87	72
S.D	36	10	35

4. Picking System productivity analysis

4.1. Case study

The case study was carried out in a Korean retailer's distribution center handling beauty & healthcare product. There are three types of picking systems in the distribution center: (1) manual picking(Box picking system), (2)part-to-picker system(Digital order assort system: DAS) and (3) auto assort system(Piece assort system: PAS). As discussed above in distribution centers picking process consists of several steps of picking. For automated or semi-automated picking system it needs advanced work to replenish products to picking system with an item level. We consider all the works before and after order picking as picking process like Fig. 3 that consist of two steps of picking. Pre-picking is the advanced process of automated picking done by human with equipment, e.g carts. The auto picking (or semi auto picking) is defined as the process of sorting the pre-picked products according to the units of clients, order, vehicles, etc. through the auto picking system.

The auto picking is processed by Digital assort system(DAS) and PAS(Piece Assorting System). DAS is a system that automatically handles the various items assorting by each destination via the digital indicator while PAS is a self-contained piece assorting system that automates the work of sorting small items by store and by category at the individual piece level. Fig.7 shows configuration of DAS and PAS applied to pharmaceutical distribution center.



(a) (b)

Fig. 7. configuration of DAS(a) & PAS(b).

4.2. Method

A general productivity index of distribution centers are usually expressed as per capital productivity (output/input manpower) or work productivity (output/working hours), etc. Such methods are subject to change according to productivity priority between systems under comparison. Because working environment and operation process closely related to productivity are not factored in, it is not easy to make decision a new system such as automated system whether to introduce or not.

Based on data envelopment analysis (DEA) method and empirical data, the research came up with and compare picking system productivity with the considering working environment and operation process. The DEA is a data analysis technique first designed by Charnes et al. (1978). It is to compare the efficiency of decision making units (DMU) in similar environments. The method measures relative inefficiency of the subjects based on their distance from its efficiency frontier. There are Charnes, Cooper and Rhodes (CCR) model and Banker, Chrnes and Cooper (BCC) model at a high level.

The CCR model analyzes efficiency by assuming that the extent of efficiency was proportional to DMU scale changes to a certain degree. Whereas the BCC model assumes the effect of size is subject to change according to DMU. Its efficiency score is market between 0 and 1, to represent the relative efficiency between DMU. As for logistical centers, their output elements tend to have a certain proportional relationship with input factors such as manpower, hour and storage capacity. In this consideration this research employed the CCR model for analysis.

4.3. Productivity analysis

For the productivity analysis of the logistical picking system based on the data envelopment analysis (DEA), logistical-center picking system was selected as a DMU. In reflection of the idea of production elements, labor and land, input manpower and storage area were considered as input elements. Exogeneous variables included the standard working time and SKU. Throughput, a basic logistical-center management index, was used as an output element.

Table 2. Input/output element selection.

Type		Element	Unit
input element	labor	manpower for total picking & auto picking	persons
	land	storage area, SKI	m^3
	exogeneous variables	standard total picking time, standard auto picking time	hours
output element		output amount	SKU

The DEA analysis shows that the distribution center under this research had a higher productivity in the DAS system than other picking systems. On the other hand, the box picking system was found to require smaller manpower but relatively longer working time for output than others, showing a lower productivity. In particular, as for the box picking systems no.1 and no.2, under perform than other system with deficiency amount of 2100~2200, meaning they processed only less than the optimal output amount. Thus they were found to have a low efficiency. Given the output of box picking system 2 which results in output of 3130, order picking productivity could be increased through downsizing the automated systems or integrating the systems. The DAS-no.3 was found to have 0.83 efficiency with 940 output deficiency.

Table 3. Results of picking system productivity analysis.

system		input element						output element	efficiency	output deficiency
DMU	picking sys.	storage size	SKU	Pre-Picking		Auto Picking		output amount	CRS	
				input manpower	working time	input manpower	working time			
DMU1	DAS - no. 1	255	712	31	25.54	12	180	32,290	1.00	-
DMU2	DAS - no. 2	255	712	34	64.96	12	528	91,610	1.00	-
DMU3	DAS - no. 3	255	712	11	11.00	12	30	4,563	0.83	940.876
DMU4	PAS - no. 1	177	735	12	37.50	20	170	24,545	0.79	6,638.253
DMU5	PAS - no. 2	177	735	15	85.33	22	440	80,702	1.00	-
DMU6	BOX - no. 1	150	674	6	6.08	5	60	6,973	0.77	2,109.52
DMU7	BOX - no. 2	150	674	5	4.17	5	30	3,130	0.58	2,224.251
DMU8	BOX - no. 3	150	674	6	19.75	5	270	33,112	1.00	-

5. Conclusions

Order picking is the most labour-intensive process among the warehouse functions. A lot of automated picking systems and human support systems are developed and applied for order picking activity but still in most warehouse particularly distribution center for light-weight cargo. For this reason we conducted the experiment on the cognition aspects of order picking systems-manual order picking and digit supported manual order picking. The result shows that the device helping cognition activities affect the decrease of the fluctuation of picking time as well as the reduction of time consumption for picking.

Other case study was conducted for distribution center dealing with light-weight cargo. Three types of order picking systems performed order picking activities, productivity analysis was conducted. The analysis is to compare the relative efficiency of each picking system through the DEA method. The result shows that by adjusting input manpower and working time, max productivity could be achieved.

Since customer's request are getting more diversified and requirement for small quantity order are more demanding, the decision on whether to introduce automated system is not easy. So it is concluded that analysing manual order picking process is very important with defining standard process.

In this research we analyzed just one case of distribution center, future research on this topic should include productivity comparison through data collection on diverse distribution centers. Moreover, it seems to be a useful method to compare pre/post-improvement productivity when a new system introduced by running a simulation.

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