POSSIBILITY OF APPLICATION OF REMOTE CONTROLLED ORDER-PICKER FORKLIFTS

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Abstract: *Warehouses and warehousing processes, as a significant component of the supply chains, are places where the possibilities of rationalization are being continuously explored. Order-picking, that generates main warehousing costs, is an especially interesting process in terms of rationalization. As such, order-picking is a subject of permanent research in the field of development and use of equipment, design, management, optimization, etc. One approach to this goal is increasing the productivity of the workforce by using remote controlled forklifts in the manually realized order-picking process in order to reduce order-picker's engagement time. This paper gives an overview of this technology with the evaluation of potential points and the level of savings in order-picker's labor time for a set of typical order-picking tasks.*

Keywords*: warehouse, order-picking, remote controlled forklift*

1. INTRODUCTION

With the aim of time rationalization of order-picker engagement, different kinds of more or less efficient solutions in the technology domain are present, applicable for the purpose of rationalization of elementary order-pickers' activities. Some of them are related to: technologies of receiving/sending of information about ordered SKUs (Stock Keeping Units) to be picked, selection of order-pickers' routes, determination of picking locations, technology/place of picked SKUs put off, etc. [1].

Although the spectrum of applied order-picking technologies is very wide, [2, 3, 4], in praxis solutions based on the method „man to goods" are mostly dominant. Also, in this method so called „low-level" principle is the most applied – so that the zone of picking goods is in ergonomically suitable area available to order-picker while moving through of the floor of the warehouse area [1]. This is very important during labor-intensive activities, where huge number of ordered SKUs have to be picked in short time window. This type of tasks require significant activities of order-pickers, where order-pickers' traveling time has the greatest share (5). Therefore, the moving phase is one of the focuses of research of rationalization possibility of order-pickers activities, and this paper presents one of the possible approaches with this aim, based on new technology – by use of remote controlled order - picker forklift (OPF).

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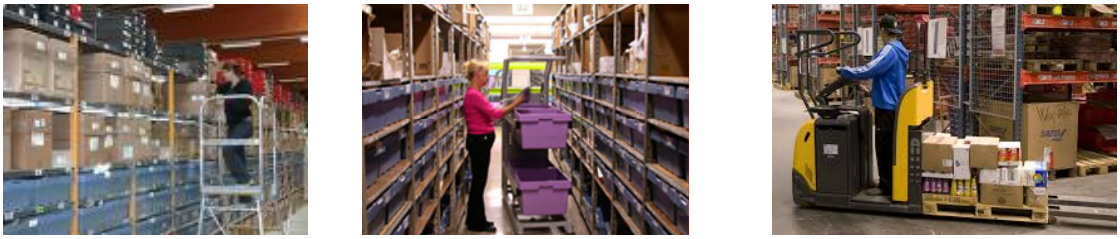
Having that in mind, this paper consists of several sections. After introduction with problem description, the second section shows short review of the most applied manual order-picking technologies with the analyze of the time structure of order-pickers' working cycle. The third section presents the characteristics of the new technology based on the appliance of OPF: it includes work principle, time working structure and difference between this and the technology of AGV system. The fourth section gives review of potential effects through overview of important measurers – possibilities of time savings, advantages and disadvantages of appliance of this technology. In this section, some effects of the use of the new technology are presented. The conclusion gives consideration of up-to-day, relatively small experiences in this area, as well as discussions about potential researches related to the use of OPF in the order-picking processes.

2. BRIEF OVERVIEW OF TYPICAL MANUAL ORDER - PICKING TECHNOLOGIES

Regardless of high level of the development of techniques and technology in logistics processes, about 80% of the activities in the domain of order-picking technologies are based on manual work. By rule it is the consequence of the frequent adjustments to the request changes of order-picking by different kinds of parameters (type of goods, logistics unit type, order pattern, etc.), when sophisticated technologies require significant time (and costs) to adapt to the new characteristics of requests.

We can see several various categorizations when we speak about manual order-picking technologies [1, 6]. The most common technologies are based on man (order-picker) movement with the transport means (forklift or carts with or without motor drive) along aisles within order-picking area (Figure 2.1). In this paper, technology OPF presented on the Figure 2.1.c is analyzed.



a) b) c)

Figure 2.1. Some examples of the manual picking technology with different transport means

Order-picker moves to the predefined picking location, where he (by rule) steps of from the OPF and walks to the picking location, picks requested number of ordered SKUs (Stock Keeping Units), moves with goods to OPF and put them on pallet that is on OPF. The mentioned process is being repeated until the completion of the order or the fulfillment of the OPF's capacity; afterwards picked SKUs are dispatched to the location of further activities realization (eventual sorting, packing, etc.). By analyzing order-picker's work in this technology, we can see that upon defining (and receipt) of picking order-list, the order-picking task on one location consists of following set of typical elementary activities:

1. Receipt of information of picking location of ordered SKUs,
2. Order-picker's stepping on (if required) on the OPF,
3. Activation of the OPF's moving,
4. Moving the OPF with order-picker to the required location and the OPF's stopping and securing,
5. Order-picker's stepping off from the OPF,
6. Order-picker's moving from the OPF to the required SKUs' location,

7. Searching/identifying and picking of the ordered SKUs,
8. Order-picker's carrying the SKUs to the OPF and put them on the OPF,
9. Confirmation of task realization for required SKUs.

During working time, these activities are being repeated for each picking location. Considering specificities and repetition of these activities, the distribution of order-picker's engagement time in this technology was the subject of the whole range of analyzes ([3, 5, 7]). According to these sources, the most dominant participation in the order-picker's time work structure is walking/movement time (app. 50%-60%), while the searching and picking time of the SKUs participates with 20-25%. Therefore, possibilities of rationalization of this time movement were the primary area of researches. The following section gives the overview of some of the appliance of the remote controlled OPF technologies, since they provide achievement of mentioned goal.

3. SPECIFICITIES OF REMOTE CONTROLLED OPF TECHNOLOGIES

Development of remote controlled OPF technologies had the goal of the elimination or the rationalization of some of the partial times of typical elementary activities. The primary idea is based on the elimination of order-picker's time for stepping on/off the OPF as well as giving the appropriate associated commands for vehicle guidance (activities 2, 3, and 5, and partially activity 4 described in Section 2). The developed solutions based on the two primary principles of giving orders for the OPF movement (i) by the order-picker, and (ii) by WMS, will be presented in details in following chapters.

3.1 Orders for OPF movement with active order-picker's participation

The principle of this technology is based on the activation of the appropriate buttons by the order-picker. Given order (start, turn, stop) is transferred to the OPF via radio-connection. This technology has several solutions and two of them are presented as follows.

a) OPF remote unit bonded around order-picker's hand by the strip

The order-picker receives information related to the next picking location (OPF stop) based on the order-picking list. By pressing the appropriate button on the remote unit (Figure 3.1.a, www.still.de; named *"iGoRemote"*) desired order of the OPF is activated.

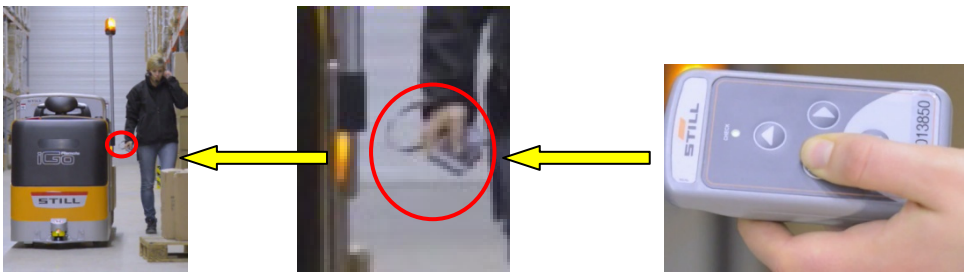


Figure 3.1.a – Overview of the remote unit bonded around order-picker's hand

It is necessary to note that the order-picker's hand activities can be partly reduced using this alternative, since the remote unit requires significant attention and higher level of hand's use.

b) OPF remote unit on the order-picker's glove

The order-picker receives information related to the next picking location (OPF stop) based on the order-picking list. The option with this remote unit is in the form of glove (Figure 3.1.b, http://video.tdcols.com/video/g_-V31UL4Ww; named *"Crown's QuickPick™"*). By pressing the appropriate button, desired order of OPF is activated, with the possibility of sound signal as well.

Figure 3.1.b – Overview of remote unit in the shape of order-picker's glove

In this technology, the freedom of the order-picker's hand activities is on the higher level compared to the alternative a), since the orders for the OPF require less attention and less order-picker's usage of hand. Also, greater freedom of hands usage during picking and putting off activities is achieved.

3.2 OPF remote control by WMS, without active order-picker's engagement

In this alternative, the applied WMS has double role: controls OPF and transfers instructions to the order-picker using *pick-by-voice* technology (Figure 3.2, http://video.tdcols.com/video/g_-V31UL4Ww; named *"Pick-n-Go"* by Toyota (BT)). Based on the WMS instructions, OPF moves to the location where the SKUs have to be picked and stops there. Order-picker receives information related to the picking location and the number of the ordered SKUs via headset, pick them and walk with items, putting them on the OPF. By voice – over microphone and communication system – WMS receives information related to the realization of the task for ordered SKUs. Based on it and according to the fulfillment of the order, WMS sends instruction to the OPF about the next picking location, order-picker's decides about the mode of movement (on OPF, or by foot behind it).

Figure 3.2 – Overview of OPF remote control using WMS

This technology influences a range of significant factors which increase the order-picker's productivity: complete freedom of hands; with the option of OPF with lifting forks, WMS additionally provides pallet unit lifting on ergonomically optimal height level for SKUs putting on; using AGVS elements increases work safety with the OPF, by using a lot of sensors/detectors

for noticing obstacles on the path, sound and light signals, etc. – this is very important on the transport paths/aisles/corridors in the order-picking area where the presence of people, vehicles, goods and equipment is very significant; WMS using AGV system provides elimination of order-picker's work related to movement to the OPF and driving to the disposal place of pallet unit when the order is completed.

4. POTENCIAL EFFECTS BASED ON APPLIANCE OF REMOTE CONTROLLED OPF

The influence of the presented technology on time reduction of the elementary activities of the order-picker (see Section 2) is shown in Table 4.1. Thereby, the estimations are given by authors, compared to the conventional technology.

Table 4.1 Level of the applied technologies' influence on the time reduction of the realization of the order-picker's elementary activities

	Technology	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9
1	3.1.a	○	+++	+	++	+++	+	-	++	○
2	3.1.b	○	+++	++	++	+++	+	○	++	○
3	3.2	○	+++	+++	+++	+++	+	+	+++	○

Legend: - unfavorable influence; ○ no influence; + small influence; ++ medium influence; +++ great influence

The available sources from companies-producers are used since, according to our knowledge, there are no expert papers which have explicitly analyzed this technology and potential effects of its appliance. By analyzing the available sources of several producers (Still, Crown, Toyota (BT)) potential effects which might result can be classified in several groups:

Time savings are mentioned as primary achieved effect – according to the data published in companies' materials, time of order-picker's movements is reduced up to 70 percent by the elimination of the range of the unnecessary movements, orders for the OPF operations etc.;

The reduction of the traveled path of order-picker with load – which results with less workload of order-picker, and thereby with the increase of the quality level of the basic processes realization;

The decrease of potential injuries and professional diseases – by the reduction of stepping on/off OPF at picking locations, effects can be expected in the decrease of workers' injuries/diseases, having in mind the extent of these activities during work (i.e. for several years);

Preconditions for working environment with higher order-picking density are achieved – in paths/aisles/corridors of order-picking area, it is possible for more order-pickers to work at the same time with OPF; the risk of injuries of workers and/or goods and equipment damage (due to activity density) are being reduced/eliminated by applying OPF equipment mentioned in previous Section;

Flexibility – when required, it is simple to move from semi-automatic/automatic to manual control of OPF;

Cost-effectiveness – The increase of the productivity and the decrease of the energy consumption have influence on cost-effectiveness and ROI to this technology can be expected in relatively short time period.

In less extent, some of described technology appliances can be met in praxis. Most of them outline general positive impressions and conclusions which imply to the favorable results/effects of the appliance that cannot be presented in this work due to limitations.

5. CONCLUSION

By analyzing presented technologies, it can be concluded that these are new solutions without significant experiences in praxis. Mentioned manufacturers state their observations, especially the ones referring to the range of favorable effects. It is clear that these states should pass theoretical and practical audits, having in mind series of specificities related to realistic tasks of order-picking, staff educations, appropriate information system support and others. However, potential effects of this technology are very interesting for warehouse system designers and it is required to have these technologies in mind when developing alternative technological concepts of order-picking subsystem(s). Therefore, it is necessary to perform series of research in this area, which can be related to the theoretical as well as to the practical aspects. Some of them might refer to the work and time studies in different environment/conditions (type of goods, orders' patterns, path conditions, etc.), the analysis of the specific strategies for goods assignment appliance, the use of additional devices and equipment on OPF and etc. That way, the more qualitative bases for decision-making in logistics' system design would be acquired, and through them, support for more qualitative level of supply chain solution.

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