INNOVATIVE TECHNOLOGIES SUPPORTING WAREHOUSE PROCESSES

[1]Ewa KULIŃSKA, [1]Ryszard BUDZIK, [2]Karolina KULIŃSKA

[1]Technical University of Opole, Faculty on Production Engineering and Logistics, Opole, Poland, EU
[2]University of Wroclaw, Faculty of Law, Administration and Economics, Wroclaw, Poland, EU

Abstract

The aim of the article is to analyze the implementation costs of innovative technologies supporting warehouse processes and to show their impact on the improvement of warehouse processes in the area of order picking. The research focused on a sample costs simulation of the following systems: Pick-by-Light, Pick-by-Point, Pick-by-Frame, Pick-by-Voice, Pick-Radar, whose cost depends mainly on the type of warehouse in which the system is to be used and on the number of employees operating the equipment. The presented systems can also be integrated with each other, further optimizing the picking process in warehouses.

Keywords: Innovations, warehouse, order picking, implementation costs

1. INTRODUCTION

Innovativeness is a very important factor in the competitiveness of a company. By introducing various innovations, companies can now gain a significant advantage in the market. In Poland, the level of innovativeness in businesses is low compared to other European countries, which is caused by a number of difficulties related to the implementation of innovations occurring inside the company or in its environment. Examples of such obstacles include the high costs of innovation which the company is unable to obtain from its own financial resources. Other factors are the lack of guarantees for the demand for innovative products, the lack of qualified employees, as well as the high interest rates on loans. In order for businesses in Poland to achieve a competitive advantage on the domestic and international market, they must first acquire and implement innovations [9].

The Research and Development Center for Logistic Systems operates at the Faculty of Production and Logistics Engineering thanks to the cooperation with one of the most innovative manufacturers of systems supporting order-picking processes, Luca Logistics Solutions. The laboratory offers the possibility of conducting research on modern order-picking systems, such as: Pick-by-Watch, Pick-by-Frame, Pick-by-Light, Pick-by-Point, Pick-by-Voice, Pick-Radar, and Mobile Pick-by-Light. [3,4]

Previous research has shown that employees of even the most complex warehouses - without any training, even seasonal - receive clear guidelines as to how to accurately track a product, retrieve it in the right quantity, and pass it on in the right direction. Depending on the warehouse, a number of devices guide the employee: from the simplest ones (such as colored diodes indicating the destination of goods), through voice commands in the headphones (offered the company in any language), to futuristic innovations (interactive glasses using virtual reality, with the arrow displayed above the appropriate container). Each of the systems provides a convenient and time-saving way of work, in which anything from a wrist scanner, voice or even a hand gesture can be used to pick selected products. Not without significance is the fact that time saving means better economic performance of the entire company. The largest market players confirm that Luca systems are, put simply, a viable investment.

Each device in the system, perhaps apart from a few-meter-long infrared curtain, is a small appliance whose principal function is always to respond to individual customer demand, for which Luka developers can design a dedicated system. Sophisticated vests, watches and interactive glasses are used to pick orders in several

hundred companies, among them: 3M, ABB, Danfoss, Daimler Crysler, DHL, Deutsche Post, Fiat Chrysler Automobiles, GlaxoSmithKline, GM, Iveco, Opel, Seat, Skoda, and Volkswagen. [4]

A question arises as to where exactly the innovativeness of the abovementioned order-picking systems springs from. To begin with, order picking is a two-stage process that occurs during the process of storage. At the time of admitting the transport unit to the warehouse, it can be separated into individual units and placed in the warehouse. However, during the release process, it is often necessary to create a new transport unit that is compatible with the order placed by the warehouse client. [1,6,7] In the traditional warehouse, the order-picking process is carried out using paper documentation, possibly replaced by a PDA terminal, which provides information on which goods, and in what quantity, should be released to a specific transport unit.

A disadvantage of this solution is the fact it is time-consuming and carries the high likelihood of human error in the process of order releasing. To reduce mistakes consisting in the incorrect release of goods, one of the modern order-picking systems can be used to perform tasks in the warehouse. In order to be fully operative, the system must be integrated with the WMS system which is used in the warehouse.

Each of these systems has a different design and serves a different purpose, although their common feature is the ease of use and simplicity of operation. However, despite the simple mode of operation, each of the system requires the employees to learn the basics of its functioning, so that the tasks in the warehouse are carried out efficiently and the order-picking system is utilized at full capacity.

The aim of the article is to analyze the cost-effectiveness of implementation of the aforementioned technologies supporting warehouse processes and to present the main advantages of systems improving business operation and mitigating errors made in the process of order picking.

2. A REVIEW OF WAREHOUSE PICKING SYSTEMS

2.1. Pick-by-voice

Pick-by-Voice is a system that uses the voice-picking technology, in which the employee's voice is compared to that previously stored in the device's memory. Before the employee starts work, they must be recognized by the device through their voice, which is done by recording the commands used at work. To improve these devices even more, the German topSPEECHLydia system, which recognizes speech in many languages, is used. Therefore, language training is not necessary, which greatly facilitates employment of seasonal and temporary workers. Further increasing the convenience for the employees, the system provides instructions in a natural voice.

The operation of the Pick-by-Voice solution relies on the communication of the company's WMS with the employee by means of online-based hearing and speech. The voice management system assigns tasks to the employees in the warehouse. By means of voice commands, it informs in detail which goods, from which place and in what quantity should be retrieved according to the client's order. In turn, the employee confirms by voice the performance of such action. The biggest advantage of the Pick-by-Voice system is the fact of having a headset and voice terminals [4], which enable the employee to have a hands-free conversation with the computer at all times. This is to reduce the likelihood of human error. Having their hands free, employees may also perform other picking activities such as driving a forklift or moving large items. The Pick-by-Voice system is very popular in warehouses using forklifts for transportation. In the Pick-by-Voice technology, it is not required to install the system in the warehouse or cabling on the shelves, as it is a mobile solution that can be freely and easily moved between locations. [5]

2.2. Pick-by-Light

Another system is Pick-by-Light, in which the communication between the person employed in the picking area and the IT system consists in mounting lamps and displays on the storage racks. The displays are connected

without any wiring in a tool-free manner. Data and power are transmitted via a strip on which the modules are located. Each of the displays has a unique address which results in the same tasks being performed anywhere on the transmission bar. [3]

The Pick-by-Light solution signals to the employee the place from which to collect the product using a signal lamp to that effect. The system is installed so that each container on the rack corresponds exactly to one display below. Upon collecting the item, the operator confirms this fact using the acknowledge button. In turn, the system automatically lights the next lamp while saving changes in the inventory in real time. When picking a large order, the use of this technology enables several people to work simultaneously without interfering with each other. This is possible thanks to the optimal arrangement of routes by the WMS. The use of Pick-by-Light systems is very extended and it is not targeted at any businesses in particular.

2.3. Pick-by-Point

The next solution is the Pick-by-Point system, whose principle of operation consists in highlighting the appropriate storage location from which the item should be retrieved. This is done using a beam of light of any color or shape, to which end a movable and easy-to-configure light source is used. The Pick-by-Point system combines the previously known modern storage technologies such as Pick-by-Light and Pick-by-Point. This means that information about the quantity and exact location of the goods collected by the employee is transmitted by means of traffic lights and sound signals. This system also allows to gather information on possible errors in retrieving ordered items for the client, as well as to indicate the error in picking to the employee. [3]

The most important advantage of this solution is the possibility of picking goods regardless of their diversity and quantity, and hence, the reduction of costs incurred by the company which are increased by errors of employees issuing goods by traditional means. Furthermore, the system is easy to both install and take off, as the lamps are placed on trade traverses and then connected to the electrical system. At this point, only the equipment needs to be calibrated for proper functioning.

2.4. Pick-by-Frame

Moving on, there is the Pick-by-Frame solution. The operation of this technology consists in mounting a self-supporting frame with modules on a standard order-picking trolley.

The frame connects with the trolley using a magnetic field that makes it possible to easily disconnect these two elements from one another by simply pressing the right button. They can also be connected mechanically.

Diode lamps and a display are mounted on the frame that is placed on the picking trolley. The diode lamps show the employee where to collect the goods from, whereas the quantity, storage location and other necessary information are provided on the display. Modules with LEDs can be placed either below or above the containers from which the employee is to retrieve the product and on the picking cart where this product should be put down. Additionally, the employee is to confirm each collection using the acknowledge button or barcode reader. The system has been programmed so that the person employed can prepare a set of parts needed for the production of several goods during the same journey [2].

The innovative solution offered by the Pick-by-Frame technology allows to utilize well the capital invested in technology, given that picking trolleys are often unused while waiting for the shipment of orders placed on them. In the Pick-by-Frame solution, the trolley awaits shipping while the frame is being used for the next picking.

2.5. Pick-Radar

Pick-Radar is yet another technology supporting warehouse processes, whose method of operation is based on the control of the space and areas in front of the place of goods collection by the employee, that is, in front

of racks or pallet ranks. A light curtain supported by specialized software is used to this end. The software processes the image, which enables the control of inserting the product into the storage slot by the employee. The system automatically confirms the collection only if it has been error-free. [3]

If the employee attempts to retrieve the product from the wrong slot, an alarm will sound off and the incident will be saved in the system.

3. METHODS AND RESULTS

The research consisted in analyzing the time of the operation of issuing five products from the warehouse using, first, the traditional method, and then, the Pick-by-radar solution. The test was carried out at the Research and Development Center for Logistic Systems of the Opole University of Technology, where all of the abovementioned picking systems can be tested.

Table 1 Measurement results for tests conducted using the Pick-by-radar system

Action	Time required to collect product from the deposition area [s]	Time required to place product in the picking area [s]
Product A	88.31	2.54
Product B	22.82	1.56
Product C	5.19	1.21
Product D	12.41	6.12
Product E	71.88	8.41
	∑= 200.61	∑= 22.40

The research was to determine the time of fulfillment of orders for a total of five products retrieved from the warehouse, which consisted of two types of tasks:

1) Tasks performed using the Pick-by-radar system,
2) Tasks performed using the traditional paper documentation and without using the Pick-by-radar system.

In both cases, the same products were being released, and the only difference was the way the task was performed. **Table 1** list the obtained task implementation times for the option using the Pick-by-radar picking system.

Table 2 Measurement results for the second option

Action	Time required to collect product from the deposition area [s]	Time required to place product in the picking area [s]
Product A	138.64	3.55
Product B	72.88	2.56
Product C	95.77	2.57
Product D	144.12	8.58
Product E	139.90	10.77
	∑= 591.31	∑= 28.03

Similarly, measurements were made for traditional order picking. In the traditional method, the process of collecting goods, in addition to quantitative and qualitative control, also included filling out the required documentation. **Table 2** shows the results obtained.

Subsequently, a comparison was made of the fulfillment times of individual orders using the two methods. As shown in **Tables 1** and **2** above, the traditional method requires a lot of time to complete the same tasks. The difference can be observed for each action of collection, while the times of placing products in the picking zone are similar, which confirms that the picking of goods from the warehouse is the most significant in terms of the time required for the entire operation. Similar research results can be found in [6,7], where other order-picking systems were tested.

The test results clearly show the effectiveness of the discussed order-picking systems, which raises a question of the estimated costs of their implementation.

4. COST-BENEFIT ANALYSIS

The research used a sample costs simulation of selected systems. The cost of introducing a given system into the warehouse consists of three components: software cost, equipment cost, and the cost of installation, implementation, training and licenses.

Table 3 Implementation costs of individual systems (Source: own study in [3])

System	Equipment	Number of employees	Cost estimate
Pick-by-Light	50 displays + software + installation	10	40 000 EUR
Pick-by-Voice	10 Pick-by-Voice sets + software + installation	10	65 000 EUR
Pick-by-Point + Pick-Radar	Pick-by-Point and Pick-Radar set adapted to 10 employees + software + installation	10	60 000 EUR
Pick-by-Frame	10 double-sided carts (50 seats) + 10 frames + additional equipment + software for 10 frames + installation	10	100 000 EUR

As shown in **Table 3**. Pick-by-Light is the most economic from among the presented solutions, with an approximate cost of 40 000 EUR. In this system, displays are mounted on shelves and used by each of 10 employees. Pick-by-voice is more costly when used by 10 employees because every employee must be equipped with a separate headset and voice terminal.

When combined, the joint cost of the Pick-by-Point and Pick-Radar systems is approximately 60 000 EUR, which is obviously a less desired solution for small warehouses. The productivity and profitability of these systems is higher when the frequency of picking is also high and the picking line is very long.

Pick-by-Frame is the most expensive system, costing approximately 100 000 EUR at 10 employees. In this case, similarly to Pick-by-Voice, one set is operated by one employee.

The cost of each of the systems depends on the issue that impedes the work process in the picking area. The system is chosen individually so as to meet the client's needs, the reason for which the above list shows only guesstimated costs of implementing the individual systems.

5. CONCLUSION

The research demonstrates that the traditional method based on paper documentation requires the employee to dedicate a much longer period of time than the method in which a modern order-picking system, such as Pick-by-radar, is used. By applying an IT solution, the task fulfillment time has been reduced from 619.34 [s] to 223.01 [s], which reduces the overall time of operations by 73 %. The traditional method is a much less efficient method due to the necessity to fill out paper documentation, which requires a considerable amount of time. The use of the order-picking system, and the associated automatic and immediate data entry into the

system, enables a significant reduction of work time per task. The saved time can be used for the fulfillment of subsequent warehouse tasks, which significantly improves the efficiency of the entire warehouse. An additional advantage of using IT solutions is the fact they almost entirely eliminate errors, which often occur when filling out paper documentation.

One of the most important factors affecting the level of customer satisfaction is fast and efficient order implementation. Human error in order picking may significantly hinder the meeting of this condition, therefore companies are increasingly implementing logistics systems to streamline warehouse processes and eliminate mistakes made by employees. In addition, the systems discussed above can be integrated with each other, which can lead to an even faster and less error-free completion of orders in warehouses. The most common joint usage concerns the system Pick-Radar with either Pick-by-Voice, Pick-by-Radar or Pick-by-Point. However, implementation of these logistics systems in warehouses is not a "shelf product". Thus, for a specific system to be utilized in a given warehouse, it is necessary to conduct prior technical analyses and tests in a specific environment, approaching each project on an individual basis.

ACKNOWLEDGEMENTS

The authors would like to thank Luca Logistic Solutions for the cooperation.

REFERENCES

[1] BARTONICZUK B., Transport wewnętrzny i magazynowanie [Internal transportation and warehousing], „Nowoczesne hale” No. 4/14.

[2] HALUSIAK S., Nowoczesne rozwiązania w logistyce [Modern solutions in logistics], Academic Journal No. 10/2011.

[3] http://www.luca.eu/images/stories/pbl/module_pl.jpg.

[4] Warehouse Processes Improvement by Pick by Voice Technology, Tehnicki vjesnik - Technical Gazette, 8/2018, Vol.25(4).

[5] Tehnicki vjesnik - Technical Gazette, 8/2018, Vol.25(4)

[6] JURCZAK M., W świetle głosu [In the light of voice], „ABC Magazyniera”, No. 3/2016, p. 44

[7] KLECHA M., Szybciej, dokładniej, wydajniej [Faster, more accurately, more efficiently], „Magazynowanie i dystrybucja” 4/2012.

[8] SOBCZAK P., Analiza efektywności systemu Pick by light [The analysis of the efficiency of the Pick-by-light system], Logistyka 4/2014, pp. 1214-1221

[9] TREBILCOCK B., Cisco's warehouse of the future, Modern Materials Handling, Jun 2015, Vol.70(6), pp.24-28.