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Designing Order Picking System Efficiency by Combining Four Planning Problems and its Influence on Picker Blocking with RFID

D. Kharisma ; M. Hartono **All Authors**

Abstract: Customers receive services that require a lot of labor from warehouse. High cost and unmet demand from customers could be the outcome of underperformance. In order to han... **View more**

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Abstract:
Customers receive services that require a lot of labor from warehouse. High cost and unmet demand from customers could be the outcome of underperformance. In order to handle this, order picking procedures must be streamlined by finding solutions to a variety of planning issues. A bad overall warehouse performance may result from progressively optimizing order picking planning challenges. This literature review is investigating combinations of various order picking planning issues and their impact on picker blocking that affects the length of time it takes for pickers to con… ased technologies like RF… ation of this technologies car… finding the best tec…

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Order picking is one of the most significant procedures that consumes the most energy and expenditures, accounting for around 60% of all labor activities in the warehouse and 55% of operational costs. [1]. In order to increase efficiency and reduce warehouse expenses, several businesses are implementing effective order picking designs [2] [3]. Efficiency gains in order picking will indirectly result in better warehouse services, which will enhance performance across the entire supply chain [1]

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Designing order picking system efficiency by combining four planning problems and its influence on picker blocking with RFID

D.Kharisma, M. Hartono
Department of Industrial Engineering, University of Surabaya, Surabaya, Indonesia
Email : markus@staff.ubaya.ac.id

Abstract – **Customers receive services that require a lot of labor from warehouse. High cost and unmet demand from customers could be the outcome of underperformance. In order to handle this, order picking procedures must be streamlined by finding solutions to a variety of planning issues. A bad overall warehouse performance may result from progressively optimizing order picking planning challenges. This literature review is investigating combinations of various order picking planning issues and and their impact on picker blocking that affects the length of time it takes for pickers to complete a customer order. To automate the search for items in storage in warehouses, IOT-based technologies like RFID can be used in order picking planning. RFID can improve traceability of products. Aplication of this technologies can support development of effective order-picking systems and enhance customer service by finding the best technological and policy combinations.**

Keywords – **Order picking, Technologies, RFID**

I. INTRODUCTION

Order picking is one of the most significant procedures that consumes the most energy and expenditures, accounting for around 60% of all labor activities in the warehouse and 55% of operational costs. [1]. In order to increase efficiency and reduce warehouse expenses, several businesses are implementing effective order picking designs [2][3]. Efficiency gains in order picking will indirectly result in better warehouse services, which will enhance performance across the entire supply chain [1]

A very important and challenging issue, according to van Gils et al. (2019), is managing an effective and efficient order picking system. Travel distance is one of the many parameters that must be adjusted when selecting a pick-up route to shorten the time necessary for order service. Aisle congestion, which can happen when several pickers are assigned to the same location at once and decrease order fulfillment efficiency while lengthening wait times, is rarely included in the selecting routing algorithms that are currently in use. According to F. Chen et al., 2016 and Franzke et al., 2017, the order picking process is also influenced by a number of other parameters, including order grouping, picking zone, order consolidation, sorting, labor level, assignment zone, storage location, and picker allocation and assignment [4].

In a number of earlier studies, order-taking robots were also utilized in the design of order picking to boost efficiency, but in actuality, manual picking systems by pickers are still more prevalent [5]. According to van Gils et al. (2019), automatic order picking systems utilizing robots still need to incorporate the manual pickers' function in the system so that they may interface with the machines [6]. This contributes to the system's comparatively high initial investment costs. Order picking system design has improved as a result of the usage of technology in the warehouse. Bar coding, radio frequency communication (RF), and warehouse management systems (WMS) are examples of technology that can assist improve warehouse operations and regulate automation processes in real-world settings. [7]

Order picking research has been conducted to investigate issues that affect the picking system by creating new models and applications of IoT-based technologies such as RFID that close the gap between real-world application and academic study. This review of the literature tries to outline some of the systematic issues with order picking, picker blocking, and the use of technology to improve order picking system efficiency in order to automation order picking system to finding the best combination planning problem to reduce picker blocking that affect to order picking total travel time.

II. BRIEF LITERATURE REVIEW

A. Order Picking

Marchet et al., 2015 describe that there are four main factors that determine the classification of an order picking system: who picks up the goods—a human or a machine—who goes through the picking area—pickers or goods—whether each picking zone is connected by a conveyor, and the picking policy that has been created. According to Fig.1 Order picking systems are classified as picker to part, picker to box, pick and sort, picker to picker, and automated picking. [9].

B. Operational Planning Problems

To build a successful order picking system, four operational planning issues must be resolved, as shown in Table 1. Regardless of the fact that layout and other strategic decisions can have a substantial influence on performance[10]. Order picking efficiency is calculated using the setup time, search and pick time, trip time, and

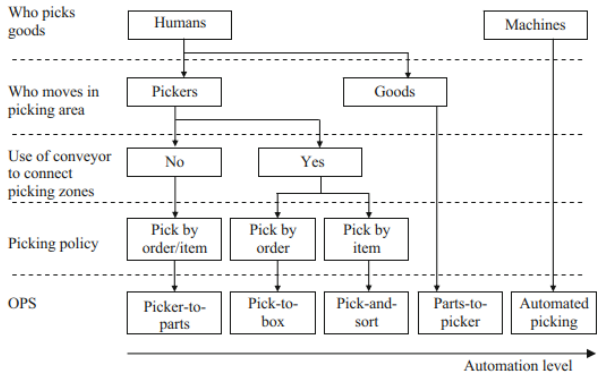

Fig. 1. Classification of order picking systems (Dallari et al., 2009)

wait time that make up total order picking time [11]. The number of aisles that a picker can travel in during each pick round is restricted, As a result of splitting the order picking region into zones, the covered area of order pickers during a pick cycle is reduced, resulting in shorter trip times. [12].

There are several affecting aspects when arranging order picking, of course. Batching, zoning, routing, and storage location are just a few of the components that have been combined based on prior research to improve order picking systems [4].

Storage location assignment policies govern how SKUs are assigned to storage facilities within a zone. [5]. When various storage classes are allocated to a pick aisle, the fast-moving products are stored at the storage sites with the shortest travel distance beginning at the aisle entry.

According to the order grouping strategy, which decides which consumer orders should be taken in one round of collection, batching is the process of deciding which orders should be taken together [13]. To achieve picking efficiency in this case, batching must balance picking effort across zones.

The zoning policy, which governs how the picking area is divided into zones, determines the flow of client orders through each order picking zone. The benefit of zoning is that each picker only needs to travel a smaller area, which can assist alleviate aisle traffic congestion, and

TABLE 1.
DEFINITION OF THE FOUR PRIMARY ORDER PICKING PLANNING ISSUES (van Gils, Ramaekers, Caris, et al., 2018)

	Description
Zoning	Zoning laws determine how to split an area into zones and where each zone should be located. Each order picker is assigned a single zone. In small aisle high level picking systems, parallel zoning is more beneficial than sequential zoning.
Storage	The regulations for assigning storage locations to SKUs spell out the procedures. The distribution of order pickup areas for swiftly moving SKUs is governed by storage location assignment.
Batching	Order batching procedures define how to mix client orders in a single pick cycle.
Routing	The order of storage facilities must be visited during each pick round in order to acquire every item on a pick list is specified by routing regulations.

pickers are better familiar with the locations of commodities in their zone [2].

The routing policy determines the order of the locations on a choose list once the batching technique has produced it. The picker must visit each storage location in turn, according to the routing rules, to obtain all needed commodities on the picking list. [15].

C. Picker Blocking

Wait times are unavoidable when many order pickers operate concurrently in the same order picking area because they may clash when picking in the same location of the order picking system.. [16]. Picker blocking causes order pickers to become idle, lengthening the overall order picking period [17]. Picker blocking occurs when a picker is unable to reach a storage rack due to another picker removing items from that rack (storage-rack blocking) or when a picker is unable to pass in an aisle (blocking inside or in the aisle).

The pick and search time at each place visited, the transit time, and the wait time due to picker blockage make up the overall order pick time. Wait times are determined for each narrow pick aisle by combining within-aisle blocking, storage-rack blocking, and aisle entry blocking. [5].

As shown at Table 2, in recent literature, four order picking planning challenges have received the majority of the attention in an effort to combine planning problems and increase order picking efficiency. The efficiency of the policies for assigning storage locations has a substantial impact on wait times depending on the number of zones. Picker zoning rules spread pickers around the order picking area by assigning them to a single pick zone, whereas storage site assignment policies increase pick density in a confined region, increasing the risk of picker blockage. By increasing the number of zones and decreasing the size of each zone, the chance that all aisles within a zone will be visited during a pick round increases, lowering the negative impact of traffic rules on travel [4].

D. Radio Frequency Identification (RFID)

RFID has developed as a critical technology for increasing efficiency and effectiveness in manufacturing, logistics, and supply chain management. FID can electronically identify, categorize, and govern the flow of objects and information along the supply chain, reducing human error. It is feasible to store and retrieve data about an object's position, condition, and history in real time, which improves decision-making visibility[18].

Four components make up a whole RFID system: a reader, a tag (also called a responder), an antenna, and an

TABLE II. OVERVIEW OF THE REVIEWED ARTICLES

	Planning problems				Picker
	Z	S	B	R	Blocking
(Petersen & Aase, 2004)		√	√	√	
(Hsieh & Tsai, 2006)		√	√		
(Ho & Tseng, 2006)		√	√		
(Manzini et al., 2007)		√		√	
(Parikh & Meller, 2009)		√			√
(Ho et al., 2008)		√	√		
(Yu & de Koster, 2009)	√		√		
(Theys et al., 2010)			√	√	
(C. M. Chen et al., 2010)		√	√	√	
(Pan & Wu, 2012)		√		√	
(Hong et al., 2012)			√		√
(Chackelson et al., 2013)			√	√	
(Pan et al., 2014)		√		√	
(Shqair et al., 2014)		√		√	
(Zhang, 2016)			√		
(Lin et al., 2016)			√	√	
(Hong et al., 2016)	√				
(F. Chen et al., 2016)				√	
(Li et al., 2017)			√	√	
(Quader & Castillo-Villar, 2018)	√	√		√	
(Dijkstra & Roodbergen, 2017)		√		√	
(Franzke et al., 2017)		√		√	√
(Wang et al., 2017)			√		
(Valle et al., 2017)			√	√	
(Scholz et al., 2017)			√	√	
(Scholz & Wäscher, 2017)		√	√		
(Matusiak et al., 2017)			√		
(Hong & Kim, 2017)		√	√		
(Bahrami et al., 2017)		√	√	√	√
(F. Chen et al., 2018)			√	√	
(van Gils, Ramaekers, Caris, et al., 2018)	√	√	√	√	
(Van Gils et al., 2019)		√		√	√

Z = zoning *S = Storage* *B = Batching* *R = Routing*

system of application software. Its operating principle is as follows: The reader transmits radio wave energy at a certain frequency to the receiver, allowing the reception circuit to transmit data within. After receiving and reading the data in sequence, the reader then receives, reads, and passes it to the application software for suitable processing. The induced current will be produced as the target object of the tag enters the working area of the transmitting antenna after the Reader transmits radio frequency signals at specific frequencies through the transmitting antenna, and then, relying on the energy obtained by the induced current, the tag actively transmits the product information stored in the chip, according to the basic work flow of an RFID.

TABLE III. MAIN EFFECT OF ORDER PICKING PLANNING PROBLEMS

	Travel time	Picker Blocking
Zoning	↓	↓
Storage	↓	↑
Batching	↓	↓
Routing	↓	↑

(van Gils et al., 2019)

system. After demodulating and decoding the carrier wave signal received from the tag to the receiving antenna, the reader transfers the information to the data management system for appropriate processing. Through logical operation, the data management system assesses the tag's authenticity, processes and regulates suitably in accordance with the different settings, and then sends out a command signal to control the actuator's function [19].

III. DISCUSSION

The findings of this literature review highlight how crucial it is to combine numerous order picking planning challenges in order to handle order picking activities efficiently. According to the findings of the literature research, the time horizon of the decisions that are made has a significant impact on the method that should be used to solve mixed order picking planning problems. The main impact of each planning issue on order picking efficiency is related to picker blocking and total travel time. Based on a number of earlier investigations, see the Table II, Numerous studies have linked the four planning issues and picker blocking in order to reduce overall travel time. Smaller covered regions of order pickers result in shorter travel times during a pick round, which is done by splitting the order picking region into zones: During each pick round, a picker is only permitted to move through a certain number of aisles. Additionally, when zoning restricts the order picking area that pickers can cover during a pick round, wait times caused by picker blockage decrease. Assigning SKUs to storage locations at random would increase the risk of picker blocking, although storage location assignment regulations seek to save travel by combining rapidly moving SKUs into a limited order picking region, resulting in high pick density in some locations. Order batching combines comparable orders in a pick round in an effort to reduce travel as shown at Table III. Because there is a limited amount of covered space in a pick round, efficient batches include storage sites that are close to one another. This reduces picker blocking. By arranging the order lines (and ensuing storage sites) inside each batch in a specific order, routing policies seek to minimize travel Despite the fact that sequences may be the most practical in terms of travel, these routing procedures are subject to stricter traffic laws to reduce the likelihood of different order pickers' routes intersecting. Longer wait times are the result of stricter traffic regulations, which are reflected as a lower permitted number of pickers per aisle.

IoT-based technologies such as RFID can be used as alternative to automate product search in storage, where mileage can already be estimated, to reduce overall journey time and picker blockage. A RFID reader can simultaneously scan multiple RFID labels. RFID. Utilizing RFID technology can assist with order picking planning so

that pickers can take items out of storage areas with open paths and minimize picker blocking concerns.

Warehouse managers can use the results of analytical and simulation models as a decision-support tool to design successful order picking systems that take into account the linkages between order picking planning difficulties..

The bulk of tactical and operational order choosing planning combinations have gotten little attention from study. Articles in this review, on the other hand, have proven the need of integrating these planning difficulties in order to improve order choosing performance..

IV. CONCLUSION

A variety of factors influence order selecting system planning like planning issues. According to earlier studies, zoning, storage, batching, and routing have a substantial influence on picker blockage and the overall travel time of pickers. In these studies, a variety of planning problem combinations have been simulated in order to optimize the order picking system, but a variety of technologies, such as the use of RFID tags, have not been combined to help with the process of looking for goods by automating distances and definite routes for pickers.

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