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Warehouse Management System for Smart Digital Order Picking Systems

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***Abstract*—The purpose of this paper is to identify problems in the identification picking process that lead to consumer dissatisfaction and provide solutions to the issues that exist in the company, especially in warehousing, supported by analysis of the running system to obtain the information needed. The decision-making system used to be able to produce reports regarding picking orders in adjusting the number of requests, availability of pickers and distribution to consumers. The research method uses the PIECES analysis and technology acceptance model method to determine the user's acceptance of the system builded. The smart digital order picking system was able to significantly accelerate the order picking business process from the ones that previously took a long time after implementation could meet consumer needs quickly.**

***Index Terms*— digital picking, order picking, warehouse management system.**

I. INTRODUCTION

The article from www.gooto.com stated that "PT Wahana Makmur Sejati, the primary dealer of Honda motorcycles in Jakarta and Tangerang which is also a subsidiary of Wahana Artha Group, throughout 2018 to April achieved sales of 127,000 units, an increase of about 5 percent compared to the period the same as last year ". From the pieces of the article, it can be concluded that the sales of Honda motorcycles increased at the beginning of 2018. With the increase in sales of Honda motorcycles also had an impact on the sale of Honda Genuine Part spare parts. And based on the article, too, throughout 2018 from January to April, sales of spare parts reached IDR 143 billion.

Availability of Honda motorcycle spare parts at PT. WMS is very influential for dealers and AHASS (in the warehouse system of PT WMS, dealers and AHASS referred to as dealers) because of dealers or AHASS as consumers of PT. WMS will undoubtedly supply their goods from PT. WMS to be sold to consumers. With many consumers providing, then ordering spare parts to PT. WMS will be even higher. With this, it will also affect the spare part warehouse management of PT. WMS located in Cimanggis or more precisely on Jl. Tapos Depok. In this four-story warehouse, it is capable of storing up to 456,000 spare parts to supply orders for up to 350 dealers.

Like the warehousing management system in general, PT. WMS performs five main activities, namely receiving (a receipt of goods), storing (storing goods by following the shelf), order picking (taking products based on requests), order packing (packing goods based on size), and shipping (shipping). Order picking is the most costly activity in warehousing and can reach 55% of the total cost of warehousing operations, so it is considered a top priority in increasing productivity (Tompkins, White, Bozer, & Tanchoco, 2010). That way, the order picking process must maximize existing resources and technology to be able to reduce costs and speed up the process of taking goods. But in the warehouse of PT. WMS, the condition of order picking still uses steps that require a long time and relatively high costs. The amount of time needed for the picking order process is due to the many steps in the process of preparing the pecking order so that many orders that are not picked-up which result in the fulfillment of orders to consumers, become longer. As in Fig.1, many picking lists are canceled rather than done. That is, due to limited working time and also due to the preparation process of the old picking list document. And also, the process of validating the picking list by sorters to cut stock in the system using only two computers, which resulted in a picking list queue that had been done by the picker and made the sorter sometimes overtime to do it.

In Fig.2, every day, the picking list is an average of 500-600 picking lists. And all the picking lists are printed then the document is grouped according to the location of the picker and distributed to the picker for the collection of the items.

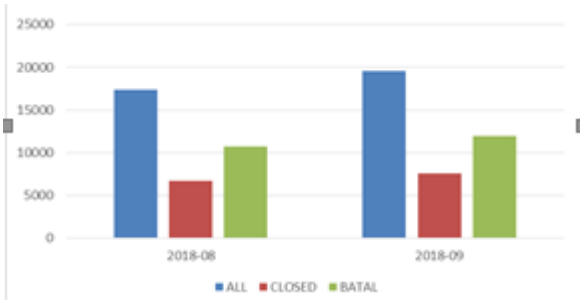

Fig.1. Picking Amount in August and September (Source: PT WMS data)

The printed picking list document only used until the picker is sorted and collected, and after that, the report not reused, which results in a buildup of paper every day.

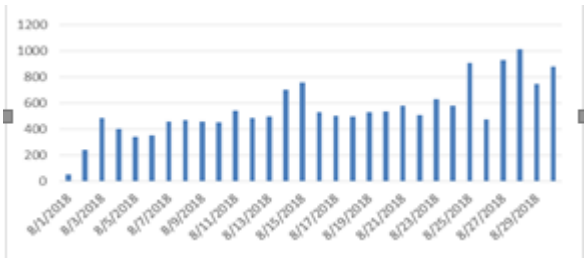

Fig.2. Picking amount per day

And from the process that is currently running, the warehouse head also has difficulty measuring the picker's performance. This is because the order picking process only uses paper-based documents, so the picker time is not visible and recorded.

From such conditions, the author will analyze and develop a system of order picking spare parts in the warehouse of PT. WMS can optimize the order picking process so that the warehouse outbound process not hampered.

II. THEORY

A. Warehouse Management System

Warehouse Management System (WMS) or warehouse management system (A, N. Subramanya, & M. Rangaswamy, 2012) aims to control the movement and storage of materials in the warehouse and process related transactions, including shipping, receiving, cancellation, and retrieval of goods. A warehouse management system (WMS) is a database-based computer application, to improve warehouse efficiency by directing cutaways and for maintaining accurate inventory by recording warehouse transactions. The system also directs and optimizes stock based on real-time information. After data is collected, there is batch synchronization with or real-time wireless transmission to the central database. The database can then provide useless reports about the status of goods in the warehouse.

B. Order Picking

Order picking defined as the process of retrieving the right number of products from a specified storage location to fulfill customer orders. The entire pick area can be divided into picking zones so that each picker dedicated to selecting items only in their respective zones (Jane & Laih, 2005). This order picking process is an everyday activity in the warehouse. A recent study in the United Kingdom revealed that 63 percent of all operating costs in a warehouse could be linked to the order taking a process (Frazelle, 2002).

C. Previous Research

Research [Atoilah et al.] [Hannes et al.] [Gaspar et al.] used android as a means of recording goods. Their research results produce a mobile system that can reduce the difficulties of warehouse workers in carrying out their duties, such as filing products and monitoring products in real-time. This mobile system can overcome the challenges of warehouse workers in carrying out their tasks such as recording goods and monitoring products in real-time. An Android information system that has designed to be able to log goods in and out and monitor the expenditure and receipts and inventory of products in the company.

This study correlates with Gaspar's research regarding business processes in the warehouse. However, the study discusses all the business processes of dispensing goods from the storage rack related to the transfer of goods and taking orders, while this research only focused on taking orders (see fig3). As well as in consideration of the device, which research uses a PDA or Personal Digital Assistant, which is a Mini Personal Computer that can be carried everywhere. However, the PDA is a reasonably expensive device of approximately 7-9 million, and this considered by management. Therefore, the solution so that the price is more affordable is to use a mobile device that is a tablet or smartphone.

Fig 3. The picker takes the order

III. Result and Discussion

PIECES analysis was carried out in 2 stages, beginning and at the end of the study. In the beginning, the PIECES analysis study was carried out as follows:

Analysis of	Current condition
Performance	-Presentation of information needed requires a long time because it must first download the outstanding picking list, then print it and must group the document picking list based on the floor. This process takes approximately 24 minutes. -Submission of picking list documents to pickers counts for two minutes because of the location of the administrative office with a warehouse area of around 200m. -When collecting items by sorter and sorter, do a validation picking list using a PC, and it takes 2 minutes to validate one picking list number. -The picker's performance hampered due to the process of preparing a picking list document that takes 26 minutes, which results in the picker having to wait to start the job. -In the morning, there is no sorter work because you have to wait for the picker to start his job. -The number of picking lists was canceled because of limited working time
Information	-Submission of picking list documents to pickers on each floor is often confused with other levels because they still grouped manually so that the information delivered is irrelevant. -Presentation of information about the number of items the picker has taken is sometimes unclear because it is still handwritten on the picking list document so that the data is inaccurate.
Economics	-It costs a lot to print a picking list document that requires paper and printer ink. A5 paper fee (1 month 25 reams) = Rp. 875,000, - and the cost of ink (1 month 3 pcs Toner) Rp. 2,670,000, -
Control	-One picking list number can be pages and pages. Because the picking list document to be scattered or tucked away during the order picking process and the sorting process.
Efficiency	-Time picker wasted when preparing document picking lists. -There is a process of copying the data in the picking list document that has been crossed by the picker copied to the system for cutting stock. -Significant expenses for purchasing printing equipment such as paper and ink. -The picking list document is not reused so that there are buildup, disposal, and waste of paper.
Service	-Picker and sorter must carry ballpoint pens and picking list documents that are so many that their traveling activities are felt to be uncomfortable.

From the PIECES analysis above, the problem that arises can be concluded that the order picking process does not run optimally and requires a relatively long time so that it can result in the fulfillment of consumer orders being hampered and requiring high operational costs. Therefore, the process of digitizing picking orders feels crucial in supporting the smooth order picking process in the spare part warehouse of PT. WMS. And this is the basis for developing a user requirement for building a new business process.

With the proposed business process, a business process that initially goes through 10 steps will summarize in just past tree steps. With that, the process of retrieving ordered items will be faster so that it can minimize the cancellation of order taking and be able to maximize the time working correctly.

The system to facilitate the proposed business process was developed based on the analysis and needs of users. The development of this system aims to change, improve, and add features to the existing system so that it can better measure and monitor the productivity of pickers and sorters and can accelerate the outbound process in the spare part warehouse of PT. WMS. This development includes changes in the process of preparing the picking list and validating the picking list based on the stock in the system. The system that I developed given the name Digital Order picking system, which means that information about the list of items picked up and validation of picking lists based on stock in the system can be done directly by the picker using web-based digital media that can be accessed via a browser on a smartphone.

In its implementation, in the morning, the picker can immediately start the job, starting with logging into the system and taking the goods according to the item picking instructions listed on the system. Then the picker takes the goods and supplies the number of items received according to the spare part number. Then the picker stores the transaction per picking list number and the status of the picking list number changes. Furthermore, the sorter monitors the status of the picking list by accessing the system as well and must pass the system login. From that sorter system, sorters can find out directly the picking list that has all the items complete. And then, the sorter does his job by collecting items from each end of the shelf to be given to the packing process. From this activity, the activity of taking goods can be monitored by the head of the warehouse by accessing a progress picker monitoring dashboard which looks like several pie charts according to the number of login pickers registered in the master picker.

A. Supporting material

Tablet (fig. 4) used for pickers and sorters in accessing the Digital Order picking system which will always be handled by pickers and sorters to view picking list information for instructions for retrieving and collecting ordered items.

Fig 4. The tablet

However, this tool is not carried by a picker and sorter but placed and taped to a trolley of goods such as fig.5.

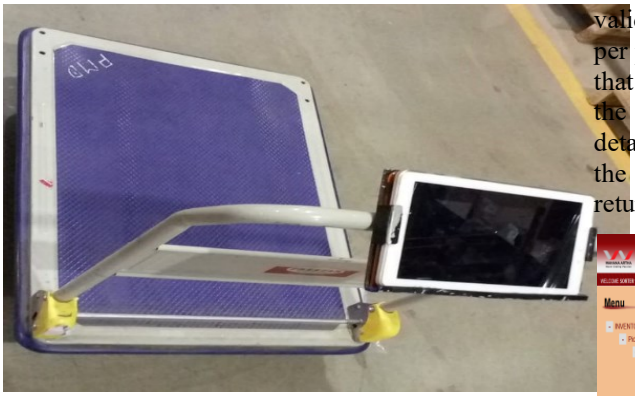

Fig 5. Goods Trolley

B. How the application works

When the login process is complete, the display for login picker directed to the home page which contains information about the progress picker on that day. And the left side contains menus that can be accessed by the picker (fig. 6). If the red, blue, and yellow boxes are selected, it will give information about the picking data according to the color chosen.

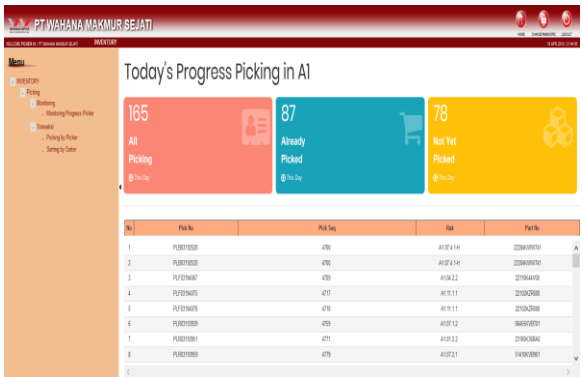

Fig. 6. Picker Detail

Next is information about picking lists per picking number that have shelves according to the login picker (Fig. 7). This page contains information about alias numbers for picking numbers, picking numbers, consumer names, picking dates, regions, order numbers, spare part numbers, spare part names, shelf names, quantity to be taken, and also the text field that must be filled by the picker the actual quantity or quantity made by the picker and picker must check the checkbox per detail to ensure that every aspect has been done correctly. For color textboxes, if the input quantity is the same as the quantity that must be taken, the textbox color will change to green, but on the contrary, if the input quantity is not the same as the quantity to be taken, the textbox will turn red.

Then, if the picker has done the existing picking details, the picker must submit the form. Submit form will process picking to update picking data and change picking status. In one picking list number, it can be accessed by several pickers if the items ordered are on different shelves. In the previous system, the validation process of picking list raises all the details per picking list number which consists of several parts that have different shelves which result in one part of the picking list being unable to validate part of the details, even though the picker has taken the item from the storage shelf. And that makes the picker have to return the item.

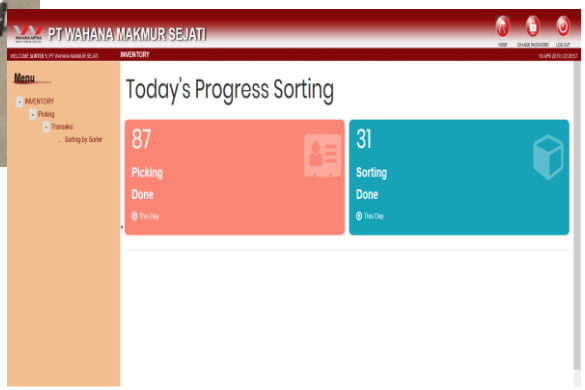

Fig. 7. Today's progress sorting

And on the system built, the validation of picking lists can be done in part, where one picking list number can be accessed by several pickers and can be directly validated (see figures 4.19 and 4.20). And it makes direct picking lists partially validated by the picker so that the sorter can find out the items that have been taken by the picker and can be collected immediately for packing. As well as items that have not been collected by the sorter because the work time is up, it will not be canceled automatically by the system but can be done the next day.

At the login sorter, after the login process will direct to the home page. This page contains information about the work progress of the sorter. Picking Done which means picking has been completed but sorter has not been collected. And the Sorting Done amount, which means the number of collections that have been done by sorter on that day. In the system developed, sorters only have the authority to access one menu, namely the Sorting by

Sorter menu. When this menu is selected, a section will appear for filtering or data search, and below that will perform a list of data picking lists and their status.

Filtering section, there is a sequence number parameter alias unique number from the picking list number and also the status. This filtering is useful for facilitating sorters in finding picking lists that are complete and ready to be collected. On this page, there is also a view button from each picking list number. If the switch is selected, then the picking list status will change to 'sorted' and will move to the next page (fig.8).

Fig 8. View Sorter

Meanwhile, the menu that can be accessed by the warehouse head is the Monitoring progress picker menu, Report picking, and Master Picker.

There are red, blue, yellow, green, and gray. The red color provides information about the number of picking lists that day. The blue color provides information about the picking list that is worked on. The yellow color provides information about the number of picking lists that have been taken and validated. Green gives information about the packing picking list, and the gray color offers information about the canceled picking list. If you select one of the colors will display the details of the packing list information. (fig. 9).

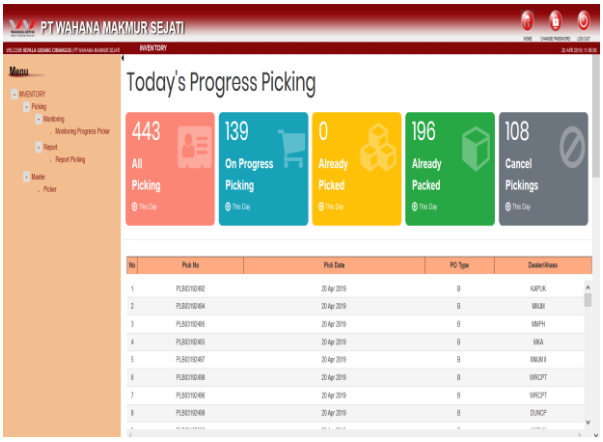

Fig 9. Monitoring by the head of the warehouse

There are red, blue, yellow, green and gray. The red color provides information about the number of picking lists that day. The blue color offers information about the picking list that worked. The yellow color provides information about the number of picking lists that have been taken and validated. Green gives information about the packing picking list, and the gray color includes information about the canceled picking list. If you select one of the colors will display the details of the packing list information. (fig. 9).

The system that we built is very smart because it implemented correctly, quickly and in realtime and has several indicators that make the user's work much more comfortable. Like the Monitoring Progress Picker (Fig. 10).

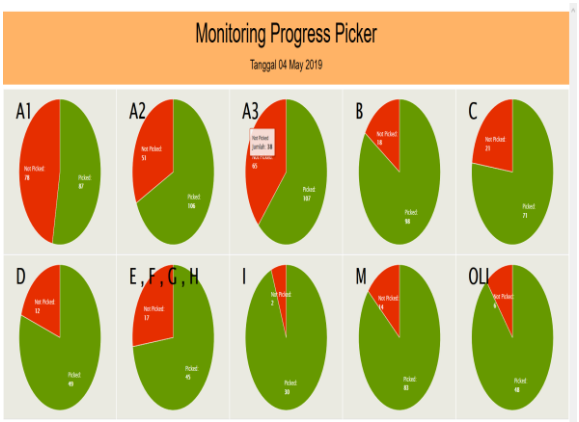

Fig 10. Monitoring Progress Picker

The Progress Picker page contains information on the number of spare part numbers that must be taken by the picker who uses a pie chart to represent the number and grouped according to the login picker. Each pie chart informs you about the amount of picking that has been done by the picker and which has not been done by the picker.

The test results for the system that was built eventually were measured based on the effectiveness of its use using the technology acceptance model method and found the results as follows:

Statistics

		Perceived Usefulness	Perceived Ease of Use	Attitude Toward Using	Behavior Intention of Use	Actual Use	Perceived Risk	Perceived Enjoyment	Trust
N	Valid	10	10	10	10	10	10	10	10
	Missing	0	0	0	0	0	0	0	0
Range		1.00	2.00	2.00	2.00	3.00	2.00	2.00	3.00
Minimum		23.00	18.00	13.00	18.00	7.00	8.00	8.00	7.00
Maximum		24.00	20.00	15.00	20.00	10.00	10.00	10.00	10.00

Fig. 11. Tabulation of data

With the cumulative details of each variable:

- Variable Perceived Usefulness → minimum number = 23.00 and maximum number = 24.00 and range = 1.00.

- Variable Perceived Ease of Use → minimum number = 18.00 and maximum number = 20.00 and range = 2.00.
- Attitude Variable Toward Using → minimum number = 13.00 and maximum number = 15.00 and range = 2.00.
- Intention of Use Behavior Variable → minimum number = 18.00 and maximum number = 20.00 and range = 2.00.
- Actual Use variable → minimum number = 7.00 and maximum number = 10.00 and range = 3.00.
- Variable Perceived Risk → minimum number = 8.00 and maximum number = 10.00 and range = 2.00.
- Perceived Enjoyment variable → minimum number = 9.00 and maximum number = 10.00 and range = 2.00.
- Trust Variables → minimum number = 7.00 and maximum number = 10.00 and range = 3.00.

The validity test conducted states that the eight components are valid. The following are the results of one part, namely "trust."

Trust_1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	10.0	10.0	10.0
	4.00	1	10.0	10.0	20.0
	5.00	8	80.0	80.0	100.0
	Total	10	100.0	100.0	

Trust_2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4.00	1	10.0	10.0	10.0
	5.00	9	90.0	90.0	100.0
	Total	10	100.0	100.0	

The reliability test results carried out also state that all parts are reliable. With Cronbach alpha, the maximum is 2 to 5.

Reliability Statistics

Cronbach's Alpha	N of Items
.625	5

IV. CONCLUSION

From the results of the analysis of ongoing business processes, it is known that the order picking business process has several problems so that all these problems can lead to a long order picking process and the fulfillment of orders to consumers hampered. So, in the research carried out obtained several results, namely:

1. presentation of data in realtime and presenting smart data makes the system that we build very useful and significant to some positive things, including data speed, system response speed, data accuracy on the information generated and quick calculation of picker and sorter performance.
2. Web Application-based system that can support order picking processes faster than before users can access that via smartphones.
3. The previous order picking business process takes 24 minutes to prepare the picking list document and 2 minutes for the validation picking list, which in total takes approximately 28 minutes. However, in the proposed business process with the system that has developed, it accelerates the process of order picking for about 26 minutes.

However, it should be stressed that there is one key factor that also affects the speed of the picking order process, namely: the condition of the user of the picking, the system in this case, the picker, sorter and warehouse head in carrying out their work. This study emphasizes the factor of digital order picking systems that can support the order picking business process by choosing the application of systems that can be accessed on smartphones and can be easily used for traveling or moving places.

ACKNOWLEDGMENT

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