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Qualitative Evaluation of RFID Implementation on Warehouse Management System

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Abstract

Logistic sector actors need innovation to improve competitiveness in providing their best services to consumers, one of them on Warehouse Management System (WMS) because the system is used to control the movement of the supply chain. There is a problem in one of Indonesia logistics companies on the process of selecting goods, so the warehouseman still difficulties in this process. Thus, RFID implementation on WMS becomes one of the solutions to handle the goods selection process. This research uses Design Science Research Methodology (DSRM) which focuses on developing and improving the model performance of a system and using waterfall model for system development. Then the authors will analyze the test results with the validity test and reliability test of the questionnaire, and the results of the data analysis will determine the feasibility of this research to be applied.

Keywords*: supply chain, WMS, RFID, DSRM, waterfall model*

1. Introduction

The Government of the Republic of Indonesia is currently focusing on building logistics infrastructure to facilitate the distribution of logistics to all regions in Indonesia. Logistics is essentially a planning orientation and framework that seeks to create a single plan for the flow of products and information through a business [1]. Logistics costs contribute a big part of the total production costs, and therefore the amount spent on logistics becomes a significant factor of firm's competitiveness [2].

Thus, Logistic sector actors need innovation to improve competitiveness in providing their best services to consumers, one of them by controlling the movement of goods in the warehouse. A warehouse should be viewed as a temporary place to store inventory and as a buffer in supply chains [3]. A warehouse is a highly dynamic environment with different numbers of goods going in and out every day [4]. In every process in the warehouse requires a system that can control all the operations that exist in it, this is called Warehouse Management System (WMS). WMS is one of the effective strategies to accelerate an organisation's development by giving priorities on the reliability of its supply chain [5].

Logistics companies certainly have warehouses because it has a significant effect on the company if they don't have it the production of any goods will be difficult to control. There is a problem in one of Indonesia logistics company in the process of selecting goods that have not been using Radio Frequency Identification (RFID) technology. So, the warehouseman still diffculties in this process and can happen wrong place the goods, consequently could cause the products damaged and lost.

Therefore, it is necessary to RFID implementation on WMS for selecting goods. RFID is the ability to make objects "speak" technology, so the RFID technology in the key technologies of Things perception layer's position is particularly prominent [6]. RFID implementation in the process of selecting goods is arranged using Arduino Uno. The Arduino Uno is an open source and user-friendly platform for hardware and software prototyping [7], and a microcontroller board grounded on the ATmega328 (datasheet) [8]. It has a power jack, 14 digital input/output pins, a 16 MHz crystal oscillator, six analogue inputs, a USB connection, an ICSP header, and a reset button [9]. So with RFID implementation using Arduino microcontroller can provide quite a lot of benefits and convenience for the logistics company, one of which is to facilitate the selection of goods. The design and development of RFID implementation on WMS requires

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PHP programming language on server-side to retrieve data. The data stored in MariaDB database in the proper format by the controller API in Web Service [10].

For the design and development of this research, the author uses Design Science Research Methodology (DSRM) which focuses on developing and improving the model performance of a system. The output of DSRM can be categorised as constructs, models, methods, instantiations and better theories [11] and using waterfall model for system development. The purpose of the research methodology is to explain the stages undertaken in the research process to run by the objectives that have been determined to achieve good results. In this research only discusses the analysis of goods selection process by RFID implementation on warehouse management system.

2. Related Work

Data warehouse (DW) is defined as a subject-oriented, integrated, and stable and variation data which sets along with time to support enterprises [12], and the key to the modern logistics management decision-making information [13]. The filter is also implemented on all data to produce one feature on each data by calculating the standard mean of each signal [14]. Automated warehouse refers to a dozen or even dozens of shelves used to carry on goods storage, with the corresponding material handling equipment for cargo inbound and outbound warehouse operations [15], and several kinds of sensors are necessary to collect much different information around the warehouse [16]. Comprehensive automatization based on warehouse management can decrease the leaks in the management of entering the warehouse, out of warehouse, and inventory. It can also save no little management cost, increasing the enterprise's revenues [17].

Information systems (IS) design that apply contemporary methodologies can provide new knowledge that could improve particular IS artefact designs [18]. The advantages of Waterfall are these phases arranged and assist new developers to understand the "big picture" of managing the development of the software through the software development lifecycle and gives a better understanding of the requirements, the logic of the codes and tests that conducted on the software [19]. Validity is the extent to which a research testing instrument measures what it is supposed to measure [20]. Reliability is the extent to which a research testing instrument can be expected to obtain consistent results when repeated [20].

3. Research Method

In this research, the author will implement RFID technology on WMS using Arduino Uno microcontroller. To continue this study required a research methodology that includes six stages shown in Figure 1.

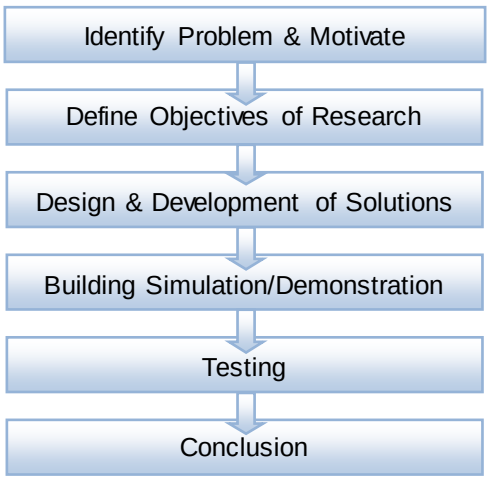

Figure 1. Flowchart of research methodology

3.1. Identify problem and motivate

At this stage, the author will identify the problems that occur in the warehouse. The author will formulate the question to be studied so that the issue to discussed becomes more comfortable in determining the method to be used. The author finds problems in one of the warehouses that are in the current process is still difficult to distinguish the type of goods, then the warehouse requires RFID technology to solve the problem.

3.2. Define objectives of research

The purpose and benefits of this research are to simplify the process of selecting goods with the implementing of RFID on WMS, so it will certainly help the warehouseman to do their work. The built system is expected to manage all existing processes in the warehouse. Moreover, it will modernise the current working process and increase productivity in the warehouse.

3.3. Design and development of solutions

At this stage make the design and development of solutions based on research objectives by using waterfall model. Waterfall model is a system development method that each stage can't continue before the previous step is complete. The design of solution is made to facilitate the authors to make an overview of the design of RFID implementation on WMS. To design Arduino device using fritzing software and create block diagram.

3.4. Building simulation/demonstration

Based on the design, the demonstration built with the aim of testing the developed system to see the suitability of the model with expectations to be achieved. If the level of conformity is considered high enough then this research can proceed to the testing stage, and if not appropriate then the author should improve the design and development of solutions.

3.5. Testing

After the demonstration is done then tested the system to determine whether the system has answered the user's request or not. Testing is done to check whether a system produced can be run. If there is a shortage in system development it will be redesigned, but if it does not exist then the test is considered to have been completed.

3.6. Conclusion

Based on the analysis of test results of the system then the authors can make conclusions from the results of this research. The conclusion obtained from the analysis of validity and reliability test results is expected to provide answers from the purpose of this research. Then the author will provide suggestions that can be considered by the logistics company if the analysis of this system will be developed again in the future.

4. Results and Discussions

This research there are three variables are development, implementation, and usability to determine the validity and reliability of the research questionnaire.

4.1. Validity test

Test validity is intended to determine whether the list of questions asked to respondents can be said to be valid or not distributed to the respondent as the object of research. Testing the validity of the questionnaire requires a comparison of product moment correlation coefficient (r count) with product moment table correlation (r table) if the r count value greater than r table then the questionnaire statement is valid. The following is the r table at a significance of 5% for the 2-tails test.

Table 1. The results of validity test

Indicator	r Count	r Table	Decision
The Current System	0.555	0.444	Valid
Controlling System	0.746	0.444	Valid
Effective and Efficient System	0.746	0.444	Valid
Simplify Work Process	0.794	0.444	Valid
Accelerate Work Process	0.811	0.444	Valid
Reduce Error Rate	0.850	0.444	Valid
Increase Warehouse Productivity	0.748	0.444	Valid
Modernize Work Process	0.701	0.444	Valid
Benefits for Warehouseman	0.711	0.444	Valid

4.2. Reliability test

The reliability testing use Cronbach's Alpha test if the alpha value is higher than r table=0.444 then the questionnaire is reliable, and vice versa. A reliable questionnaire is a questionnaire which if repeatedly attempted to the same group, will produce the corresponding data.

Table 2. The results of reliability test

Variable	Cronbach's Alpha	N of items
Development	0.719	3
Implementation	0.844	3
Usability	0.684	3
All Variables	0.891	9

Based on Table 2, reliability test results of all variables greater than r table=0.444, it can conclude that the questionnaire to be reliable as a means of data collection in this research.

4.3. Results of Data Analysis

The results of the survey were recapitulated and calculated using the class interval formula and average value, then measured by the assessment characteristics in each variable.

$$i = \frac{r}{k} = \frac{5-1}{5} = 0.8$$

The class interval value obtained is 0.8, so that based on the combination of Likert scale and the class interval, it will show Table 3.

Table 3. Assessment characteristics

Category	Scale
Strongly disagree	1 – 1.8
Disagree	1.81 – 2.61
Neutral	2.62 – 3.42
Agree	3.43 – 4.23
Strongly agree	4.24 – 5.04

Here are the results of questionnaires related to the process of selecting goods by implementing RFID on WMS. In each variable, there are three statements, the results of calculations on each statement can show in Table 4.

Table 4. Results of Data Analysis on All Indicator

Indicator	Mean	Category	Total
The Current System	4.4	Strongly agree	4.6
Controlling System	4.7	Strongly agree	(Strongly agree)
Effective and Efficient System	4.7	Strongly agree	
Simplify Work Process	4.55	Strongly agree	4.55
Accelerate Work Process	4.55	Strongly agree	(Strongly agree)
Reduce Error Rate	4.55	Strongly agree	
Increase Warehouse Productivity	4.35	Strongly agree	4.5
Modernize Work Process	4.6	Strongly agree	(Strongly agree)
Benefits for Warehouseman	4.55	Strongly agree	

From the result of 3 variables in the research questionnaire, then got the result of data analysis shows in Table 5.

Table 5. Results of Data Analysis

Variable	Mean	Percentage	Category
Development	4.6	92%	Strongly agree
Implementation	4.55	91%	Strongly agree
Usability	4.5	90%	Strongly agree
Total	4.55	91%	Strongly agree

4.4. Discussions

The RFID implementation on WMS will certainly help the warehouseman to do their work. Moreover, it will modernize the current working process and increase productivity in the warehouse. RFID technology is seen as the answer to the barcode technology's weaknesses because barcodes can only be identified by bringing them closer to a reader and the storage capacity of barcodes is very limited. In addition to RFID technology, there are still other technologies that can be utilized in the warehouse, maybe even better than that.

However, the frequency of RFID may be interrupted if there are other frequencies emitted by other equipment not intended for RFID, so the chip will respond to that frequency. The problem is also in the process of identifying the goods, RFID will be difficult to identify goods if LAN network is not connected. An alternative is required to improve system performance in the process of selecting goods such as using a conveyor belt to transport goods.

5. Conclusion

After analyzing the process of selecting goods by implementing RFID on WMS, it can conclude that the analysis has been able to answer the purpose of this research. First, respondents stated strongly agree (92%) with the development of the current process, where the built system must be able to control the operation of selecting the goods to be more efficient. The purpose of this development to facilitate the work of warehouseman. Second, respondents stated strongly agree (91%) with the process of selecting goods by implementing RFID on WMS to simplify and speed up the work process and reduce the error rate in the process of selecting goods. Third, respondents stated strongly agree (90%) with the usefulness of implementing RFID on warehouse management system to increase warehouse productivity, modernize work process, and beneficial to the warehouseman.

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