E-ISSN 2503 - 1430
ISSN 2541 - 3090

Journal of Industrial Engineering Management
(JIEM Volume 6. No 2 Tahun 2021)

DECISION MAKING ANALYSIS OF AUTO-ID SYSTEM USING ANALYTICAL HIERARCHY PROCESS (AHP) AT PT. AKG

Rezananda Yulian Akbar[1], Muhammad Hisjam[2]
Program Studi Sarjana Teknik Industri, Fakultas Teknik, Universitas Sebelas Maret,
Jl. Ir. Sutami No. 36A, Jebres, Surakarta, 57126, Indonesia
e-mail: rezanandaya@gmail.com[1], hisjam@staff.uns.ac.id[2]

Article history:
Submit 20 Mei 2021
Received in from 15 Juni 2021
Acceted 5 Agustus 2021
Avilable online 20 Agustus 2021

ABSTRACT

The increasingly competitive industrial competition makes companies from all sectors around the world change the system to be more efficient and effective. One of the efforts to improve the company is by implementing a Warehouse Management System (WMS). Lately, many large companies are implementing Auto-ID (automatic identification) technology to solve existing problems. The types of Auto-ID technology that are often used are barcode, RFID and QR code technology. PT AKG is a manufacturing company that produces and markets plastic finished materials to serve the needs of other companies has not yet implemented WMS, this causes human error due to the process still manual. This research proposed to find the best warehouse management system using the Analytical Hierarchy Process (AHP) method for PT. AKG. Alternative systems in this study are barcode, RFID, and QR code with the criteria used are cost, fuctionality, performance, and sustainability. Based on the results, the system chosen is the QR code with a score of 0.578084. QR codes can make it easier for operators and PPIC department staff to take notes and minimize recording errors. Recording that originally used Microsoft Excel and paper as a tool is no longer needed because operators only need to scan using a smartphone that is connected to the company's warehouse management system.

Keywords: Analytical Hierarchy Process (AHP), Auto-ID technology, QR code, Warehouse Management System

Published By:
Fakultas Teknologi Industri
Universitas Muslim Indonesia
Address :
Jl. Urip Sumoharjo Km. 5 (Kampus II UMI)
Makassar Sulawesi Selatan.
Email :
Jiem@umi.ac.id
Phone :
+6281341717729
+6281247526640

DOI : http://dx.doi.org/10.33536/jiem.v6i2.929

1. INTRODUCTION

The increasingly competitive industry competition makes companies from all sectors around the world change the system to be more efficient and effective. Cost effectiveness, product reliability and quality, and customer satisfaction are important keys to increase the company's competitive advantage in all industrial fields (Pipatprapa, 2019). There are many ways that companies can do to improve company efficiency and effectiveness, such as waste reduction, production optimization, inventory control, defect control, and so on.

One of the efforts to improve the company's efficiency is by implementing a Warehouse Management System (WMS). Warehouse Management System is a key part of the supply chain and mainly aims to control the movement and storage of materials in the warehouse and the associated transaction processes, including shipping, receiving, storing and retrieving goods (Haslindah et al., 2017). In summary, the warehouse management system contains an understanding of the management of interrelated activities in temporary goods storage activities. WMS is able to make processes that occur in the warehouse faster and more efficient.

PT. AKG was founded in 2009 in Tangerang. In 2015, PT. AKG has developed its production capacity by building a factory in Tegal Regency with a production capacity of around 1,500 tons per year. The scope of the company's activities includes industries that use plastic as the main raw material. With its main activities producing and marketing finished plastic materials to serve the needs of other companies, especially those that provide gifts for the products produced, such as various children's toys, household appliances, food packaging and others with a production capacity of up to 500 tons per year.

Every item in the company's inventory is placed in the company's warehouse. PT. AKG has 2 types of warehouses, namely raw material warehouses and finished goods warehouses. The raw material warehouse is a place to store various production raw materials such as plastic seeds, plastic dyes, and cardboard for packaging. Finished goods warehouse is a place to store manufactured goods that are ready to be sent to customers or those that are still semi-finished (unassembled).

In the supply chain, the warehouse is an important component that connects all parties in the chain. The performance of warehouse operations, which are labor-intensive or capital-intensive, not only affects the productivity and costs of warehouse operations, but also the performance of the entire supply chain (Hassan et al., 2015). Based on an interview with the PPIC department, PT. AKG is aware that manual data input causes errors due to the operator's carelessness. This leads to ineffectiveness in carrying out activities in the warehouse. Warehouse operators must often do stock checking to equalize input data and actual data.

Along with the development of technology, there are various kinds of new technologies to improve the effectiveness and efficiency of the company. The warehouse which is an important part of the company must also continue to grow following technological developments. Warehouse is a place to store all kinds of goods belonging to the company, both raw materials and manufactured goods. In the warehouse there are many important activities related to the company's supply chain.

Recently, many large companies have implemented Auto-ID (automatic identification) technology to solve existing problems. Auto-ID technology is a popular technology in manufacturing companies and the service industry, especially in warehousing, purchasing, and delivery systems. Several types of Auto-ID technology that are often used are barcode technology, RFID, and QR code. Barcode is a technology that collects data from the width and spacing of parallel lines (Nurrohkayati, 2016), RFID is the process of identifying a person or object using radio transmission frequencies, and QR code is a two-dimensional code developed by a division of a company from Japan. Each of these technologies has advantages and disadvantages in its application. Barcodes and QR codes are usually applied to simpler systems than RFID because of limitations in data storage and processing. However, QR codes and barcodes in their application require relatively low costs.

Based on the explanation above, this research was made to find the best system using the Analytical Hierarchy Process (AHP). After getting the results of the decision then made a simple system design from the selected system.

2. LITERATURE REVIEW

2.1. Warehouse Management System

Warehouse Management is a task to organize warehousing issues. Organizing will run well if it is supported by the right and efficient system. A warehouse management system, or a warehouse management system, is a key part of the supply chain and primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, storage and retrieval of goods. Warehouse management system will optimize the workforce, reduce processing time, reduce unnecessary inventory process that will ultimately improve service to the customer (Haslindah et al., 2017).

2.2. Auto-ID

Auto-ID technology has an important role in information processing in service or manufacturing companies. Several types of Auto-ID that are often used are Optical Character Recognition (OCR), barcode system, fingerprint procedure, voice identification, RFID, and smart cards (Hassan et al., 2015). In this study, the auto-ID technology used is barcode, RFID, and QR code.

Barcode or binary code is a technology to collect data from the width and spacing of parallel lines (Nurrohkayati, 2016). Barcode label is a visual display consisting of lines and the numbers below. The display is a representation of data that can only be translated using a certain machine (Amanda Istiqomah et al., 2020). Barcodes can be translated using a special optical scanner called a barcode scanner (RF machine).

RFID is the process of identifying a person or object using radio transmission frequencies. RFID uses radio frequencies to read information from a small device called a tag or transponder (Transmitter + Responder). The RFID tag will recognize itself when it detects a signal from a compatible device, namely an RFID reader (Micro-Reader) (Herwin & Saputra, 2010). RFID technology is believed to be the barcode revolution technology, RFID can automatically read, retrieve, and identify an object. The RFID system is always connected to the company's application system to process data on business activities. Based on (Sweeney II, 2005) there are some costs that must be prepared when investing in RFID technology, the cost of purchase, installation costs and maintenance costs. The estimated cost or price for passive tags is between 0.5 EUR and the price for active tags is between 5 EUR and hundreds.

QR code is a two-dimensional code developed by a division of a company from Japan, namely Denso Wave Incorporated as an ISO/IEC18004 industry standard. QR code was created to simplify the process of reading the code by the scanner. QR Code can be referred to as a matrix symbol consisting of a string of square boxes arranged in a larger square pattern. These square boxes are then referred to as modules. The extent of this square pattern will determine the version of the QR Code (Wulung et al., 2017). Now, in a QR code can encode two messages are presented in a code that has two layers. Different messages can be translated by scanning at a certain angle (Wicahyo & Tanone, 2020). The QR code size for one module is 4x4 pixels with a resolution of 300 dots per inch and structured binary digits (black = "1" and white = "0"). The capacity of each type of data used in the QR code is a maximum of 7,089 characters for numeric data, 4,296 characters for alphanumeric data, and a data byte or binary has a maximum capacity of about 2,953 bytes. In the factory warehouse system, the QR code is used to identify the product, the location of the product in the factory warehouse, serial numbers and batch, and containers such as cartons and pallets (Pipatprapa, 2019).

2.3. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) was first developed by Thomas L. Saaty, a mathematician from the University of Pitsburg, USA (Lestiani, 2011). Hierarchy is defined as a representation of a complex problem in a multilevel structure wherein the first level is the goal, which was followed by the level of factors, criteria, sub-criteria, and so on down to the last level of the alternative (Darmanto et al., 2014).

This analysis is basically trying to take a quantitative approach to qualitative problems by paying attention to consistency in doing quantification. For this reason, a consistency ratio is introduced that can be used as a reference to test whether the quantification is consistent enough.

The advantages of the AHP method in decision making are (Saaty, 2002):

1. Can solve complex problems, irregular structures, even problems that are not structured at all.
2. Lack of complete data is written or quantitative data on the issue did not affect the smooth running of the decision making process because the assessment is a synthesis of thought the various viewpoints of respondents.
3. In accordance with the basic human ability to assess something so as to facilitate the assessment and measurement of elements.
4. The method is equipped with consistency testing so that it can guarantee the decisions taken.

The drawback of AHP in decision-making:

1. AHP cannot be applied to a very sharp/extreme difference in point of view among respondents.
2. Respondents involved must have sufficient knowledge and experience about AHP problems and methods.

3. RESEARCH METHOD

3.1. Literature Study

Literature study was conducted to find out more accurate information related to the problems discussed in the practical work report, so that the research results became valid and in accordance with the theory. In addition, a literature study was conducted to determine the method that will be used to analyze and solve problems that exist in the company, especially at PT AKG. This literature study was obtained from various references, such as papers, journals, theses, and other scientific works. The literature used is literature related to the concept of Warehouse Management System (WMS), Analytical Hierarchy Process (AHP), and Auto-ID system design.

3.2. Observation

This initial observation was carried out to obtain direct and in-depth information related to the problems discussed in this practical work report. Observations were carried out at the PPIC Department of PT. AKG which has an important role in warehousing and production planning so that at this stage we get a detailed explanation of how the process of going in and out of goods and production planning. In addition, the constraints and systems that are directly related to the smooth running of the existing warehousing and production processes are also explained. Therefore, based on these observations, it was shown on the various problems faced in the department, one of the problems associated with the warehouse management system.

4. RESULT AND ANALYSIS

4.1. Analytical Hierarchy Process

a. Hierarchical Structure

In the AHP method, the criteria are usually arranged in a hierarchical form. The hierarchical structure designed can be seen in Figure 1 with the following explanation:

- Goal: is the intended target, which can determine the choice of the best system that can be obtained based on the existing criteria.
- Criteria: are the limits set on each alternative choice. The criteria in this study are: cost, functionality, performance, and sustainability.
- Alternatives: are the options available in this problem. In this case, there are three alternative systems, namely: Barcode, RFID, and QR code.

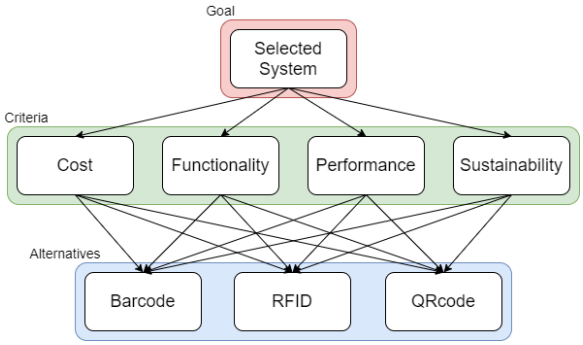

Figure 1. Hierarchical Structure

b. Pairwise Comparison Matrix

Based on the results of the questionnaire distributed to the PPIC manager at PT AKG, the values of the pairwise comparison matrix between criteria and the pairwise comparison matrix between alternatives are shown in Table 1 – Table 5.

Table 1. Pairwise Comparison Matrix Between Criteria

Criteria	Cost	Functionality	Performance	Sustainability
Cost	1	5	5	5
Functionality	0.2	1	5	5
Performance	0.2	0.2	1	0.2
Sustainability	0.2	0.2	5	1

Table 2. Pairwise Comparison Matrix Between Alternatives Based On Cost

Cost	*Barcode*	RFID	*QR code*
Barcode	1	0.2	5
RFID	5	1	5
QR code	0.2	0.2	1

Table 3. Pairwise Comparison Matrix Between Alternatives Based On Functionality

Functionality	*Barcode*	RFID	*QR code*
Barcode	1	0.2	5
RFID	5	1	5
QR code	0.2	0.2	1

Table 4. Pairwise Comparison Matrix Between Alternatives Based On Performance

Performance	*Barcode*	RFID	*QR code*
Barcode	1	3	5
RFID	0.33	1	5
QR code	0.2	0.2	1

Table 5. Pairwise Comparison Matrix Between Alternatives Based On Sustainability

Sustainability	*Barcode*	RFID	*QR code*
Barcode	1	0.2	0.2
RFID	5	1	5
QR code	5	0.2	1

c. Decision

Data processing is done by using Super Decisions software. Based on the data processing that has been done, the results obtained that the QR code has the largest score or weight compared to other alternative solutions, which is 0.578084. From these results, the selected system is QR code. Result from Super Decision software is shown in Figure 2.

Name	Graphic	Ideals	Normals	Raw
Barcode		0.469700	0.271526	0.135763
QRcode		1.000000	0.578084	0.289042
RFID		0.260153	0.150390	0.075195

Figure 2. Decision results using Super Decisions software

d. Sensitivity Analysis

Sensitivity analysis was performed using Super Decisions software. This sensitivity analysis is carried out by changing the weight value of the alternatives tested on the software. The results of the sensitivity analysis on the QR code can be seen in Figure 3.

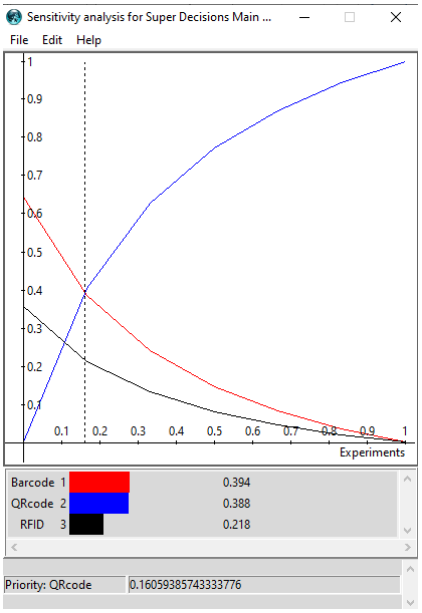

Figure 3. Sensitivity Analysis QR code

After analyzing the sensitivity of the QR code, it is known that the critical weight value is 0.16059. Next, a sensitivity analysis was carried out by changing the weight values on the criteria. This is done to see if the change in value affects the ranking results or the priority of alternative solutions.

On the results of the analysis of all the criteria are not obtained intersection between the lines. The results of this sensitivity analysis prove that this model is strong, stable, and unaffected by changes. The result of sensitivity analysis that changes in the value of the weight of the criteria is shown in Figure 4.

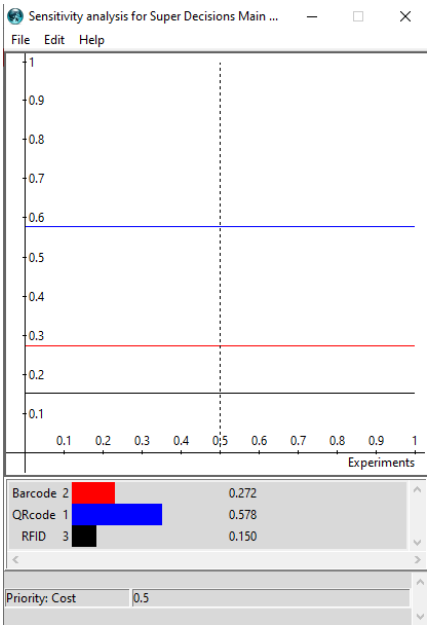

Figure 4. Sensitivity Analysis Criteria

4.2. System planning

a. *Workflow* Data

Workflow is an automated work system related to flow of works. This workflow is related to flow of works and also the company's work system, especially in the document handling flow. Simply put, workflow is a mechanism for how someone completes a job with the stages to complete it and can be illustrated with diagrams that have been made previously. The workflow planned for WMS can be seen in Figure 5.

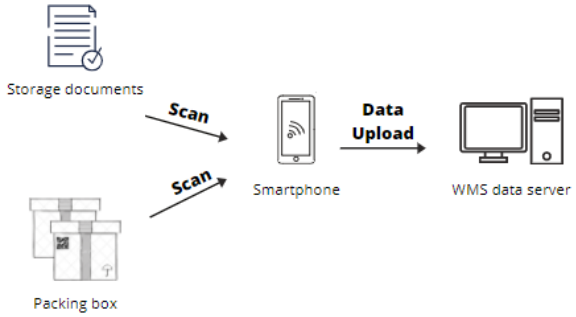

Figure 5. Workflow of Warehouse Management System

In this study, a smartphone is used as a tool to scan a QR code. The scanned data then uploaded to the WMS data server. The first step is that the QR code on the list of receipts and deliveries of goods is scanned using a smartphone camera. Task receipt or delivery tasks issued by the department of PPIC imported to the smartphone. The task includes various data such as number, product name, color and quantity of materials and goods to be received or shipped. Then the QR code on the tag of materials and goods is identified. The identified information is compared with the assignment document. After the data has been scanned with a smartphone, then uploaded to the WMS server data. Data receipt or delivery that can be used to query, statistics, and analysis stored on the data server.

b. Design Flow of Incoming Goods

The design of the incoming goods flow is adjusted to the SOP for receiving goods that already exist in the company with adjustments after the addition of a warehouse management system using a QR code. The incoming goods flow contains the process of goods coming from the supplier until the goods are placed on the available shelves. The planned flow of incoming goods can be seen in Figure 6.

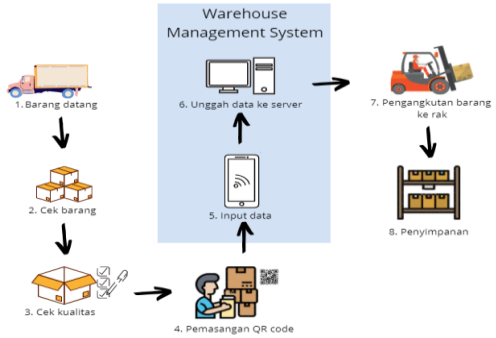

Figure 6. Incoming Goods Flow

Newly arrived goods from suppliers are checked at the raw material warehouse whether they are in accordance with the purchase order or not. Then the goods are checked by the quality control department to adjust the quality standards of the goods. After the product is suitable, the QR code label is attached and data input such as code, name, type, color, quantity, and location of goods using a smartphone is carried out to the warehousing system. The input process is carried out by the warehouse operator. Then, the goods that have been labeled with the QR code are transported to the available shelves using a forklift or hand pallet according to the racks that have been inputted.

c. Design Flow of Outgoing Goods

The design flow of outgoing goods is adjusted to the SOP for releasing goods that already exist in the company with adjustments after the addition of a warehouse management system using a QR code. The flow of outgoing goods contains the process of checking the request form until the receipt of goods by the production department. The planned flow of outgoing goods can be seen in Figure 7.

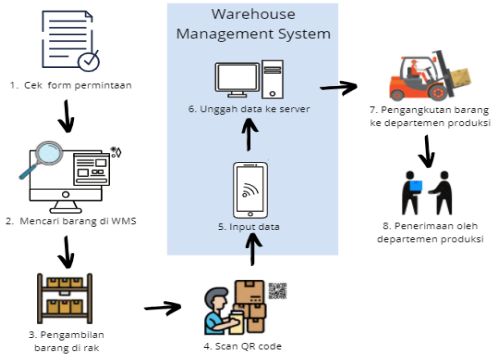

Figure 7. Outgoing Goods Flow

The form issued by the production department will be checked first by the PPIC department. The PPIC admin will check the availability and location of the goods requested by the production department. If the item is there, the item will be picked up on the shelf in the warehouse according to the admin's instructions. The operator then scans the QR code using a smartphone to make sure the item is the item that are looking for and updates the stock amount of the item in the system. Then the goods will be sent to the production department by using a forklift or hand pallet. The last step is handing over the goods to the production department.

4.3. Previous and Proposed System Differences

At PT AKG, the recording and warehouse management system is carried out in a semi-manual way. Incoming goods and outgoing goods are recorded using paper which is then inputted into Ms. Excel manually. This recording process is prone to errors in data input from the operator, causing differences in the number of stock items recorded on the computer with the actual situation. The ineffectiveness of the manual system makes it difficult to find items carried out by the PPIC department. Update the inventory is done by the operator manually using excel cause difficulty in finding the shelves, and the laying of the goods that come. The Excel used in the stock update process is not designed for warehouse management and its features are not suitable for recording tools.

The proposed QR code system will change the previously error-prone recording system to be more accurate. The use of Microsoft Excel software and paper for stock updates is no longer needed because all records can be done using a system that is connected to a smartphone. The process of finding items and the location of empty shelves will be faster because the database on the system is neater and user friendly and can filter the available shelves. Warehouse operators can also search and check stock using a smartphone easily if it has been given permission by the admin. Another advantage is that by using a warehouse management system, all data will be centralized and can be accessed by anyone if they have permission even from other departments so that the ordering process and delivery between departments becomes faster and easier.

5. CONCLUSION

Based on the results and analysis, conclusions can be drawn:

1. Warehouse Management System is a management system to organize warehousing problems. Based on data processing performed using Super Decision software, the results obtained that the QR code has the largest score compared to other with a score of 0.578084. So, the selected system is QR code.
2. The uses of QR code can be easier for operators and PPIC department staff in doing the recording. Previous recording was using Microsoft Excel and documents. Operators only need to scan using a smartphone that is connected to the company's warehouse management system.

References

Darmanto, E., Latifah, N., & Susanti, N. 2014. Penerapan Metode AHP (Analythic Hierarchy Process) Untuk Menentukan Kualitas Gula Tumbu. *Simetris : Jurnal Teknik Mesin, Elektro Dan Ilmu Komputer*. https://doi.org/10.24176/simet.v5i1.139

Haslindah, A., Fadhli, F., Adrianto, A., & Mansyur, R. 2017. Pengaruh Implementasi Warehouse Management System Terhadap Inventory Control Finish Good Berbasis *Barcode* PT. Dharana Inti Boga. *ILTEK : Jurnal Teknologi*. https://doi.org/10.47398/iltek.v12i02.378

Hassan, M., Ali, M., Aktas, E., & Alkayid, K. 2015. Factors affecting selection decision of auto-identification technology in warehouse management: An international Delphi study. *Production Planning and Control*. https://doi.org/10.1080/09537287.2015.1011726

Herwin, H., & Saputra, R. 2010. Analisis dan Perancangan Aplikasi Inventori Berbasiskan Rfid Pada PT. ABC. *ComTech: Computer, Mathematics and Engineering Applications*. https://doi.org/10.21512/comtech.v1i2.2633

Istiqomah, A.N., Sansabilla, F.P., Himawan, D., & Rifni, M. 2020. The Implementation of Barcode on Warehouse Management System for Warehouse Efficiency. *Journal of Physics: Conference Series*. https://doi.org/10.1088/1742-6596/1573/1/012038

Lestiani, M. E. 2011. Faktor-Faktor Dominan Promosi Yang Mempengaruhi Motivasi Konsumen Dalam Membeli Suatu Produk Dengan Menggunakan Metode Ahp. *Industri Elektro Penerbangan (INDEPT)*.

Meilani, D., & Putri, I. A. 2015. Perancangan Sistem Otomasi *Barcode* dengan Mengevaluasi Kinerja pada Aktivitas Transaksi Gudang (Studi Kasus : PT . Astra Komponen Indonesia). *Jurnal Sains, Teknologi Dan Industri*.

Nurrohkayati, A. S. 2016. *Pengembangan Model Analisis Ekonomi Dan Keputusan Pemilihan Supplier Pada Investasi Teknologi Auto-Id* (Doctoral dissertation, Institut Teknologi Sepuluh Nopember).

Pipatprapa, A. 2019. QR Code on Mobile Platform for Improving Order Picking Process of Lean Factory Warehouse. *International Journal of Innovation, Management and Technology*. https://doi.org/10.18178/ijimt.2019.10.1.836

Saaty, T. L. 2002. Decision making with the Analytic Hierarchy Process. *Scientia Iranica*. https://doi.org/10.1504/ijssci.2008.017590

Suryadi, K. & Ramdhani, A. 2000. Sistem Pendukung Keputusan Suatu Wacana Struktural Idealisasi dan Implementasi Konsep Pengembangan Keputusan, 2nd ed., Wuly Anisah, Ed. Bandung, Indonesia: PT. Remaja Rosdakarya

Sweeney II, P. J. 2005. RFID for dummies. Indianapolis (US): Wiley

Véronneau, S., & Roy, J. 2009. RFID benefits, costs, and possibilities: The economical analysis of RFID deployment in a cruise corporation global service supply chain. *International Journal of Production Economics*. https://doi.org/10.1016/j.ijpe.2009.06.038

Wicahyo, D. V., & Tanone, R. 2020. Sistem Manajemen Hasil Produksi Berbasis Android Menggunakan Teknologi Qr Code Di PT. Pura Nusapersada. *Jurnal Teknologi Informasi*.

Wulung, I. A., Ekojono, E., & Asri, A. N. 2017. Sistem Informasi Logistik Stock Opname Menggunakan Quick Response Code Berbasis Android. *Jurnal Informatika Polinema*. https://doi.org/10.33795/jip.v1i1.86