Designing a Traceability System for Rice Distribution Process Using QR Code Bassed Android Application at Perum Bulog Subdivre III Surakarta

Afan Sutopo[1a◆], Susy Susmartini[1b], Lobes Herdiman[1c]

Abstract. *The state-owned Enterprises (SEO) that manages businesses in the food sector, especially rice, is Perum Bulog. However, there were often reports from the public about the quality of Perum Bulog's rice. Such as the rice had contaminated with gravel or plastic and did not match with premium rice standards. Moreover, The distribution process of premium rice to outlet (RPK) found uncertainty over the arrival time of orders. It caused out of stock and lost sales at the outlet. This paper introduces a traceability system for the rice distribution process based on Android with QR Code technology. Furthermore, this paper discusses the system architecture and the development of traceability system design using the data flow diagram of the company's business process. The developed prototype system shows the system's functional requirements and can be used by stakeholders to monitor the production process and assist decision-making.*

Keywords: traceability; quality; QR code; android.

I. INTRODUCTION

Rice has become the main staple food in various regions of Indonesia (Mardianto & Ariani, 2008). The State-Owned Enterprise (BUMN) managing business units in the food sector, especially rice, is Perum BULOG. Perum BULOG has 26 Regional Divisions (Divre) and 101 Regional Sub Divisions (Sub Divre), which are the largest throughout Indonesia, one of which is the Surakarta Regional III Sub Division. There are four pillars in carrying out its duties, namely availability (implementing the policy of purchasing grain/rice), affordability (distribution rice to the public), stability (maintaining the price stability at the farmer and consumer level), and quality (providing quality and healthy staple foods for the community). Perum BULOG manages two types of rice differentiated based on their function: PSO (Public Service Obligation) rice and commercial rice. Commercial rice is premium quality rice sold by Bulog in 5 Kg packs to the public through RPK outlets (Rumah Pangan Kita).

Storage time of 5 kg packaged Premium Rice in the warehouse is 14 days. Premium 5 kg packaged rice, which is approaching its shelf life, will be distributed to the marketing network through Rumah Pangan Kita (RPK) outlets. The distribution process is carried out based on RPK outlet orders. However, RPK outlets often experience shortages of premium rice supplies due to an unintegrated information system. RPK outlets could not know the arrival date of the premium rice ordered through Perum Bulog Sub Divre III Surakarta. According to Tjahyono (2018), uncertainty about the arrival time of orders can cause a shortage of inventory and lead to lost sales opportunities.

The information system not integrated and traceable also lacks supervision of sending premium rice from BULOG to RPK. In 2019, the Perum BULOG investigation team received public reports that premium rice under the BULOG brand was mixed with low-quality rice. In addition, according to deJurnal.com (2020), premium rice produced by Perum BULOG is often found with other objects such as gravel/lastic. Based on these conditions will have an impact on the company's image because the quality of products received by consumers has a significant impact on purchasing decisions (Vannesa &

¹ Industrial Engineering Department, Faculty of Engineering, Universitas Sebelas Maret, Jl. Ir. Sutami No.36, Kentingan, Surakarta, 57126, Indonesia

ᵃ email: sutopoafan@gmail.com
ᵇ email: susysus2011@gmail.com
ᶜ email: lobesh@gmail.com
◆ corresponding author

Arifin, 2017)

The method to overcome this problem is to design a piece of integration information with a traceability system from upstream to downstream. The implementation of traceability requires mapping activities at Perum Bulog Subdivre III Surakarta. Activity mapping is carried out using a business process analysis approach. Traceability based on business process analysis allows for complete activity mapping. The whole tracking level will ensure consumers' food quality and safety (Scroeder & Tonsor, 2012).

Traceability refers to "the ability to trace and follow a food, feed, food-producing animal or ingredients, through all stages of production and distribution" (European Commission, 2000). The Codex Alimentarius Commission (CAC) has pointed out that traceability is a key to risk management, especially in the monitoring and identifying unintended effects. To achieve these goals, traceability systems have been used in different areas all over the world. Several EU countries, such as France and the UK, proposed applying such systems to animals and animal products due to the massive outbreak of mad cow disease in Europe (Souza-Monteiro & Caswell, 2009; Houghton et al., 2008). Traceability systems are currently being developed and used to track and trace various foods (Hu, Zhang, Moga, & Neculita, 2013; Schroeder & Tonsor, 2012; Ruiz-Garcia, Steinberger, & Rothmund, 2010).

The technology used in the traceability system is an android system application and is connected to the internet network by integrating the 2D barcode system. According to Taibo Chen et al. (2020), the traceability system with the 2D barcode system, especially the QR Code type, is relatively inexpensive and can record large amounts of data, besides being easy to adopt into companies. Meanwhile, Android provides an open platform for developers to create their applications for various needs. Aung and Chang (2014) also suggest that smartphones and the internet will be the foundation for developing a traceability system where high-cost issues can be resolved.

This paper aims to develop a traceability system using an Android-based QR Code to identify physical characteristics, specifications, and quality and maintain product image.

II. RESEARCH METHOD

The design and development of traceability systems adopted System Development Life Cycle (SDLC) approach that consists of several steps (namely: (1) system investigation, (2) system analysis, (3) system design, (4) prototype development, and (5) system evaluation system. Figure 1 shows the method of developing a traceability system (Figure 1).
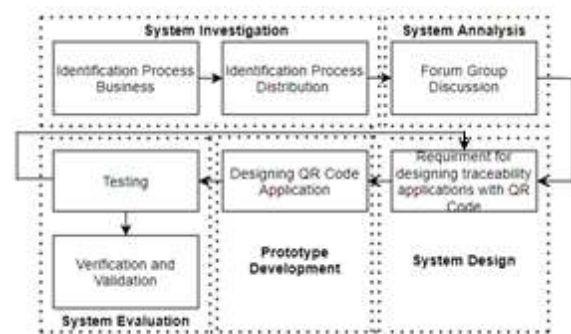

Figure 1. System Development Life Cycle

System Investigation

The system investigation consists of identification process business and identification process distribution.

The purpose of identifying the business process and distribution process of Perum Bulog Subdivre III Surakarta is to determine the management of premium rice 5 Kg packs. Identification begins with compiling a framework in the form of a Business Reengineering Process. The reengineering process for premium 5 kg packaged rice starts from planning, procuring, rebagging (packaging), storage, and marketing.

System Analysis

Forum Group Discussion activities were carried out with several stakeholders: Head of Branch, Head of Processing Warehouse, Head of Storage Warehouse, Head of Distribution Center, Marketing, RPK Outlets, Developers.

Researches focused on product traceability

during Distribution and premium rice quality. The foundation of the Forum Group Discussion (FGD) activity is based on the 4 pillars owned by Perum Bulog Sub Divre III Surakarta. 4 pillars Perum Bulog are availability, quality, affordability, stability.

System Design

From the Forum Group Discussion results, it was agreed that 2 main pillars (quality and affordability) were used as the basis for identifying design needs in solving problems at Perum Bulog Subdivre III Surakarta.

The identification of design requirements that have been carried out will be the basis for input to determine the technical specifications of the Bulog mobile application design that will be made.

Prototype Development

Designing QR Code application to integrate information in every activity carried out by the company so that it can track and trace information accurately, steps are needed such as: designing a QR Code flow pattern system, designing a QR Code, designing a database designing a user interface and also designing role model (Figure 2).
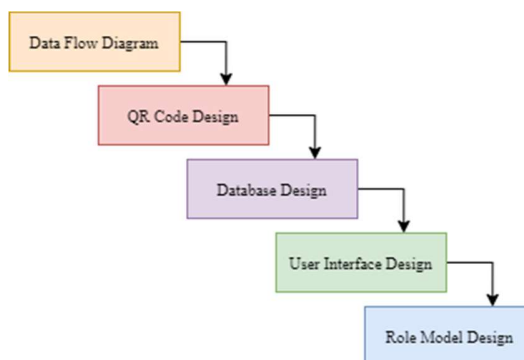
Figure 2. Prototype Development Step

System Evaluation

The test is carried out to find out whether the application is running according to the expected function. Testing the BULOG Mobile application using the Usability Testing method. Usability testing is giving the respondent the task of doing something. The aspects in usability

testing include five things (Battleson, Booth & Weintrop, (2001), as follows: (1). Learnability explains the level of ease of users to complete basic tasks, (2). Efficiency describes how fast the user can complete a task to learn the BULOG Mobile application for the first time, (3). Memorability explains the level of ease of users in using the Mobile BULOG application properly after not using it for a while, (4). Errors explain the possibility of errors made by users and how easy to solve the BULOG Mobile application's error, and (5). Satisfaction describes the level of user satisfaction in using the Mobile BULOG application that has been made.

Testing was carried out using 10 respondents consisting of employees of Perum BULOG Sub Divre III Surakarta and Supervisors.

System Evaluation also provides validation and verification for mobile Bulog applications. The aim is to ensure that the application testing method can produce valid results so that if it produces valid results, it can be used for further testing. Validation and verification are done by testing using several brands of smartphones and several types of android versions.

III. RESULT AND DISCUSSION

System Investigation

The first step in system investigation is the identification process business and Business processes at Perum Bulog Sub Divre III Surakarta through identification by observations, interviews, and collection of SOP documents (Standard. Operating Procedures) in processing premium rice weighing 5 kg. The processing of premium rice at Perum Bulog Subdivre III Surakarta begins with the demand for premium rice in the Surakarta area. The process of procuring premium rice raw materials comes from medium rice. The activities of procuring premium rice from suppliers include planning for rice procurement, selecting suppliers, and making contracts for premium rice procurement agreements. In addition, the quality control officer checks the rice samples from the supplier based on the quality standards by the company.

Premium   rice   with   company   quality

standards (up to 100% sosoh degree, 14% maximum moisture content, 95% maximum head rice, 5% maximum broken grain) will be stored in the warehouse. In the storage process, before going into the rebagging process, warehouse officers take care of the rice to prevent quality degradation. The warehouse clerk performs rice maintenance by cleaning the storage warehouse periodically, controlling the temperature not exceeding 37 ° C, and spraying if pests are found in rice. Maintenance activities continue until the premium rice enters the rebagging process.

Premium rice that has been packed into 5 Kg packs later carried out by the distribution company of Perum Bulog Subdivre III Surakarta. Premium 5 kg packaged rice is ready to be delivered to Rumah Pangan Kita (RPK) outlets.

The second step is the identification distribution process. Distribution of premium rice orders ordered by RPK outlets carried out by the distribution center. The distribution center will send rice orders after receiving information and delivery orders from the marketing department. But so far, RPK has not been able to know when the arrival of premium rice orders ordered through Perum Bulog Sub Divre III Surakarta. Uncertainty and unclear orders for premium rice often result from stock out at RPK outlets. (Figure 3)
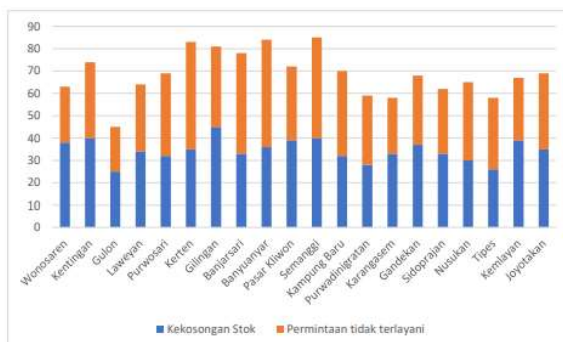

Figure 3. Demand and Lost Sale Graphic

Figure 4. Data Product *Return*

According to Tjahjono (2018), uncertainty and uncertainty in the arrival time of orders can cause a shortage of inventory and cause lost sales opportunities.

Premium rice produced by Perum Bulog Subdivre III Surakarta must comply with company standards. However, the Perum BULOG task force received reports from the public that premium rice with the BULOG brand was often substandard premium rice quality. The data recorded during the January-June 2020 period showed that rice was not up to standard and was damaged, then returned by the RPK outlet can be explained in Figure 4.

A control system that has not been integrated has resulted in poor control of product quality standards, resulting in many products being returned.

Integrated documentation and records in management premium rice distribution can find out the origin of the rice supplier, the mix of rice composition used, the date of entry to the warehouse, the date of processing, the location of selling rice to RPK, and other information. In addition, if there is an issue of mixing plastic rice, the Perum Bulog Sub Divre III Surakarta can narrow down the search and identify the causes of the problem so that an evaluation can be carried out.

The food product traceability system is also in line with the Regulation of the Head of the Food and Drug Supervisory Agency (BPOM) 22 of 2017 concerning the withdrawal of food from Distribution, namely Producers, Importers, and Distributor Services, must have a food traceability system as the basis for the effective recall.

System Analysis

The process of identifying technical needs for designing solution with Forum Group Discussion (FGD) activity to the stakeholders of the 5 kg premium rice distribution process, namely Perum Bulog Sub Divre III Surakarta, developers, and researchers. The purpose of the FGD is to involve stakeholders in the formulation, decision making, supervision, control, and involvement of implementing tools for solving problems at Perum Bulog Sub Divre III Surakarta.

The discussion activity involved 11 people, namely 1 head of the Perum Bulog Subdivre III Surakarta branch, 1 head of premium rice processing, 1 head of premium rice warehousing in Subdivre III Surakarta, 5 representatives of RPK Solo Region, 2 application developer teams, and 1 researcher.

Forum Group Discussions (FGD) method is a common approach for data collection in qualitative research projects, without exception in nursing research in recent years. Similar to the FGD method, Hollander (2004) defines the FGD method as a method for obtaining data/information products through the social interaction of a group of individuals who in this interaction mutually influence one another.

System Design

From the Forum Group Discussion results, it was agreed that 2 main pillars (quality and affordability) were used as the basis for identifying the design needs in solving problems at Perum Bulog Subdivre III Surakarta. (Tabel 1)

Identification of design requirements such as A reporting information system is available the results of checking the quality of rice processing, Information systems that can identify products that have been made, available information on distribution activities premium rice to an accurate RPK sales outlet, easy to operate, accessible and guaranteed data security. Identification of design requirements that have been made will become the basis for input to determine the detailed technical requirements to understand the requirements of the Bulog mobile application (Table 2)

Identification of needs is carried out to adjust policies with real systems. Stakeholders for the preparation of the application are selected according to the needs of the QR Code application design.

Technical Details Of Design Mobile Bulog

Using a quality checking system that is integrated with the rice processing process. The quality checking system integrated directly into the rice processing process can help and facilitate the Perum Bulog Sub Divre III Suraarta in

Tabel 1. Bulog and Application Requirements

Pillar	Requirement BULOG	Requirement Application
Quality	Guarantee the quality of the rice products being sold. Build a good name for the company by producing the best products, especially premium rice products.	Providing an information system reporting the results of checking the quality of processed rice. Information systems that can identify products that have been made
Afford ability	Ensure that the rice produced can be spread to the community through the Rumah Pangan Kita (RPK) sales outlet network. Ensure the existence of food that is physically close to consumers and always available	Provide accurate information on premium rice distribution activities to RPK sales outlets with QR Code. The tool is easy to operate and easy to access, and guaranteed data security.

Tabel 2. Technical Requirements Application

No	Requirement Application	Technical Requirements Application
1	Information system for reporting the results of real-time rice quality checking.	Using a quality checking system that is integrated with premium rice processing
2	Information systems that can identify products that have been made	Placing a QR Code in each product.
3	Information system on activities for distributing premium rice to RPK outlets that are accurate.	Tracking the results of orders and delivery of rice to RPK with QRCodeReceipt.
4	The tool is easy to operate and easy to access	Using Android-Based Mobile Application

monitoring the results of the quality of rice that has been processed. Meanwhile, the quality checking officer enters the data from checking the premium rice processing into the system that has been made and can automatically determine

whether the rice meets the premium rice standard.

Placing a QR Code in each product. QR Code given to each premium rice product can identify physical characteristics, specifications, quality and maintain the image of premium rice products. QR Code is a relatively inexpensive system and can record large amounts of data so that it can record all product travel information in detail. Besides that, it is easy to adopt into the company.

The tracking feature for ordering and sending rice to RPK.

Placing the results of ordering and sending rice to our Home Food Outlet was made to provide detailed information on rice orders ordered by RPK. Meanwhile, the producer of Perum Bulog can monitor and ensure that the premium rice orders sent have arrived in the RPK accurately.

Using Android Based Applications. Android-based applications can be easy to operate and easy. As a result of observations, most of the

stakeholders use Android-based smartphones to communicate. The Android-based application was chosen as the basis for developing an information system.

Creating a Login system based on the type of User (Application User). The Login system based on the type of User is made to ensure that the data accessed is in accordance with the duties and roles of each stakeholder so that there are no mistakes in accessing information.

Prototype Development

The stages for designing the Bulog mobile application are QR Code flowchart, QR Code design, application system database design, application user interface design, and the role in the QR Code application.

1. Data Flow Diagram

The design of the Bulog QR Code Mobile application for integration information in every activity carried out by the company so that it can track and trace information accurately; steps are needed such as: designing a QR Code flow
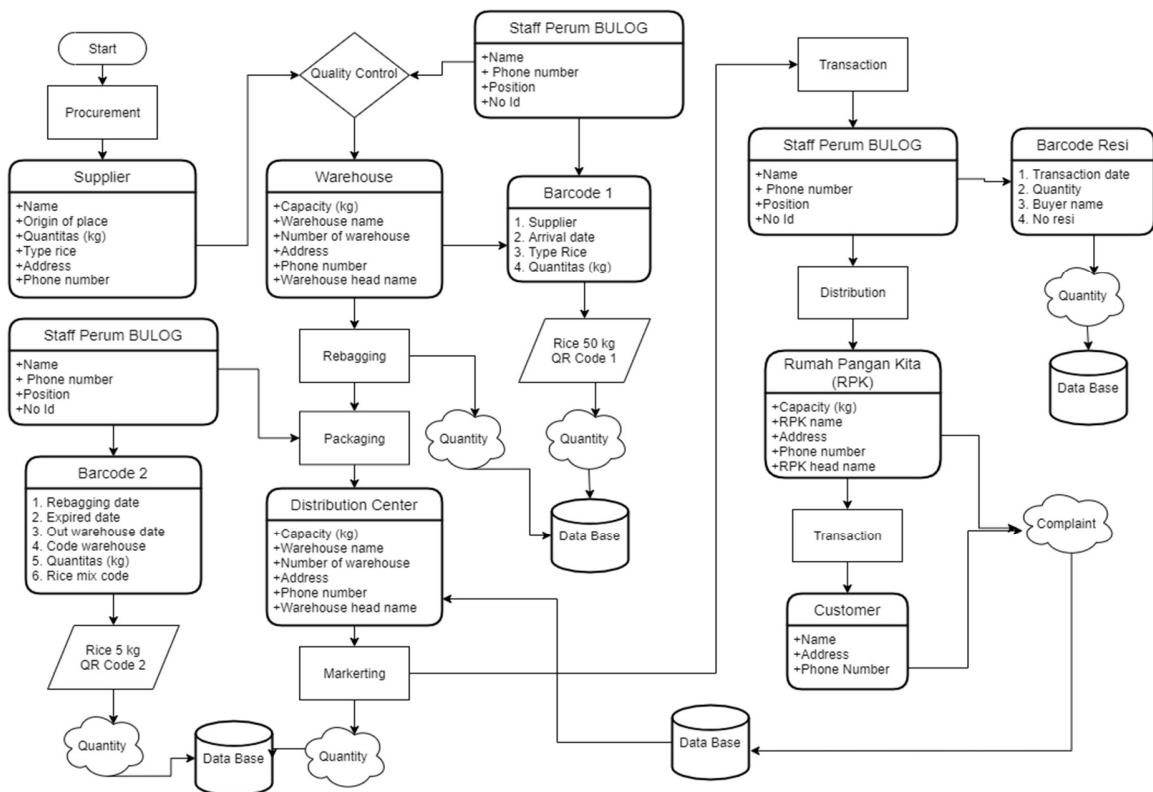
Figure 5. Data Flow Diagram

pattern system, designing a QR Code, designing a database and designing a user interface. (Figure 5)

The design of the QR Code flow diagram system comes from the business process of Bulog Subdivre III Surakarta so that the QR Code can provide accurate information. QR Code Flow Pattern System 1, The supplier (Gapoktan, Task Force, Partners) sends lots of premium rice orders to the warehouse of Perum Bulog Subdivre III Surakarta. Quality inspectors check rice samples at Minilab. The quality standards of Bulog's Premium rice are water content max 14%, the minimum degree of foam 95%, broken grains max 20%, and groats grains max 2%. After passing the quality test, the rice storage warehouse officer enters the data, containing the date of arrival of the rice, the supplier of origin of the rice, the quantity, and the location of the warehouse. This information is generated into QR code 1. QR Code Flow Pattern System 2, before the rebagging process (packing rice into 5 Kg packs).

The scanning process is carried out on QR code 1. This process stores and identifies information about 5 kg packaged rice to the information system database. The packaging clerk performs the 5 Kg premium rice rebagging process in the warehouse. The 5 Kg premium rice packs rebagg depend on the marketing division's DO (Delivery Order). The shelf life of 5 kg packaged premium rice in the warehouse is 14 days. A QR code 2 will be generated and attached to each 5 Kg premium rice package in the rebagging process. QR code 2 contains information regarding the rice production date and rice expiration date. (automatically filled, 6 months from the rice production date), packaging code, processing warehouse code, and rice mixture code.

Premium Rice Order QR Code Flow Pattern System, Premium rice 5 Kg packs are sent and distributed to 9 warehouse complexes of Perum Bulog Subdivre III Surakarta. Distribution center officers enter information about the location of the storage warehouse. The data is stored in the information system database to be recorded and tracked quickly and accurately. The marketing

division received requests for premium rice from RPK outlets. Premium rice with a shelf life of close to 14 days (based on QR Code 2 data) is sold automatically by the system. This system was designed to facilitate the delivery process, and the selection of premium rice sent to the RPK.

The marketing officer inputs the location of the RPK outlet, the nearest warehouse complex area, and the time of delivery to the RPK outlet. The data is printed in the QR Code for premium rice orders. RPK uses the ordering QR code to check and monitor the premium rice orders ordered. In addition, the QR code for ordering can be used to report damage to 5 Kg of premium rice packaging.

2. QR Code Design

QR Code design is used to determine the information to be stored in the QR Code. This information is designed and made according to the needs of Bulog mobile application (Table 3).

Tabel 3. QR Code Information

QR Code	Information
QR Code 1	Arrival time of premium rice (date, day, and hour), type of rice, supplier, quality check, and quantity (kg)
QR Code 2	Rebagging date (date, day, hour), expired date (date and year), packaging code, warehouse location, rice mixture.
QR Code Resi	QR Code Receipts are used to recapitulate sales of 5 kilograms of premium rice to RPK (Rumah Pangan Kita).

3. Database Design

Database design using MySQL in its manufacture. The MySQL database will determine the relationships between existing entities. so that the application can run with the wishes that have been designed before. (Figure 6)

The MySQL database system was chosen because it supports several features such as multithreaded, multi-user, and SQL database management systems (DBMS). This database was created for a database system that is fast, reliable, and easy to use (Budi Asmara, Septian, 2016)
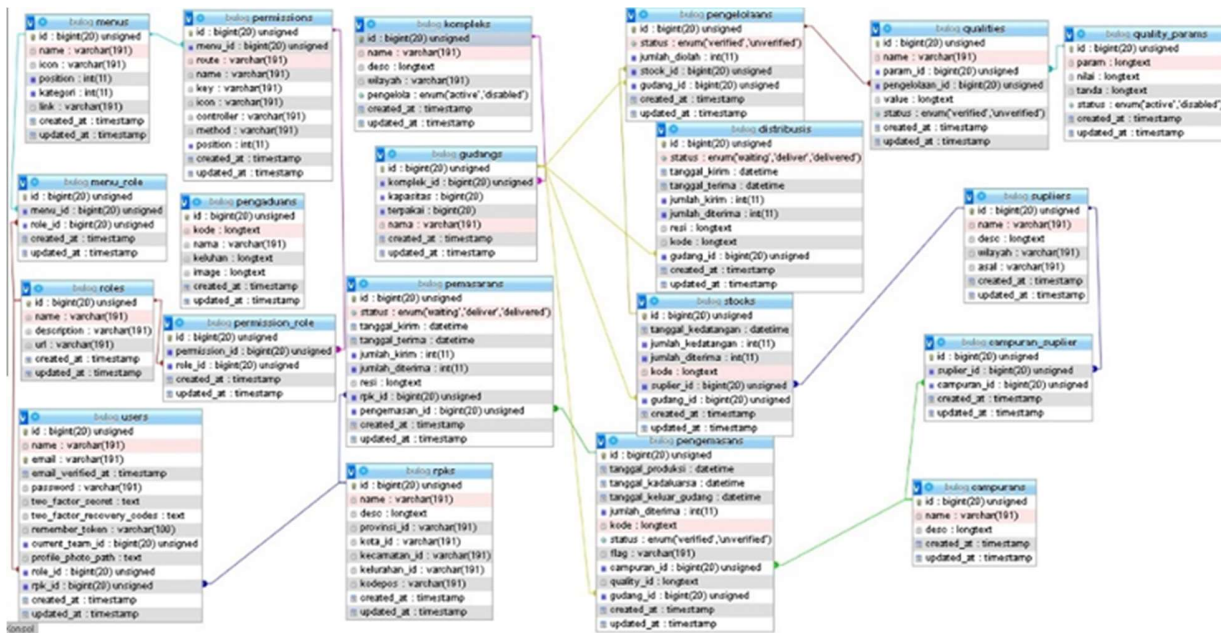
Figure 6. Database Relationship

4. User Interface

The user interface design consists of the main menu form design, which can be explained in Figure 7.

Choosing the dominant color of orange and blue to match the color of company pride, besides that the dominant color of orange (Yellow-Red) will create a joyful effect for someone (Nijdam, N.A. (2005). Mapping emotion to color)

5. Designing Role Model

The design of roles in the BULOG Mobile application login is needed to maintain the level of data confidentiality. Authorization is given to Bulog mobile users to access certain resources such as data files, applications, printers, and scanners. User permissions also determine the type of access.

System Evaluation

1. Testing
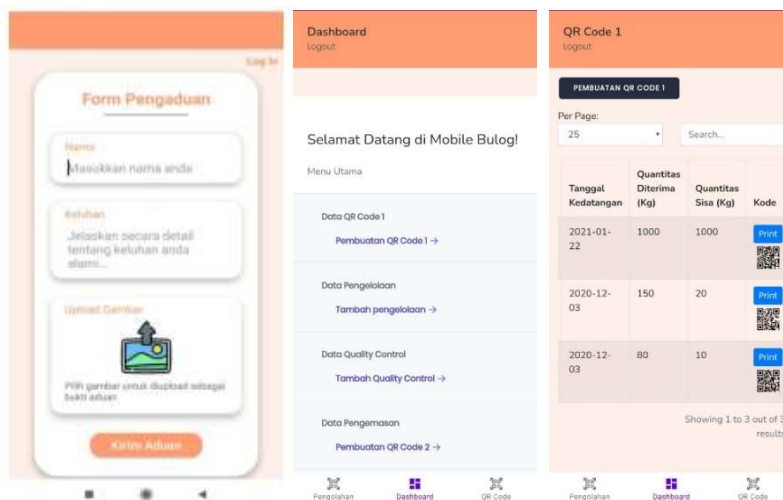
Testing the BULOG Mobile application to

Figure 7. User Interface

determine the research objectives using usability testing. The test results obtained by the Bulog Mobile application, among others, help make it easier to analyze and identify problematic products, make it easier to check the Distribution of 5 Kg packaged premium rice orders. (Figure 8)

From the usability testing results, from the application aspect, the user aspect, and the research objective aspect, satisfactory and positive results were obtained.
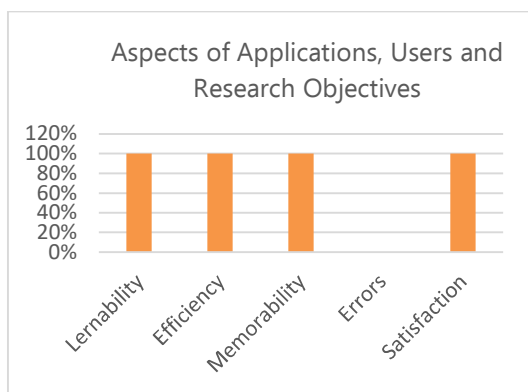
2. Verification and Validation

Figure 8 Aspects of Applications, Users, and Research Objectives
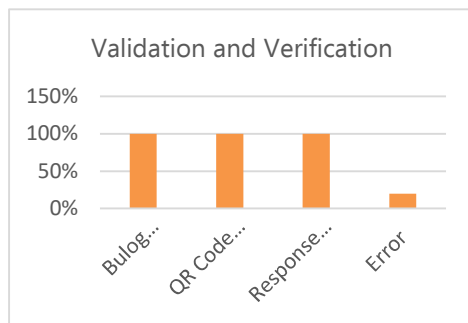

Figure 9 Validation and Verification

Verification and validation are done by testing using several brands of Android smartphones. Android smartphone brands that are tested on the BULOG Mobile application are Samsung A70 2018, Android 10, Samsung S20 2020, Android 10, Realme 5 Pro, Android 10, Xiaomi Mi 10, Android 10, Lenovo S5, Android 8, Redmi Note 7, 9, Vivo V20, android 10, Oppo Reno 4F, android 10, Xiaomi Redmi 5, android 9, Asus Zenfone 6, and android 10. (Figure 9).

On Realme 5 Pro, Android 10, there are problems when scanning the QR Code because there are scratches on the rear camera. On the Lenovo S5, Android 8, there are problems when the application is run for a long time and has experienced a system crash due to the full smartphone memory.

IV. CONCLUSION

Successfully designed a tracking system for the Distribution of premium 5 kg rice at Perum Bulog Sub Divre III Surakarta using a QR Code based on an android smartphone application. The design result is an application called "Mobile BULOG." Testing the BULOG Mobile application obtained positive results and the benefits felt by Perum Bulog Sub Divre III Surakarta. Suggestions for further research are to improve the more attractive BULOG Mobile user interface. level of tracking should be done in more detail down to the farmer so that they can trace the problem down to the root

REFERENCES

Aung, M. M., & Chang, Y. S. (2014). Traceability in a food supply chain: Safety and quality perspectives. *Journal of Food Control*, 39, 172–184.

Battleson, B., Booth, A., & Weintrop, J. (2001). *Usability testing of an academic library Web site: a case study. The Journal of Academic Librarianship, 27(3), 188–198.* doi:10.1016/s0099-1333(01)00180-x

Budi Asmara, Septian. (2016). Design And Implementation Of Mobile Application As Monitors And Controllers At Building Security System Based On Embedded. *e-Proceeding of Engineering.* Vol.3, No.1 April 2016 | Page 674

Dejurnal. (2020). Ada Beras Plastik Beredar Di Masyarakat, Dedi Mulyadi Sidak Gudang Beras Bulog Subang [web page]. Retrieved from https://www.dejurnal.com/2020/10/ada-beras-plastik-beredar-di-masyarakat-dedi-mulyadi-sidak-gudang-beras-bulog-subang/.

Chen, T., Ding, K., Hao, S., Li, G., & Qu, J. (2020). Batch-based traceability for pork: A mobile solution with 2D barcode technology. *Food Control, 107, 106770.* doi:10.1016/j.foodcont.2019.106770

European Commission (2000). Regulation (EC) No 1760/2000 of the European Parliament and of the Council of 17 July 2000, establishing a system for the identification and registration of bovine animals and regarding the labeling of beef and beef

products and repealing Council Regulation. EC) No 820/97 (16/03/2012.

Mardianto S. dan Ariani M. Kebijakan Proteksi dan Promosi Komoditas Beras di Asia dan Prospek Pengembangannya di Indonesia. Pertanian. Departemen Pertanian. Bogor. 2004: 2(4); 340-353.

Nijdam, N.A. (2005). Mapping emotion to color: Semantic Scholar.

Ruiz-Garcia, L., Steinberger, G., & Rothmund, M. (2010). A model and prototype implementation for tracking and tracing agricultural batch products along the food chain. *Food Control, 21(2), 112–121.* doi:10.1016/j.foodcont.2008.12.003

Schroeder, T. C., & Tonsor, G. T. (2012). International cattle ID and traceability: Competitive implications for the US. *Food Policy, 37(1), 31–40.* doi:10.1016/j.foodpol.2011.10.005

Souza-Monteiro, D. M., & Caswell, J. A. (2009). Traceability adoption at the farm level: An empirical analysis of the Portuguese pear industry. *Food Policy*, 34(1), 94–101.

Hollander, J.A. (2004). The social contexts of focus groups. *Journal of Contemporary Ethnography*, 33, 5, 602-637.

Hu, J., Zhang, X., Moga, L. M., & Neculita, M. (2013). Modeling and implementation of the vegetable supply chain traceability system. *Food Control*, 30(1), 341–353.

Vanessa, I., & Arifin, Z. 2017. Pengaruh Citra Merek (Brand Image) dan Harga Terhadap Keputusan Pembelian Konsumen. *Jurnal Administrasi Bisnis* (JAB). 51(1).

Tjahyono, Erlin. 2018. Analisa Penyebab dan Upaya Mengurangi Lost Sales yang Terjadi di PT Emaro Online Indonesia. Jurnal Titra, vol. 6, No. 2, Juli 2018, pp. 215-222 Natalla, D.; Nurozy. (2012), "Kinerja daya saing produk perikanan Indonesia di pasar global". *Buletin Ilmiah Litbang Perdagangan*, Vol. 6 (1), 68 – 88.