Design of Waste Management System Using QR Code for Effective Management in Wastebank

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Abstract. Waste management is one of the problems faced in almost every city in Indonesia. One way to manage waste is through the waste bank. The business process of a waste bank is similar to a bank, but it is processed in the form of inorganic waste that has been sorted. In general, data management in waste banks is still conventional but the others have used web-based or mobile technology. But in this way there are still some weaknesses such as the time needed to input the collected waste data because the data cannot be directly entered into the system. In addition it can occur inaccurately entered data. The proposed method is using the QR code for the waste management system. In this method, admin only need to scan the QR code label attached on the waste bin stored above the weighing device using a smartphone camera. With this system QR scanner application based on mobile can be synchronized automatically with android smartphone. Admin then input the weight of the waste that is weighed and will be stored in the database. In this way the data input process can be faster and with the use of QR code, more data can be stored.

1. Introduction
Waste management is one of the problems faced in almost every city in the city Indonesia. The volume of waste produced is not proportional to the amount of waste that is transported to the disposal landfill. Waste can have negative impacts on the environment, health and socially. Garbage can pollute the environment both on land and in the water so, it can affect public health conditions. One type of waste which difficult to decompose is plastic waste, which on average will decompose after 100 years. US’ National Oceanic and Atmospheric Administration (NOAA) and Woods Hole Sea Grant compare decomposition rate for man-made marine debris to biodegrade in the sea. Decomposition rate of several debris shown in table 1.

| Type of debris          | Decomposition rate (years) |
|------------------------|----------------------------|
| Plastic grocery bag    | 10-20                      |
| Foam cup               | 50                         |
| Disposable diaper      | 450                        |
| Plastic beverage bottle| 450                        |
| Fishing line           | 600                        |

Table 1. Decomposition rate of debris
According to research conducted by McKinsey and Co and Ocean Conservancy, in 2019 Indonesia is the second largest producer of plastic waste in the world after China. Produces plastic waste in Indonesia every day can reach 175,000 tons. With this amount, in one year plastic waste in Indonesia reached 63.9 million tons.

One way to handle waste is by using the waste bank program. According to the Minister of Environment Regulation Life No. 13 in 2012, a waste bank is a place for sorting and collecting waste that can be recycled reused and / or reused that has economic value. The business process of a garbage bank is similar to a bank, but it is processed in the form of inorganic waste that has been sorted. Through the waste bank, in addition to reduce the volume of waste at the disposal site, it also provides economic benefits to the community. One way to solve the waste problem is through the 3R principle (reduce, reuse, recycle). The development and strengthening of public awareness through the local people will solve waste problems with waste banks management model. Waste banks already exist in several cities in Indonesia. According to the environment ministry in the waste bank management information system site at http://sipsn.menlhk.go.id/ there are around 7000 waste banks spread in Indonesia with customers reaching hundreds of thousands of people. With potential customers who a lot of these then the velocity of money in thousands of waste banks reaches billions of rupiah per year.

In general, data management in garbage banks has not yet utilized information technology. Management still uses conventional methods where recording only uses books. There are several weaknesses of the system including the need for papers for data storage media, data is easily lost, and the need for time to input data. These things cause inefficient and effective management [1] but there are also who already use web-based and mobile technologies.

The purpose of this article is to design a system that using QR codes for the system waste management at a waste bank. In this method the admin only needs to scan the QR code label attached in a waste bin that is stored above weighing device using smartphone camera. With this system it is expected that the process of managing data in a waste bank can be more effective and efficient.

2. Literature review
2.1. Waste bank
Waste bank operates like a bank which people in a community, subdistrict, and district can use to deposit them garbage or extract money from the value of the garbage provide to the facility [2]. In addition to managing waste based on 3R principal, the waste bank also has the aim to improve the level of the economy through community economic empowerment programs so as to increase public income [3] and sustainable waste management [4]. Waste to be processed in the waste bank in the form of inorganic waste such as plastic, paper, metal, and glass. The working mechanism of the trash bank includes waste sorting before deliver, delivery where waste is deliver to waste bank by the customer itself or pick up, waste weighing, recording, which is submitted to the savings book and sharing of waste revenue between customer and the waste bank institutions. The mechanism of waste bank can be seen in figure 1.
2.2. QR code
QR Code or commonly known as QR Code is a form of evolution of barcode from one dimension into two dimensions. QR Code is a two-dimensional matrix code or barcode that comes from the word "Quick Response ", where the contents of the code can be deciphered quickly and accurately. QR Code was developed by Denso Wave, a Japanese company that was published in 1994.

QR codes are quickly arriving at high degrees of acceptance. More and more people adopt and use this technology every day. One of the reasons behind the rapid growth of the QR code is that it gains momentum as smartphone users grow across the world and marketers use QR codes to reach mobile consumers [5]. Compared to ordinary bar codes, QR Codes are easier to read by the scanner and able to store data both horizontally and vertically. QR Code works by reading several components on code box. Three large boxes in each corner depict the code barrier. Whereas more boxes small is useful for measuring large boxes. Some of the components in the middle of the code are time patterns, information data, and version number. These areas are read by the scanner and processed so that the QR data Code works. Example of QR code is shown in figure 2.

The capacity of the data contained in the QR code is very large. QR code has high data density which is around 100 more times than barcode. QR code can contain more information than a barcode comparable to 7000 alphanumeric characters. Besides of its capacity, QR code has several other advantages such as freely available, follow ISO standard, dynamics, and completely measurable [6][7]. But using the qr code can also be unsecure if the user scans for unknown qr code. Users can be attacked and directed to websites that contain viruses, worms and trojans. It can damage software and hardware [7].

![QR Code Image](image)

Figure 2. Example of QR code

Currently QR code has been used for several fields. Such as research of QR code application in education [8] shows that QR codes supports both independent and collaborative learning and can create an interactive learning environment and application in academic libraries to promote their service and resources [6]. While researching QR codes for infectious waste management systems [9]. In the smart waste management usage QR code for intelligent bin. The QR code is used by waste management company to justify the garbage is already collected [10].

3. Method
The method used in this research is software engineering with waterfall model. The waterfall model consists of several sequential stages. It flows like a waterfall. Waterfall stages are analysis, design, implementation and deployment. At the analysis stage a description of the system will be made and functional requirements of the system are modeled.

3.1. System description
The proposed method is using the QR code for the waste data management system. Waste deposited by the customer is inorganic waste that has been sorted before. Waste is divided into four categories: plastic, paper, glass, and metal. This application is mobile and web based. Admin can manage data through computers or mobile phones, while customers use application that is installed on an android hanphone. Admin only need to scan the QR code label attached on the waste bin which is stored above the weighing device using QR scanner camera. If the waste data has been stored in the database, the data
will be displayed in the admin application, but if data has not been entered, it will not be displayed. Admin then input the weight of the waste that is weighed and will be stored in the database. Each type of waste has a different price. Money received by customers will be put into savings. Customers can check saving information in real time through application mobile. In addition, the amount of waste stock in the waste bank is immediately updated in real time. The proposed system flow is shown in figure 3.

Figure 3. Proposed system flow diagram

3.2. System modeling
Functional requirements modeling is create to design the proposed system. With graphical illustrates, system descriptions and designs will be easier to understand. In this research, design modeling is used unified modeling language (UML).

3.2.1. Use case diagram
Use case diagram illustrates user interaction with the system to be created. In the use case diagram, the functions of each actor in the system are explained. Use case diagram is shown in figure 4. There are two actors as system users, admin at the waste bank institution and waste bank customer. Admin performs the functions of managing customers, waste and transactions. Whereas customers can only see savings updates. Before performing these functions, the admin and customer must login first.

Figure 4. Use case diagram
3.2.2. Activity diagram
Activity diagram illustrates the flow of processes or activities contained in each use case diagram of the system. Activity diagram of waste deposit management can be shown in figure 5 and activity diagram manage waste data can be shown in figure 6.

4. Result and discussion
The result of this research is design of waste management system using QR code. There are two result of main design in form of QR code and interface design.

4.1. QR code design
QR code labels can be made easily and free. There are several websites that can create QR codes, such as at https://www.the-qrcode-generator.com/. The QR code created is dynamic so that information can be changed according to need. The information contained in the QR code consists of the code, type, name, price and description of the waste. Examples of designed QR codes are shown in table 2.

| QR Code Information                  |
|-------------------------------------|
| Code: P01                          |
| Type: Plastic                      |
| Item: Mineral water plastic cup    |
| Price: Rp 5000,-/kg                |
| Description: Clear plastic cup with cut end |
|                                    |
| Code: P01                          |
| Type: Paper                        |
| Item: Archive                      |
| Price: Rp 1700,-/kg                |
| Description: HVS, book without cover, long cut white paper |

Figure 5. Activity diagram waste deposit
Figure 6. Activity diagram manage waste data
4.2. QR code design

Interface is a connector between the user and the system. Figure 7 shows the interface design for the transaction and waste deposit function. On the transaction menu there are several options such as deposits, selling waste, and taking savings. QR code scanning can be found in the waste deposit menu using the QR scanner connected to the mobile camera.

![Figure 7. Interface design of transaction](image)

5. Conclusion

Waste management system using QR code application that able giving benefits to admin in waste bank institution and to costumer of waste bank. The admin can manage data more effectively and efficiently, while customers can find savings in real time.

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