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PROTOTYPE OF A MOBILE AND WEB-BASED WASTE BANK APPLICATION TO SUPPORT COMMUNITY WASTE MANAGEMENT

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Abstract

Waste banks, as a community-based management model, have proven effective in reducing waste volume and increasing environmental awareness. This study aims to design a prototype of a mobile and web-based waste bank application that can simplify the process of recording, transacting, and monitoring customer data for waste bank managers. For customers, this application can facilitate tracking of transaction history and facilitate the dissemination of information and education related to waste management. The method used is a prototype approach, the results show that the designed application is able to provide features for recording transactions, managing customer data, scheduling waste pickup, and financial reporting. Based on the results of the evaluation using the system usability scale (SUS), there are several improvements and optimizations in the features of selling waste to recycling partners and financial reporting. However, in general, this application can facilitate users and functions according to user needs.

Keywords: Mobile application, Prototype, Waste bank, Waste management, Web application.

1. Introduction

The problem of waste management, especially in big cities in Indonesia, is an issue that is still not well handled. Poorly managed waste can have an impact on environmental sustainability, health, operational efficiency and economic [1, 2]. Separating organic and inorganic waste is essential as it is a fundamental step in proper and effective waste management, especially to reduce waste accumulation [3]. One of the efforts to reduce the accumulation of waste is through the implementation of waste banks, which is a community-based waste management system that allows customers to save inorganic waste that has economic value [4]. The implementation of waste banks is a strategic step in urban waste management and not only has an impact on the environment, but can also increase household income, which in turn has an impact on the local economy and entrepreneurship [5-7].

Bank Sampah Bumi Inspirasi (BSBI) is one of the active waste banks in Bandung City. The activities carried out by BSBI are: depositing inorganic waste by customers, managing waste inventory, selling waste to recycling partners, and withdrawing customer balances. However, in carrying out its activities, BSBI still uses manual recording using books and spreadsheet applications that cause various obstacles, such as the risk of damage and loss of transaction data, difficulty in tracking transaction data, the length of time to process recapitulation and reporting, to less than optimal transparency and accuracy of information. Along with the development of digital technology, the integration of mobile and web-based systems is a great opportunity to improve efficiency, transparency, and community participation in waste management. This application allows real-time recording of transactions, data integration between managers and customers, and presentation of accurate and easily accessible reports.

This study aims to design an integrated mobile and web-based waste bank application system that can support waste bank management, such as digital transaction recording, monitoring, and reporting of waste transactions, as well as improve the efficiency and accuracy of waste bank management through an integrated system between managers and customers. As for customers, this application is designed to allow them to check their savings balance in real time, withdraw funds, and obtain information on waste prices. The system development method used is a prototype consisting of the stages of requirement analysis, rapid design, prototype creation, and user evaluation.

2. Literature Review

Digital technology-based waste management has been one of the global research focus in the last five years. Digitalization transforms waste management practices that were previously manual, complex, and prone to error into smart, integrated systems that are essential for creating more sustainable smart cities and supporting community-based waste management models such as Waste Bank in Indonesia [8-11]. Digital transformation in the waste management sector aims to improve the efficiency of waste collection, sorting, and processing processes, while encouraging community participation through easily accessible platforms [12].

Several previous studies have discussed the application of waste banks. In previous study, a Java desktop-based waste bank application was implemented to automatically accumulate transactions using the Design Science Research methodology [13]. Another study developed a web-based information management system for waste bank savings using the Prototype method [14]. A mobile-based waste bank application was developed to facilitate real-time balance withdrawals and waste deposits for customers and managers using the prototype method [15].

Applications that were previously only used for transaction management can now be integrated with AI technology that optimizes waste management [16-18]. The concept of smart waste management has integrated the internet of things (IoT), machine learning, and application-based information systems to monitor waste volume, track transactions, and optimize collection routes [19, 20]. Meanwhile, the application of the K-Means machine learning algorithm can improve future waste management strategies for more efficient and sustainable waste disposal practices [21]. Several studies have examined the implementation of mobile applications in waste bank management, which facilitate transaction recording, data reporting, and digital incentives for users [22]. The success of this system depends on user-friendly interface design and real-time database integration for rapid data processing [23]. Meanwhile, gamification-based approaches are also being applied to increase user engagement in sorting and depositing waste [24].

Additionally, digital waste banks support sustainable waste management through the integration of information technology, artificial intelligence (AI), and circular economy models to improve efficiency, accuracy, and public participation [25]. Case studies in various countries show that waste bank applications connected to government programs have higher adoption rates [26]. By combining the findings from these various studies, it can be concluded that an effective waste bank application prototype must integrate digital transaction features, real-time reporting, AI support, and user participation enhancement strategies. This approach not only improves waste management efficiency but also contributes to achieving sustainable development goals (SDGs), particularly targets 11 and 12.

3. Method

This study uses the prototyping system development method. The prototyping method stages applied in this study begin with Requirement Analysis to identify user and system requirements through observation, collection of relevant data, and interviews with waste bank managers. The next stage is quick design, which creates an initial model (mock-up) of the application that describes the appearance and workflow of the system by designing the user interface (UI) for mobile and web, creating Use Case diagrams to describe the system usage flow, and designing data relations using ERD. After designing the application prototype, the next step is to develop the initial application model, including the front end of the mobile application (using Flutter) and web application (using Laravel), implementing the back end for creating basic functions: customer data input, waste transaction recording, and report generation. The next stage is User Evaluation. Field testing is conducted by waste bank managers and several customers using the system usability scale (SUS). In this study, the application development process is in the prototype refinement stage, with several improvements made to application functions such as waste sales transactions, recycling partners, and financial reporting.

4. Results and Discussion

During the requirements analysis stage, functional and non-functional requirements for this application were obtained, as shown in Table 1. After defining functional and non-functional requirements, preliminary application design is carried out. The design includes the system usage flow described in the use case diagram as shown in Fig. 1.

Table 1. Requirement's analysis.

No.	Functional Requirement	Non-Functional Requirements
1	User Management (registration and login for waste bank managers and customers, access management)	Security (access restrictions based on roles, password hashing)
2	Waste Transaction Recording (waste deposit and sales transactions)	Usability (simple and responsive interface)
3	Reporting (customer balance reports and transaction history, waste deposit and sales report, waste stock)	Performance (fast report processing time)

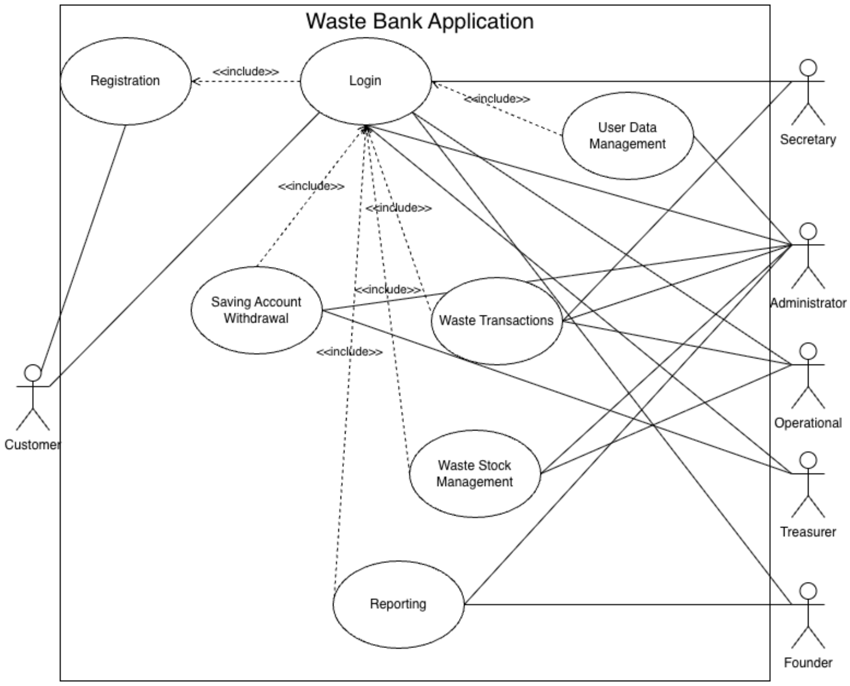

Fig. 1. Use case diagram waste bank application.

The users of the application are described in the system actor notation as customer, and waste bank managers (secretary, administrator, operational, treasurer, and founder). Each actor is associated with each use case designed to suit functional requirements such as user data management, waste transactions (deposits and sales), waste stock management, saving account withdrawal, and reporting. After designing the system usage flow, the next step is to design the database. The design of the relationship between entities is illustrated in the entity relational database (ERD). The mock-up design aims to provide a clear picture to the development team, waste bank managers, and potential users regarding the layout of elements, colours, icons, and application navigation. The mock-up was created for two platforms, namely mobile applications and web applications, as shown in the mock-up examples in Fig. 2.

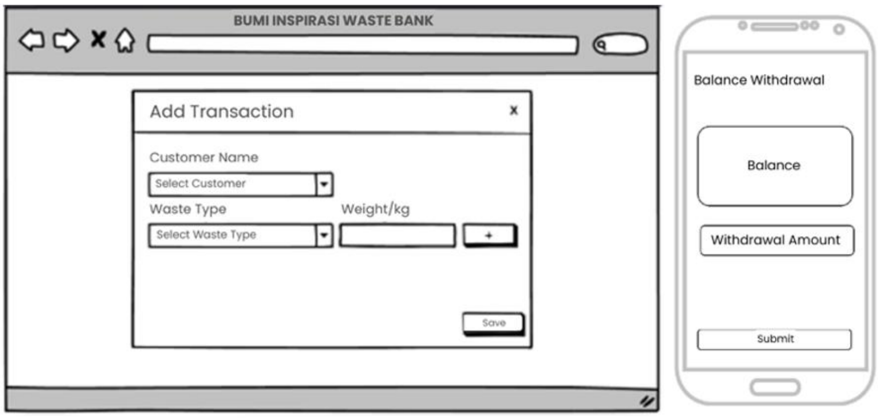

Fig. 2. Mock-up web and mobile application UI.

At this stage, the interface design (mock-up) and agreed-upon requirements specifications are implemented into a functional prototype that can be run, although it does not yet have all the features and performance of the final system. Prototype development begins with creating the front-end structure on mobile platforms, using Flutter. Next, the front-end is connected to the back-end API developed using Laravel, which manages business logic and communication with the database. At this stage, the core features that are the primary focus are recording waste deposit transactions, selling waste to recycling partners, and generating simple financial reports. These features are implemented first to ensure that the main workflow can be tested by users. The prototype build results are then used as evaluation material in the next phase, namely user evaluation and refinement. This allows the development team to receive direct feedback from users and make improvements before the system is fully developed. Examples of web and mobile application prototypes that have been built are as shown in Fig. 3.

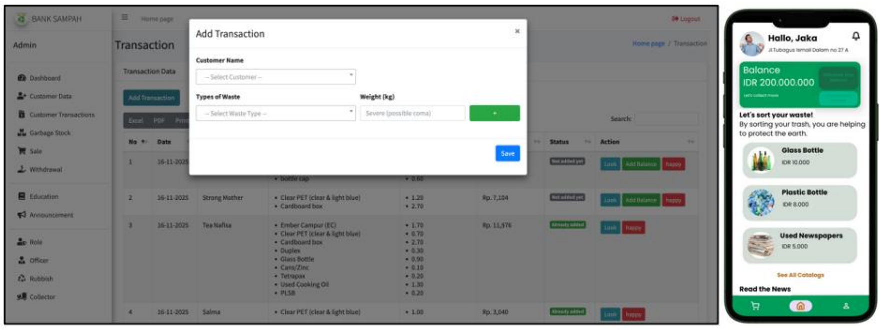

Fig. 3. Web and mobile application prototype.

The evaluation process involved respondents consisting of waste bank managers and bank customers. The evaluation method used is direct testing (user testing), where respondents are asked to use the prototype to record waste deposit transactions, sell waste to recycling partners, view transaction history, and view financial reports. After using it, respondents complete an SUS based questionnaire to measure the system's usability level. The SUS score obtained was 82.5 (Excellent), whereby the prototype of this waste bank application is very easy to use, has clear navigation, and its functions are in line with user needs. However, there are several improvements that need to be made, namely, the sale transaction to recycling partners does not yet have a price negotiation feature, and the financial reporting is not yet in line with the required format.

The prototype of the waste bank application that was developed integrates key features such as customer registration, waste storage transaction recording, savings balance calculation, transaction history, and waste management reports in accordance with the Requirement Analysis. The users of the application are customers and waste bank administrators with roles tailored to each user's tasks. Data relations connect the data needed to build a database, such as user data, waste data, transaction data, and other data. The user interface (UI) design has been adapted from the previous mock-up design, so that the layout, icons, colours, and navigation follow usability principles [27]. Initial testing was conducted using the system usability scale (SUS), involving respondents from potential application users, such as waste bank managers and customers. The test results provided an overview of the level of usability, interaction efficiency, and user satisfaction with the prototype that had been created. The evaluation results obtained will be used to make improvements during the refinement stage. Once the improvements are complete, implementation will continue [28].

5. Conclusion

The development of this waste bank application prototype has generally succeeded in producing a digital system that can simplify the process of managing transactions and customer data at waste banks. Key features such as deposit recording, balance withdrawal, customer data management, and transaction reporting have been implemented with a simple and user-friendly interface. Evaluation results indicate that this application can improve recording efficiency, reduce the risk of data loss, and simplify information access for both staff and customers. Therefore, this prototype will undergo further improvements and feature optimizations to be developed further and implemented to support a sustainable waste bank ecosystem.

References

1. Olawade, D.B.; Fapohunda, O.; Wada, O.Z.; Usman, S.O.; Ige, A.O.; Ajisafe, O.; and Oladapo, B.I. (2024). Smart waste management: A paradigm shift enabled by artificial intelligence. *Waste Management Bulletin*, 2(2), 244-263.
2. Mahmoud, H.A.; Essam, S.; Hassan, M.H.; and Sobh, A.S. (2024). Modeling circular supply chains as an approach for waste management: A systematic review and a conceptual framework. *Journal of Engineering Research,* 14(3), 2527-2537.
3. Chazanah, I.N.; and Nandiyanto, A.B.D. (2022). Literature of waste management (Sorting of organic and inorganic waste) through digital media in

community. *International Journal of Research and Applied Technology (INJURATECH)*, 2(1), 114-123.

4. Wijayanti, D.R.; and Suryani, S. (2015). Waste bank as community-based environmental governance: A lesson learned from Surabaya. *Procedia-Social and Behavioral Sciences*, 184, 171-179.
5. Budiyarto, A.; Clarke, B.; and Ross, K. (2025). Overview of waste bank application in Indonesian regencies. *Waste Management and Research*, 43(3), 306-321.
6. Kastolani, W.; Warlina, L.; Luckyardi, S.; Oktafiani, D.; and Francois-Meyer, D. (2022). Improving local economy through integrated waste management in Bandung City, Indonesia (Case study of Sukasari district). *Journal of Eastern European and Central Asian Research*, 9(5), 874-888.
7. Soegoto, E.S.; Luckyardi, S.; Rafdhi, A.A.; and Oktafiani, D. (2022). Computational analysis of waste management and entrepreneur using vosviewer application. *Moroccan Journal of Chemistry*, 10(3), 1-18.
8. Idrovo-Hurel, M.; Morán-Herrera, A.; and Peralta, D. (2025). Applications of artificial intelligence in urban solid waste management: A systematic literature review. *International Journal of Innovative Research and Scientific Studies*, 8(2), 3350-3363.
9. KS, A.; Bhadani, G.; Ninawe, S.S.; and Manjunath, T.C. (2025). Artificial Intelligence applications in e-waste sorting and recycling processes. *Grenze International Journal of Engineering and Technology (GIJET)*, 11(1), 958-970.
10. Szpilko, D.; de la Torre-Gallegos, A.; Jimenez-Naharro, F.; Rzepka, A.; and Remiszewska, A. (2023). Waste management in the smart city: Current practices and future directions. *Resources*, 12(10), 115-124.
11. Fang, B.; Yu, J.; Chen, Z.; Osman, A.I.; Farghali, M.; Ihara, I.; and Yap, P.S. (2023). Artificial intelligence for waste management in smart cities: A review. *Environmental Chemistry Letters*, 21(4), 1959-1989.
12. Adeyemi, I.O.; Olatunji, S.O.; and Akinlabi, E.T. (2020). Smart waste management system for developing countries using IoT. *Journal of Cleaner Production,* 267*,* 122-156.
13. Effendi, D.; Noviansyah, B.; Lestary, L.; Mauluddin, S.; and Nurhayati, S. (2023). Implementation of waste bank information system to manage waste transaction data from the community. *Journal of Engineering Science and Technology*, 18(6), 2835-2846.
14. Soegoto, E.S.; Arifin, F.H.; and Oktafiani, D. (2021). Information system for waste bank savings. *Journal of Physics,* 1764(1), 012192-012205.
15. Pramono, A.; and Muchlasin, A. (2025). Mobile-based waste bank application design: A case study of the Anggrek sectoral waste bank. *Asian Journal of Social and Humanities*, 3(4), 825-835.
16. Zhao, Y.; Li, B.; and Xu, X. (2021). Artificial intelligence-based approach for waste classification in smart cities. *Journal of Environmental Management,* 282, 111-949.
17. Shah, S.; Singh, R.; and Gupta, S. (2022). AI-powered waste classification system using convolutional neural networks. *Environmental Technology and Innovation,* 25, 102-179.

18. Rachma, N.; Jayanti, D.E.; Zakaria, A.; Ferbrianto, D.; and Setiabudi, R. (2024). Web-based waste recording application at the Mandiri waste bank of Kayu Putih village. *Jurnal Inovatif: Inovasi Teknologi Informasi dan Informatika*, 7(2), 76-88.
19. Azevedo, S.G.; Carvalho, H.; and Cruz-Machado, V. (2021). A sustainable framework for smart waste management. *Sustainable Cities and Society,* 65, 102-146.
20. Biswal, B.; Kumar, R.; and Sahoo, S. (2020). IoT-enabled smart waste management system. *Materials Today,* 33, 621-626.
21. Setyawan, R.; and Pamuji, G.C. (2024). Comparative study of k-means and mean shift clustering algorithms for waste data in West Java province. *Journal of Engineering Science and Technology*, 19(3), 869-879.
22. Oladokun, V.O.; Komolafe, A.O.; and Lawal, O.O. (2022). Development of a mobile-based waste management system for smart cities. *International Journal of Environmental Science and Technology,* 19, 457-468.
23. Hannan, M.A.; Akhtar, M.; Begum, R.A.; Basri, H.; Hussain, A.; and Scavino, E. (2021). Capacitated vehicle-routing problem model for scheduled solid waste collection and route optimization using PSO algorithm. *Waste Management,* 71, 31-41.
24. Morganti, E.; Pilla, V.; and Langenus, M. (2021). Gamification strategies for waste sorting: A systematic literature review. *Resources, Conservation and Recycling,* 168, 105-366.
25. Kaburuan, E.R.; and Heriyati, P. (2019). Mobile apps business design and development for integrated waste management. *International Journal of Recent Technologi Engineering (IJRTE)*, 8(3), 7091-7099.
26. Prasetyo, D.; Andini, A.; and Nugroho, P. (2021). Waste bank system and policy integration for urban sustainability: An Indonesian case study. *Sustainability,* 13*,* 2435-2446.
27. Khoerul, V.; Priyatna, B.; Huda, H.; Baenil, B.; Nurapriyani, N.; Fitria, F.; and Awalludin, D. (2023). Data management system design website-based waste bank (Case study: DLHK Karawang Regency). *Edutran Computer Science and Information Technology*, 1(1), 51-58.
28. Hasanah, S.R.; and Purwanda, E. (2024). Waste bank innovation management using digital innovation system management in Cicadas village, Gunung Putri district, Bogor regency. *Majalah Bisnis dan IPTEK*, 17(1), 10-22.