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A LIGHTWEIGHT WASTE MONITORING INFORMATION SYSTEM USING MICROSOFT ACCESS: A RAD-BASED APPROACH FOR RESOURCE-CONSTRAINED ENVIRONMENTS

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Abstract

This research aims to create a waste monitoring system that offers an affordable digital solution with limited technological infrastructure, namely Microsoft Access with the rapid application development (RAD) method. The system created makes it easy to record waste data in a structured manner, allows real-time reporting, is easy to access, and is cost effective. System testing involved five simulated users, the results showed an average input duration of 2 minutes 57 seconds, a minimum error rate of 0.4 per session, and a user satisfaction level of 4.7 out of 5. This system can be used by institutions with limited technological infrastructure, such as educational institutions, small and medium businesses. For further research, additional research is needed to increase adoption by incorporating IoT sensors through the creation of online or mobile applications.

Keywords: Management information system, Microsoft access, Rapid application development, Sustainable engineering, Waste monitoring.

1. Introduction

The development of a waste monitoring information system is currently becoming increasingly important. One reason is the increasing volume of waste; it is estimated that by 2050 global waste production will reach 3.4 billion tons per year [1]. However, the current state of waste management involves significant reliance upon manual record-keeping [2, 3]. This can result in inefficiencies in the process and will potentially lead to the issues of increased waste, delays in the handling process, suboptimal resource consumption, and environmental pollution [4-6].

Although waste management is a critical component of sustainable engineering, it moreover covers areas such as green materials synthesis and environmental policy for green technologies [7, 8]. In implementation, institutions with limited resources, including small and medium enterprises (SMEs) and educational institutions in developing countries, face significant barriers in adopting modern systems due to the substantial infrastructure costs associated with the internet of things (IoT) and cloud-based technologies [5, 6].

Previous research shows various advanced technological approaches to waste management. For example, the application of artificial intelligence and chatbot systems has been explored, a cloud-based IoT monitoring framework, predictive analytics combining IoT edge computing and blockchain technology for smart city applications is recommended [9-11]. Then, smart battery storage was integrated into an IoT-enabled solar waste management system, as well as a web-based reporting platform [12, 13].

Most previous studies tend to take a technologically advanced approach, concentrate on urban environments or smart cities, and prioritize operational efficiency over usability and user satisfaction. These things pose challenges in themselves regarding infrastructure planning and achieving universal access targets in Indonesia [14]. In addition, the literature does not provide desktop solutions that are lightweight and can be accessed offline which are specifically designed to accommodate the needs of smaller institutions.

This study introduces a practical, low-cost management information system (MIS) developed using Microsoft Access for offline operations. To fill any gaps that have been identified, the system employs the rapid application development (RAD) approach to facilitate sustainable engineering decisions through the organized data of waste and creation of visualization reports. The application of the RAD approach makes it easier to rapidly iterate and test [15].

2. Literature Review

2.1. Management information system (MIS) concept

This study refers to management information systems as a computer-based system that provides accurate, timely and relevant data. The MIS is needed to make informed organizational decisions, while at the same time strengthening the main managerial functions in planning, monitoring and control [16, 17]. In this integrated era between sustainability and competitiveness, SIM application is increasingly needed to be able to support operational and environmentally responsible functions [18]. In addition, MIS capability could also provide advanced analytical features, including trend

analysis and dynamic visualization [19]. This is important for developing solid and sustainable strategies for managing waste.

2.2. Waste monitoring

Its use in the sustainable engineering era, one of which can be identified in waste monitoring system [20]. The technology can detect the type, quantity, and location of waste in different organizational settings [21, 22]. In the process, identification takes into consideration waste type, quantity collected, collection procedure, and procedure of recycling or treatment. An appropriate waste management system helps in preventing environmental pollution, improves the utilization of resources, and raises environmental awareness [23]. In addition, the technology allows all stakeholders to behave responsibly when dealing with wastewater and allows them to assess the efficiency of environmental policy [24].

2.3. Microsoft access technology

Microsoft Access serves as a technology platform for system development because it offers connectivity in a LAN network, security of data, as well as the ability to generate reports in excel [25]. Microsoft Access further allows for the aspects of automation, encryption, and validation through the employment of VBA and macros [26]. Therefore, in the capacity of the relational database management system, Microsoft Access-based systems support the creation and management of databases using the graphical interface [27]. In fact, the simplicity in its utilization without programming makes it suitable in cases where the institutional or organizational capacity lacks significant technical know-how and infrastructural make-up.

2.4. Rapid application development (RAD) approach

The system developed in our research gives importance to speed and flexibility [9]. It therefore follows the RAD model of development (see Fig. 1) because it is a model of development which can speed up the process of development through user feed-back [28].

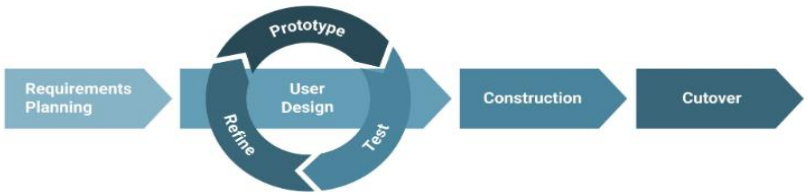

Fig. 1. Rapid application development (RAD) model.

Unlike traditional linear models, RAD is used with consideration of rapid prototyping and collaborative refinement to ensure that the final system meets user needs [29]. RAD is well suited for projects with iterative requirements and that require rapid system delivery [8]. Similar to the waste monitoring system, RAD supports the rapid capture of data, simple reporting, and ease of use for non-technical users. Thus, this approach is in line with the principles underlying sustainable engineering, in which the social and environmental impacts of a system are considered throughout its life cycle [7].

3. Method

In order to identify the requirements, observations and semi-structured interviews were initially conducted with two operational officers from the department of waste management. Afterwards, the prototype of the system was identified through short iterative cycles and direct user feedback, in which the four stages of the RAD process are: identification of requirements, system design, prototyping, and functional evaluation.

4. Results and Discussion

4.1. User needs identification

Analysis of the interviews showed that the current practice for waste data documentation was manual, involving the use of disparate tools such as excel spreadsheets and physical notebooks in the absence of any standardized mechanism for reporting. Thus, based on these, the significant user requirements identified for a new system included the ability to record type, volume, and location of wastes; produce automated graphical reports; be functional in a local setting without internet access; and be easy to use by non-technical personnel (see Fig. 2).

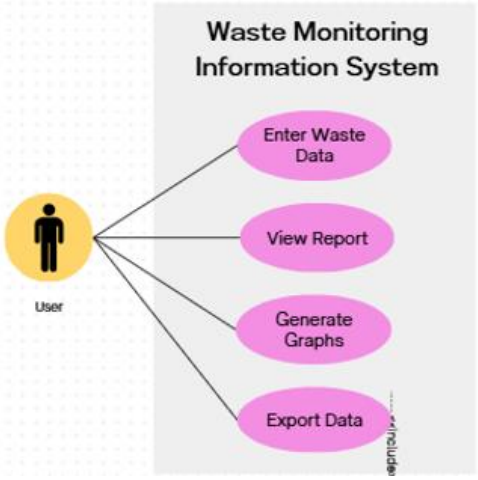

Fig. 2. Use case diagram of the waste monitoring information system.

4.2. System design

System design was performed in the Microsoft Access environment and included the design of database entities, data input forms, reporting queries, and visual dashboards. A use case diagram was utilized to model the system actors and their interactions (see Fig. 2). The resultant system was designed with a user-friendly, form-based interface that included input validation, drop-down menu options, and report export functionality to excel.

4.3. Prototyping

The prototype was tested by five simulated users from non-technical backgrounds. Evaluation was conducted through: measuring data input time; the number of input

errors per session; and a user satisfaction questionnaire (scale 1-5). A system prototype was successfully developed using Microsoft Access with four main components: a waste data input form, a disposal form, a transportation schedule, and a reporting dashboard. All functions run locally without an internet connection and do not require an external server. The system interface was developed to be user-friendly by including automatic validation of dates, a drop-down list for the selection of types of wastes, and a report form exportable into Microsoft Excel (see Fig. 3). Figure 4 shows the main input form.

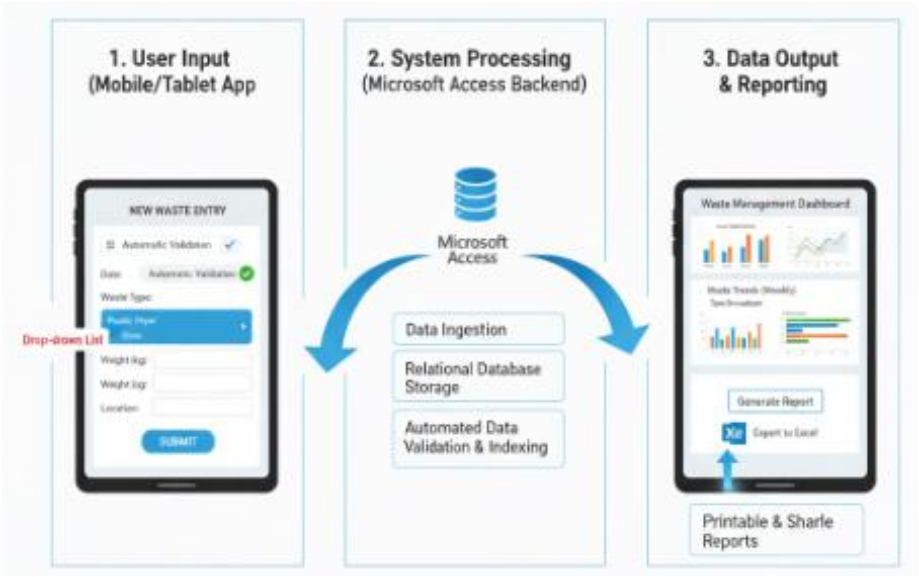

Fig. 3. Waste data input and system flow.

Fig. 4. Waste data input form display.

4.4. Functional evaluation

Table 1 shows the results of the system test measurements based on five simulated users running the test scenario in a LAN-based work environment. On average, it took

2 minutes and 57 seconds to record a single entry. The number of errors was very low, 0.4 errors per session.

Table 1. System test measurement results.

Evaluation Aspect	Mean	Standard Deviation
Input Time	2 minutes 57 seconds	0.35 minutes
Input Error	0.4 per session	0.2
User Satisfaction Score	4.7 out of 5	0.3

Results from the implementation show that a Microsoft access-based system is ideal for small organizations with limited technical and financial resources. The system was also found to be effective in solving the core needs of waste management, namely recording, reporting, and scheduling, without relying on cloud or IoT infrastructures.

This study adopted a methodology that prioritizes ease of access, affordability, and ease of replication at capacity-constrained sites. In contrast, other research [10-13] is more dependent upon advanced technologies such as the use of IoT sensors and online waste reporting. In fact, this showcases how the presented research contributes to the topic of sustainable engineering solutions [27].

The success in the application of the RAD approach, where emphasis is placed on the direct involvement of the users, has likewise attracted attention through the high level of satisfaction expressed by the users [30]. The positive reaction towards the application from the users can thus be considered as evidence of how the design of the system fully takes into consideration human-centred design tenets. In turn, the basic interface form applied ensures success in projecting an appealing user interface.

5. Conclusion

For this study, a waste monitoring management information system was developed using Microsoft Access and the rapid application development model. It was proven to be able to help manage data in an organized and satisfactory manner, with few errors, and an average time of less than three minutes per data entry. The high level of satisfaction confirms the effectiveness of the interface in monitoring without using complicated technology. These findings indicate that the developed low-cost system can function effectively as a pragmatic alternative in rapidly changing but financially constrained corporate environments, such as in local governments, SMEs, or educational organizations. For future research, it can add the use of internet of things (IoT) technology, online or mobile versions of the existing system to make it applicable in all fields.

References

1. Sharma, K.D.; and Jain, S. (2020). Municipal solid waste generation, composition, and management: The global scenario. *Social Responsibility Journal*, 16(6), 917-948.
2. Nanda, S.; and Berruti, F. (2021). Municipal solid waste management and landfilling technologies: A review. *Environmental Chemistry Letters*, 19(2), 1433-1456.

3. Voukkali, I.; Papamichael, I.; Loizia, P.; and Zorpas, A.A. (2024). Urbanization and solid waste production: Prospects and challenges. *Environmental Science and Pollution Research*, 31(12), 17678-17689.
4. Haque, M.S.; Uddin, S.; Sayem, S.M.; and Mohib, K.M. (2021). Coronavirus disease 2019 (COVID-19) induced waste scenario: A short overview. *Journal of Environmental Chemical Engineering*, 9(1), 104660-104673.
5. Fidje, E.; Haddara, M.; and Langseth, M. (2023). Sustainable smart waste management adoption challenges in developing countries. *Procedia Computer Science*, 219, 905-914.
6. Gharibvand, V.; Kolamroudi, M.K.; Zeeshan, Q.; Çınar, Z.M.; Sahmani, S.; Asmael, M.; and Safaei, B. (2024). Cloud based manufacturing: A review of recent developments in architectures, technologies, infrastructures, platforms and associated challenges. *The International Journal of Advanced Manufacturing Technology*, 131(1), 93-123.
7. Nandiyanto, A.B.D.; and Akbar, A.N.P. (2024). Carbon particle size from galangal rhizomes as the sustainable adsorbent. *Journal of Studies in Science and Engineering*, 4(2), 21-47.
8. Suthakavatin, S.; and Shatila, K. (2024). The role of environmental policy in promoting green transportation technologies. *Bio Web of Conferences*, 145, 6013-6024.
9. Luckyardi, S.; Karin, J.; (2024). Chatbots as digital language tutors: revolutionizing education through AI. *Indonesian Journal of Science and Technology*, 9(3), 885-908.
10. Farjana, M.; Fahad, A.B.; Alam, S.E.; and Islam, M.M. (2023). An IoT-and cloud-based e-waste management system for resource reclamation with a data-driven decision-making process. *IoT*, 4(3), 202-220.
11. Palagan, C.A.; Joe, S.S.A.; Mary, S.J.; and Jijo, E.E. (2025). Predictive analysis-based sustainable waste management in smart cities using IoT edge computing and blockchain technology. *Computers in Industry*, 166, 104234-104234.
12. Hafidz, I.; Samuel, G.W.; Kurniawan, C.J.A.; Alfattah, H.; and Putranto, R.D. (2025). Solar-powered organic leaves waste shredder machine with IoT-based monitoring integration. *elinvo (Electronics, Informatics, and Vocational Education)*, 10(1), 30-43.
13. Oghenekaro, L.U.; and Favour, P.L. (2025). Web based application for waste management in port-harcourt metropolis. *Open Access Library Journal*, 12(3), 1-15.
14. Sakti, A.D.; Andani, I.G.A.; Putri, A.D.R.; Zakiar, M.R.; Faruqi, I.A.; Santoso, C.; and Shalannanda, W. (2024). Geospatial intelligence framework for BTS infrastructure planning toward universal internet access target in Indonesia. *International Journal of Applied Earth Observation and Geoinformation*, 135, 104274-104283.
15. Anaking, P.; Ma'ady, M.N.P.; and Rahim, A.F.A. (2023). Implementation of rapid application development (RaD) method in the design of research partner recommendation system in higher education. *Asia Information System Journal*, 2(2), 53-59.
16. Adhikari, N.P.; Budhathoki, J.K.; and Adhikari, S. (2024). Management information systems' role and effects on school administration: A review. *Perspectives on Higher Education*, 14, 81-94.

17. Hossain, Q.; Yasmin, F.; Biswas, T.R.; and Asha, N.B. (2024). Integration of big data analytics in management information systems for business intelligence. *Saudi Journal of Business Management Studies*, 9(9), 192-203.
18. Cozniuc, O.; and Suslenco, A. (2022). Improving the modern management system through the use of information technologies. *Economia Contemporană*, 4, 171-176.
19. Aljawarneh, N.M.; Sokiyna, M.; Obeidat, A.M.; Alomari, K.A.K.; Alradaideh, A.T.; and Alomari, Z.S. (2020). The role of CRM fog computing on innovation and customer service quality: An empirical study. *Marketing and Management of Innovations*, 2, 286-297.
20. Al-Yarubi, K.S.; Khairy, S.O.F.; Hossain, S.M.E.; and Hayder, G. (2025). Internet of things-driven waste management: Paving the way for sustainable smart cities. *Processes*, 13(4), 1140-1148.
21. Ahmad, R.W.; Salah, K.; Jayaraman, R.; Yaqoob, I.; and Omar, M. (2021). Blockchain for waste management in smart cities: A survey. *IEEE Access*, 9, 131520-131541.
22. Bułkowska, K.; Zielińska, M.; and Bułkowski, M. (2023). Implementation of blockchain technology in waste management. *Energies*, 16(23), 7742-7751.
23. Zhang, Q.; Zhang, X.; Mu, X.; Wang, Z.; Tian, R.; Wang, X.; and Liu, X. (2021). Recyclable waste image recognition based on deep learning. *Resources, Conservation and Recycling*, 171, 105636-105647.
24. Zhao, X. (2021). Stakeholder-associated factors influencing construction and demolition waste management: A systematic review. *Buildings*, 11(4), 149-158.
25. Aldoseri, N.F.; and Elmedany, W. (2023). Strengthening data security in Bahrain: Leveraging Microsoft Purview to prevent leakage of sensitive information. *IET Smart Cities Symposium,* 23, 477-483.
26. Kumar, R. (2025). Sales and collection-MS Access application: A comprehensive reporting and data management solution. *Journal Dekstop Application* (*JDA*), 4(2), 58-67.
27. Fauziyyah, L.Z. (2025). Development of an employee training information system using the deductive training model. *Intelmatics*, 5(2), 82-88.
28. Singgalen, Y.A. (2024). Implementation of rapid application development (RAD) for community-based ecotourism monitoring system. *Journal of Information System Research (JOSH)*, 5(2), 520-530.
29. Sidik, R.; and Ray, Y. (2021). Interactive map-based Optical Distribution Point (ODP) mapping design and implementation. Jo*urnal of Engineering Science and Technology*, 16(3), 2128-2138.
30. Nguyen-Duc, A.; Cabrero-Daniel, B.; Przybylek, A.; Arora, C.; Khanna, D.; Herda, T.; and Abrahamsson, P. (2025). Generative artificial intelligence for software engineering - A research agenda. *Software: Practice and Experience*, 55(11), 1806-1843.