



IMPLEMENTATION OF CMMI IN MEASURING THE PERFORMANCE OF THE WASTE BANK INFORMATION SYSTEM DEVELOPMENT PROJECT IN KELURAHAN DURI KEPA JAKARTA BARAT

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Abstract

The goal of CMMI (Capability Maturity Model Integration) adoption in project performance measurement is to enhance and optimize the Waste Bank Information System project's development process. Through the adoption of the CMMI's best practices and principles, the project team can increase the productivity and efficiency of project implementation. With improved risk identification and management, the project is less likely to encounter difficulties or fail. This is made possible by CMMI. The GAP Analysis assessment stage of the research process is used to determine how well Duri Kepa Village has followed the CMMI process. Next, the project's goals and scope are established. Finally, the CMMI process is mapped to the stages of implementation and process modifications in accordance with CMMI practices, as well as the process of performance monitoring and measurement. The aim of this study is to improve the project completion predictability for the Waste Bank Information System design and implementation in Duri Kepa Village. The project team will be better equipped to plan, coordinate, and manage project resources in order to promote project success by putting CMMI standards into practice.

1.0 INTRODUCTION

By enhancing waste management procedures and encouraging environmental sustainability, a waste bank information system can have a big influence on society at large. garbage banks lessen the quantity of garbage that ends up in landfills by promoting recycling and appropriate waste segregation. By lowering waste collection fees, efficient waste management can also save household spending by lowering municipal waste disposal costs[1]. Organizations can enhance their processes systematically by achieving the maturity levels defined by CMMI. Strong project planning and monitoring procedures are emphasized by CMMI [2]. The Capability Maturity Model Integration (CMMI) framework offers systematic guidelines for project management and process improvement, which can have a substantial impact on the development of an Information System (IS) for a Waste Bank System.

The success and long-term viability of the waste management program can be increased by incorporating CMMI into the creation of a Waste Bank Information System, which can result in more effective, efficient, and high-quality project outcomes. In e-business product development, the application of CMMI helps guarantee that the product is built effectively,

satisfies high standards, and fits client expectations. It improves organizational maturity overall, risk reduction, quality assurance, and project management, which results in improved project outcomes and higher client satisfaction [3].

CMMI offers an organized method for process improvement and aids in raising performance and quality standards inside enterprises. Organizations can systematically enhance their processes through the use of CMMI, which will boost project productivity and product quality. The secret is to concentrate on creating standardized processes, monitoring and managing these processes, and always looking for methods to get better. Organizations can significantly increase the quality of their software development efforts by carefully planning, carrying out, and continuously evaluating their efforts [4]. A widely accepted paradigm for process improvement, CMMI offers an organized approach to process development and enhancement, assisting companies in achieving better performance [5]. The Waste Bank Information System Development Project in Kelurahan Duri Kepa can gain from enhanced project management techniques, greater quality control, and standardized processes by putting CMMI into effect.

This research explores the implementation of CMMI in measuring the performance of the WBIS development project. The focus is on understanding how CMMI can be applied to improve the efficiency and effectiveness of the project, thereby contributing to the overall success of the waste bank initiative in Kelurahan Duri Kepa. Through this study, we aim to provide insights into the practical application of CMMI in a real-world context and highlight the benefits it brings to project performance and quality assurance [6].

The introduction of CMMI into this project is expected to address several key challenges, including risk management, process standardization, and continuous improvement. By leveraging CMMI, the project team can ensure that the WBIS is developed following best practices, leading to a robust system that meets the needs of the community and supports sustainable waste management efforts [7]. In summary, this research presents a detailed examination of the implementation of CMMI in the WBIS development project in Kelurahan Duri Kepa, Jakarta Barat. It aims to demonstrate how CMMI can enhance project performance, improve quality, and contribute to the long-term success of waste management initiatives.

2.0 THEORETICAL

2.1. Capability Maturity Model Integration (CMMI)

CMMI is an approach to process improvement that gives organizations the tools they need to change their processes effectively. It is a framework for raising the maturity and capabilities of processes throughout an enterprise. Integrating diverse organizational tasks and processes is the main objective of CMMI in order to enhance efficiency, quality, and performance [8].

▪ Key Components of CMMI

1. **Maturity Levels** : CMMI defines five maturity levels for processes—Initial, Managed, Defined, Quantitatively Managed, and Optimizing. Each level represents a layer in the foundation for continuous process improvement.
2. **Process Areas** : Specific goals and practices related to areas such as Project Management, Process Management, Engineering, and Support.
3. **Generic Goals and Practices** : Ensure that the processes associated with a process area are effective, repeatable, and continuously improving.

▪ Application in Project Performance Measurement

Implementing the Capability Maturity Model Integration (CMMI) framework in project performance measurement functions ensures structured process improvement, efficient project execution, and enhanced product quality [9].

1. **Process Standardization** : Establishing standardized processes ensures consistency in project execution.
2. **Performance Metrics** : Using quantifiable metrics to measure process performance, identify bottlenecks, and implement improvements.
3. **Continuous Improvement** : Encouraging a culture of continuous process assessment and enhancement to achieve higher maturity levels.

2.2. Information System Development Lifecycle (ISDLC)

The Information System Development Lifecycle (ISDLC) is a structured approach for developing information systems and includes several phases [10] :

Planning: Defining the project scope, objectives, and feasibility.

Analysis: Collecting and analyzing user requirements and business needs.

Design: Creating detailed system designs, including architecture, interfaces, and data models.

Implementation: Coding and developing the system based on the design specifications.

Testing: Verifying that the system meets all requirements and is free from defects.

Deployment: Installing and configuring the system in a production environment.

Maintenance: Providing ongoing support and enhancements to the system.

Table 1. The Process of Waste Bank Information System Development

Application in Waste Bank Information System Development		
Structured Development	User-Centric Design	Quality Assurance
Ensuring that each phase of the development lifecycle is planned and executed systematically.	Involving users throughout the development process to ensure the system meets their needs.	Conducting rigorous testing and validation to deliver a reliable and functional system.

2.2. Rapid Application Development (RAD)

Rapid Application Development (RAD) is an adaptive software development methodology that prioritizes rapid prototyping and iterative development over strict planning and requirements recording [11].

- **User Involvement:** Engaging users continuously to provide feedback and refine requirements.
- **Iterative Development:** Developing the system in small, incremental releases or prototypes.
- **Flexibility:** Allowing for changes and modifications based on user feedback and evolving requirements.
- **Speed:** Accelerating development timelines to deliver functional prototypes quickly.

2.3. Waste Management Theory

Community-based waste management involves the active participation of local communities in waste segregation, recycling, and disposal processes [11].

- **Waste Banks :** Establishing waste banks as community centers for collecting and recycling waste materials.
- **Incentives :** Providing incentives to encourage community participation in waste management efforts.
- **Education and Awareness :** Promoting awareness about the benefits of waste segregation and recycling.

Application in Waste Bank Information System Development

- **Community Engagement :** Ensuring that the information system supports community participation and makes it easier for residents to engage in waste management activities[11].
- **Data Management :** Efficiently managing data related to waste collection, processing, and incentives to ensure transparency and accountability [12].
- **Sustainability :** Supporting sustainable waste management practices through effective information system design and implementation.

2.4. Integrating Theories for Research

Integrating CMMI, ISDLC, RAD, and waste management theory provides a comprehensive approach to developing and measuring the performance of the Waste Bank Information System:

- **CMMI Framework :** Provides a structured process improvement model to ensure high-quality and efficient project execution [13].
- **ISDLC Methodology :** Offers a step-by-step guide for developing the information system[14].
- **RAD Methodology :** Ensures rapid and user-centric development, allowing for quick iterations and refinements[15].

- **Waste Management Theory** : Ensures the system meets the specific needs of community-based waste management initiatives[16].

By combining these theories, the research can effectively measure the performance of the Waste Bank Information System Development Project in Kelurahan Duri Kepa. This involves evaluating process maturity, system quality, user satisfaction, and overall project efficiency. The integration of CMMI, ISDLC, RAD, and waste management theory provides a robust theoretical foundation for the development and performance measurement of the Waste Bank Information System in Kelurahan Duri Kepa. By leveraging these theories, the research aims to deliver a high-quality, efficient, and sustainable information system that enhances waste management practices and community engagement.

3.0 METHODOLOGY

The methodology in this research process follows the following stages :

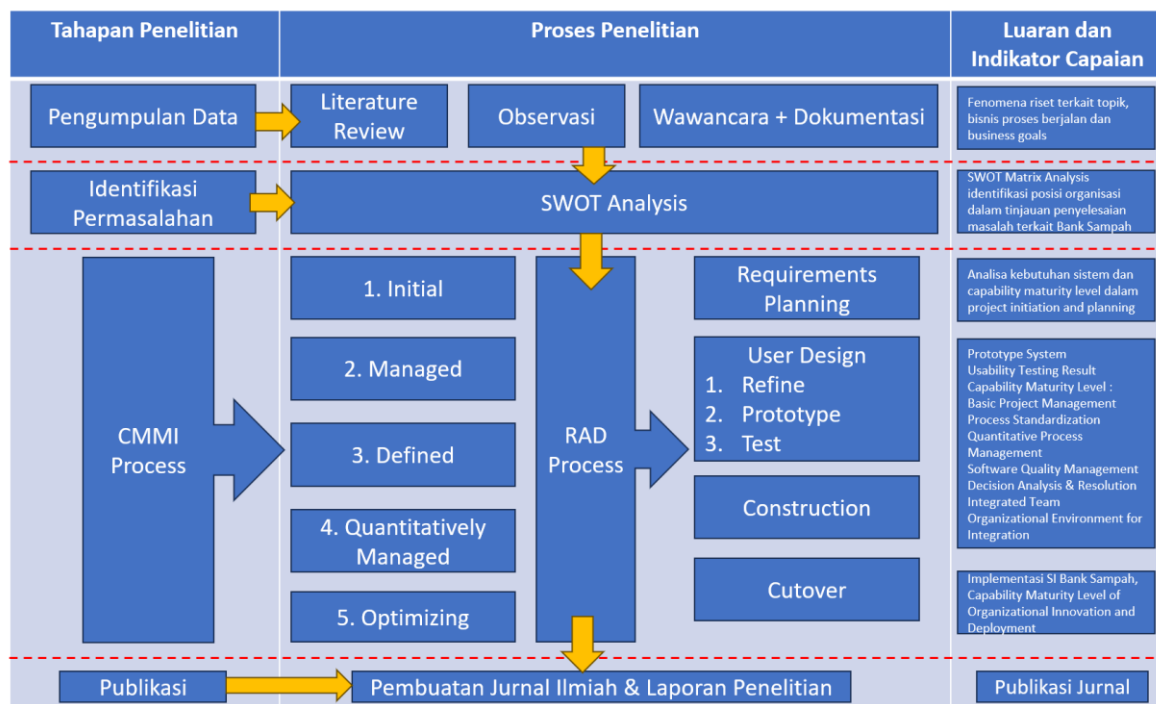


Figure 1. Research Framework

The research framework illustrates that the research process goes through the main stages of data collection, problem identification, CMMI process with RAD Methods integration and publication of research results. Data collection is carried out by the process of direct observation and interviews with user and the entire team involved in managing the waste bank in Kelurahan Duri Kepa. The data that will be collected later will help in the process of creating software development requirements for a Waste Bank Information System that is useful for the needs of managing waste bank data in Kelurahan Duri Kepa. Furthermore, the research analysis process in designing the Waste Bank Information System is also integrated with the CMMI Process to evaluate the level of maturity of the project work rather than running optimally according to the expected target. The final results of the research are expected to be published in international publications in order to add to the literature related to research on the topic of information system design with CMMI Process integration.

4.0 RESULTANTS

4.1. Problem Identification

The method in identifying problems using the SWOT Analysis approach to evaluate the position of Kelurahan Duri Kepa in the context of Strength, Weakness, Opportunities and Threats analysis related to the design of the Waste Bank Information System is as follows:

Table 2. SWOT Analysis of Problem Identification

OPPORTUNITIES	STRENGTHS	WEAKNESSES
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Service development, Partnership in integrated waste management, Use of New Technology and Optimization of Environmental Waste Management Process, Network Development, Environmental Education and Awareness	Proximity to Community, Access to Local Resources, Commitment to Environmental Sustainability, Management and Stewardship Skills, Strong Partnerships and Networks, Flexibility and Innovation.	Limited Financial Resources, Lack of Technical Skills, Inadequate Infrastructure, Lack of Integration with Existing Systems, Community Resistance or Incomprehension, Lack of Development and Training Plans, Reliance on Certain Leaders or Individuals.
	S-O Strategy/Analysis	W-O Strategy/Analysis
	High environmental awareness in the surrounding community.	Lack of Information Technology Understanding
	Active involvement of relevant parties such as local communities, schools, and environmental organizations.	Limited Funds for System Development
	Support from local governments in terms of regulations and incentives for environmental initiatives.	Limited Number of Trained Workers
	Availability of basic infrastructure such as internet and computer networks.	Basic Infrastructure Limitations
THREATS	S-T Strategy/Analysis	W-T Strategy/Analysis
Competition, Policy Change, Resource Scarcity, Security Vulnerability, Changing Consumption Patterns, Technology Dependency, Community Resistance, Economic or Social Crisis	Technology Excellence, Strong Partnerships, Community Support, Financial Sustainability, Good Risk Management, Flexible Capacity	Reliance on Local Resources, Lack of Experience and Knowledge, Financial Limitations, Lack of Community Integration, Lack of Community Awareness and Support

Based on Table 2. related to SWOT Analysis in the Design of the Waste Bank Information System, it can be understood that there is a potential opportunity to develop additional services, such as transaction tracking, more accurate waste management information, or integration with household financial management applications.

4.2. CMMI Process

Capability Maturity Model Integration (CMMI) is a framework used to measure and improve process maturity in the development of information systems or other products [17]. In the waste bank information system development project at the Duri Kepa Village level, CMMI implementation can help improve efficiency, quality, and consistency in the development process. Here are some CMMI processes that are relevant in this research :

1. Project Planning with RAD Methods Approach

- Identifying the needs and objectives of the waste bank information system development project.
- Determination of project planning that includes schedule, budget, resources, and risks.
- Development of configuration management plans, change control, and project monitoring.

2. Requirements Management

- Identify, document, and verify the functional and non-functional requirements of the Duri Kepa Village Waste Bank Information System.
 - Manage requirements change management and its effect on the project.
- 3. Process and Quality Management**
- Manage the development process of the information system development process that is defined, measured and controlled.
 - Implement quality metrics to measure process and product performance.
 - Plan process audits to ensure consistency and compliance with standards and procedures.
- 4. Configuration Management**
- Structured and managed configuration management of software, documents, and project artifacts.
 - Version control, change monitoring, and configuration recovery if required.
- 5. Development and Integration**
- Development of the Duri Kepa Village Waste Bank Information System by complying with the established requirements and design.
 - Effective integration of system components and validation of their functionality.
- 6. Testing and Verification**
- Planning, design, and execution of information system tests to ensure quality, reliability, and expected performance.
 - Verification against established requirements and specifications.
- 7. Delivery and Maintenance**
- Delivery of the waste bank information system to end users with complete documentation and appropriate training.
 - Maintenance of the system, handling repairs, and continuous updates as needed and feedback from users.
 - The implementation of CMMI processes in the urban village waste bank information system development project can help achieve greater consistency, predictability, and quality in project and product management.

4.3 Evaluation of CMMI Process Analysis Based on Maturity Level

1. Initial Project Stage

Table 3. Analysis Maturity Level in Initial Project Stage

Initial Project - CMMI Process		Maturity Level
Basic Process Introduction	Start by documenting the basic processes used by the Duri Kepa Village Waste Bank Information System development project.	Level 3 - Defined
Training and Awareness	Provide training to the information system development team on the importance of structured processes and how this can improve the performance of the Duri Kepa Village Waste Bank Information System project.	Level 1 - Initial
Formal Project Management	Apply basic project management practices such as project planning, scheduling, and monitoring the performance of the Waste Bank Information System project.	Level 2 - Managed
Risk Management	Start identifying and managing risks more proactively, even in simple ways.	Level 1 - Initial
Review and Supervision	Conduct regular reviews to identify what is working and what is not, and make necessary adjustments.	Level 2 - Managed

The organization has well documented process standards that are used consistently throughout the project.

2. Managed Project Stage

Table 4. Analysis Maturity Level in Managed Project Stage

Managed Project - CMMI Process		Maturity Level
Project Planning	Establish clear project objectives, timelines and budgets. Identify and plan the resources needed in the development of the waste bank information system.	Level 3 - Defined
Project Monitoring and Control	Monitor project progress against established plans. Identify deviations from the plan and take necessary corrective actions. Used project management tools and techniques to track the status of the Waste Bank Information System project.	Level 3 - Defined
Requirements Management	Clearly document project requirements. Ensure that all team members understand the requirements of the waste bank information system development.	Level 2 - Managed
Risk Management	Identify potential project risks. Analyzing the impact and probability of risks. Developing risk mitigation plans and monitoring risks on an ongoing basis.	Level 1 - Initial
Quality Assurance	Conduct regular quality reviews and audits. Ensure that products and processes conform to established quality standards.	Level 2 - Managed
Configuration Management	Manage changes to project products and ensure that all changes are well documented. Maintain product integrity and consistency throughout the lifecycle of the waste bank information system project.	Level 1 - Initial

The Managed stage of CMMI emphasizes the application of basic project management and ensures that the project is well managed according to the established plan. The processes at this stage are more structured and documented compared to the Initial stage, but have not yet fully reached the level of standardization and optimization found at the Defined stage.

3. Defined Project Stage

Table 5. Analysis Maturity Level in Defined Project Stage

Defined Project - CMMI Process		Maturity Level
Process Definition and Documentation	Define standard processes that will be used throughout the organization. Document the process in detail, including procedures, policies and work guidelines in the development of the waste bank information system.	Level 4 - Quantitatively Managed
Training and Process Awareness	Provide training to the team on the defined process. Raise team awareness about the importance of following documented processes. Developed a training program in waste bank information system development.	Level 3 - Defined
Process Integration	Integrate standardized processes into all aspects of the project, including project management, development and testing. Ensure that all organizational units use the same processes.	Level 1 - Initial

Defined Project - CMMI Process		Maturity Level
Configuration and Change Management	Manage changes to project processes and products with defined procedures. Ensure that changes are well documented and communicated to the entire team.	Level 2 - Managed
Quality Assurance	Implement a structured and documented quality assurance process. Conduct regular quality audits and reviews to ensure compliance with standardized processes.	Level 3 - Defined
Knowledge Management	Managing and disseminating organizational knowledge through an organized knowledge repository. Documenting lessons learned and best practices from previous projects.	Level 1 - Initial
Measurement and Analysis	Use metrics to measure process performance and project outcomes. Analyze data to identify trends, issues and improvement opportunities.	Level 1 - Initial

The processes at this stage are not only well-defined but also consistently applied throughout the project, ensuring uniformity and high quality. By having documented and standardized processes, organizations can be more proactive in managing projects, improving quality, and managing organizational knowledge, ultimately improving the overall efficiency and effectiveness of the organization.

4. Quantitatively Project Stage

Table 6. Analysis Maturity Level in Quantitatively Project Stage

Quantitatively Project - CMMI Process		Maturity Level
Data Collection and Measurement	Systematically collect process performance data to gain a deep understanding of the variability of the waste bank information system development process.	Level 4 - Quantitatively Managed
Performance Data Analysis	Analyze the data that has been collected to understand process performance and identify the waste bank management process in the Duri Kepa village to design a waste bank information system.	Level 4 - Quantitatively Managed
Quantitative Process Control	Controlling the process by using quantitative data to ensure that the process remains within acceptable limits, especially regarding the number of waste bank transactions managed by Kelurahan Duri Kepa every day.	Level 3 - Defined
Setting Performance Targets	Set measurable performance targets for important processes based on data analysis of the requirements for the waste bank information system needed to be developed according to the needs of Kelurahan Duri Kepa.	Level 1 - Initial
Continuous Improvement	Use performance data to identify opportunities for improvement and implement changes to achieve higher levels of performance.	Level 2 - Managed
Quantitative Risk Management	Manage project risks by using quantitative data to predict and mitigate possible risks.	Level 2 - Managed
Data-driven Decision Making	Make management decisions based on quantitative data analysis to improve decision accuracy and effectiveness.	Level 1 - Initial
Performance Reporting	Regularly report process performance to stakeholders using quantitative data to	Level 1 - Initial

Quantitatively Project - CMMI Process		Maturity Level
	demonstrate achievement of targets and areas requiring improvement.	

In this stage CMMI focuses on using quantitative data to understand, control, and improve process performance. At this level, the waste bank information system development project team has systematically collected and analyzed performance data, set measurable performance targets, and made data-driven decisions to better achieve project goals. With this approach, organizations can reduce process variability, manage risks more effectively, and achieve consistently higher levels of performance.

5. Project Optimizing Stage

Table 7. Analysis Maturity Level in Project Optimizing Stage

Optimizing Project - CMMI Process		Maturity Level
Continuous Improvement	Identify and implement continuous improvement based on data analysis and feedback for future development of the waste bank information system.	Level 2 - Managed
Innovation and New Technology	Adopt and integrate new technologies and methods to improve process performance and capability.	Level 2 - Managed
Advanced Performance Management and Measurement	Apply advanced measurement techniques to monitor process performance in real-time and detect areas for improvement.	Level 2 - Managed
Organizational Learning	Promote a culture of learning and knowledge sharing across the organization to enhance team capabilities and skills.	Level 2 - Managed
Proactive Risk Management	Manage risk with a proactive approach, using data and predictive models to anticipate and address risks before they occur.	Level 2 - Managed
Enhanced Collaboration and Communication	Improve collaboration and communication across project teams and with stakeholders to ensure effective information flow.	Level 2 - Managed
Integration of Processes and Standards	Integrate widely recognized processes and standards to ensure consistency and high quality in project development.	Level 2 - Managed
Data-driven Optimization	Continuously optimize processes based on in-depth data analysis and feedback from project implementation.	Level 2 - Managed

At this stage CMMI implementation focuses on continuous improvement and innovation through the use of deep data, new technologies, and organizational learning. The project team has a culture that encourages continuous development and improvement, and manages risks with a proactive approach. By achieving this level, the waste bank information system development project team can achieve high efficiency, top quality, and sustainable competitive advantage. For this stage, the maturity value has not reached the maximum, but has only reached level 2 or managed conditions.

4.4 Project Team Organization Structure

The organizational structure of the project team involved in working on the Duri Kepa Village Waste Bank Information System consists of :

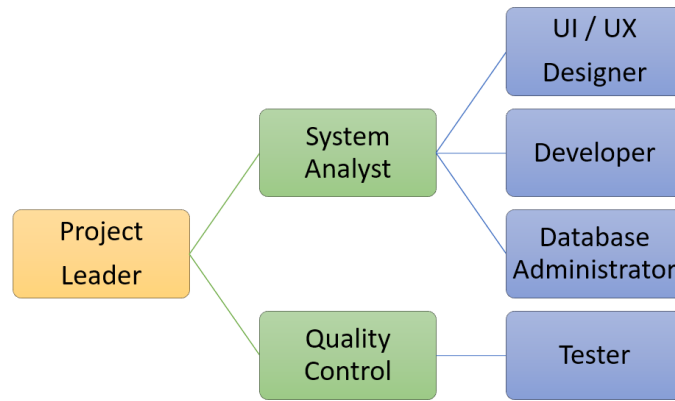


Figure 2. Project Team Organization Structure

In designing the Waste Bank information system in Duri Kepa Village using the Rapid Application Development (RAD) method, each role has important responsibilities and functions to ensure the project is successfully implemented efficiently and effectively.

4.5 Requirements System

In the design and development of information systems, both functional and non-functional requirements play an important role. Functional requirements describe what the system should do, while non-functional requirements describe how the system should do it and its quality characteristics. The following is an explanation of these two types of requirements in the context of the waste bank information system in Kelurahan Duri Kepa:

Table 8. Functional and Non-Functional Needs of Waste Bank Information System

Functional Requirements	
1	Display Login
2	Display the register function of the waste bank web
3	Can perform system login
4	Can add a new user through the register function
5	Can view news on environmental empowerment activities, cleanliness and waste bank activities in Duri Kepa Village
6	Can see the procedure in joining the waste bank program
7	Can view the waste bank map
8	Can view waste collection statistics through waste bank collectors at the RW level through the Waste Bank coordinator in Duri Kepa Village
9	Can view our contact data
10	Can apply for garbage pickup
11	Can do garbage drop off for residents
12	Can manage the e-wallet of waste collection point results at the waste bank collector
13	Can view waste collection points in the waste bank
14	Can redeem points from the sale of waste at the waste bank
15	Can find out the bill of sales of waste to waste bank collectors in the waste bank system
16	Can manage accounts
17	Can make a waste bank management report
Non Functional Requirements	
1	The system shall respond to user inputs within 2 seconds for 95% of transactions.
2	The system shall be designed to minimize energy consumption, utilizing efficient server hardware and optimized software algorithms.
3	The system shall support sustainability initiatives, such as promoting recycling and waste reduction through user education and awareness features.

Functional Requirements	
4	The system shall be deployable on various operating systems, including Windows, macOS, and Linux.
5	The system shall include logging and monitoring tools to track system performance, errors, and user activity, enabling quick identification and resolution of issues.

4.6 User Design

The function of user design in developing a waste bank information system using use case diagrams is to ensure that the needs and interactions of users with the system are clearly defined and structured. Use case diagrams help in describing the main functions that will be used by various types of system users. The use case diagram in designing the Waste Bank Information System in Kelurahan Duri Kepa is as follows :

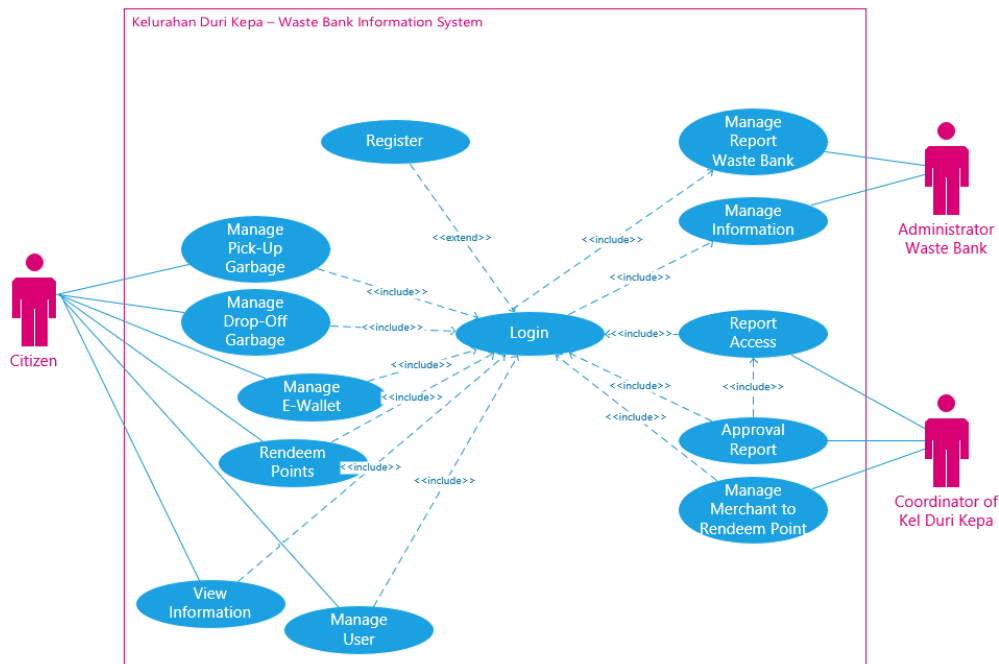


Figure 3. Use Case Diagram Waste Bank Information System in Kelurahan Duri Kepa

4.6 Construction System

The following are the results of the development of a waste bank information system that will be implemented by Kelurahan Duri Kepa :



Figure 4. Homepage of the Waste Bank Information System

In Figure 4. obtained information that information that can be accessed by users or residents on the waste bank information system is related to :

News, Procedures, Waste Bank Map, Statistics and Contact us.

Furthermore, if community members want to become members of the waste bank activities in Duri Kepa Village, it is mandatory to register from the waste bank information system web by pressing the register button / selecting register.



Figure 5. Registration Form of the Waste Bank Information System

In Figure 5. obtained information that can be accessed by users or residents in the waste bank information system is related to:

- Participant Name
- Email Address
- Date of Birth
- Address
- Password
- Phone/Mobile number
- Account Number
- The bank name of the account number registered by the waste bank participant.



Figure 6. Display of User Features on the Waste Bank Information System

In Figure 6. is a display when the user has logged in, which can select features, namely:

- Pickup
- Drop Off
- E-Wallet
- Waste Bank Points
- Top Up
- Share
- Redeem Points
- Bank Sampah Bills

System features have adjusted to the system requirements according to user needs.

5.0 CONCLUSION

The researcher can conclude that in the management of the Waste Bank in Duri Kepa Village, the identification of the main problems through SWOT Analysis shows that there are strengths and opportunities that can be utilized to overcome weaknesses and threats. The process of designing and developing information systems with RAD allows a fast and iterative approach. Maturity level measurement using CMMI can help assess and improve the quality of the development process and the results of a good maturity level with an average level 3 and 4. The right strategy is needed so that the project runs according to the targets and goals of the organization. Researchers suggest for further research are involve all stakeholders from the beginning of the process to get support and constructive feedback and also adopt technology that is appropriate and in accordance with user needs.

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