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Digitalization Of Waste Bank Management: A System Requirements Analysis For The Situsari Village Waste Bank Information System (SIBASARI)

Elliana Gautama[1], Nani Krisnawaty Tachjar[2], Dwi Atmodjo W.P.[3], Muhammad Rizky Azwan[4]
[1] Data Science Systems Study Program, Perbanas Institute, Indonesia
[2,3,4] Informatics Study Program, Perbanas Institute, Indonesia

Email: nani.krisnawaty@perbanas.id

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ABSTRACT

Waste bank management at the community level is still largely carried out manually, giving rise to problems such as recording errors, difficulty in data tracing, low transparency, and limitations in report compilation. This study aims to conduct a system requirements analysis for the Situsari Village Waste Bank Management Information System (SiBaSaRi) as the basis for developing a digitalization solution within a Community Service (PKM) activity. The digitalization of waste banks is aligned with the principles of the circular economy and supports sustainable community development as a form of digital transformation with tangible impact. The methods employed include field observation, in-depth interviews with managers, and functional and non-functional requirements analysis based on IEEE 830 standards. The analysis results indicate that the required system encompasses seven main functional modules and eight interrelated relational database tables. Mapping of 10 core problems yielded PKM solutions with measurable indicators, including targets of ≥95% recording accuracy and ≥20% increase in customer participation. Beyond its administrative function, SiBaSaRi is positioned as digital infrastructure supporting circular-economy-based waste management and sustainable community development, and is projected to serve as a replication model for other waste banks in Indonesia.

I. INTRODUCTION

Waste banks are one of the community-based waste management instruments designed to reduce waste volume while providing economic value to residents. In Indonesia, waste banks have proven to be an effective solution for addressing solid waste problems at the community level. This concept aligns with the principles of the circular economy, namely re-utilizing spent resources to maximize economic value while minimizing environmental impact (Circular Economy 2025-2045, 2024).

Nevertheless, the majority of waste banks in Indonesia, including the Situsari Village Waste Bank, still operate manually. Based on preliminary observations, the recording of customer data, waste deposit transactions, savings balance management, and monthly report compilation are all conducted through conventional methods using handwritten ledgers or paper documents. This situation gives rise to various problems such as recording errors, difficulty in data tracing, low transparency, and limitations in report compilation.

Digital transformation in community-based institutions such as waste banks is a strategic step in supporting sustainable community development. Research indicates that the adoption of digital management information systems (MIS) significantly improves operational efficiency, data accuracy, and community trust in waste management organizations (Chafid et al., 2023). Digitalization also enables transparent tracking of material flows, which is a key prerequisite for implementing circular economy principles at the community scale (Geissdoerfer et al., 2020).

Therefore, this study aims to conduct a system requirements analysis for the Situsari Village Waste Bank Management Information System (SiBaSaRi) as the basis for developing a digitalization solution within a Community Service (PKM) activity. The system is expected to support administrative processes, data management, reporting, and increase community participation and trust in the waste bank as part of a community-based circular economy ecosystem.

II. LITERATURE REVIEW

Waste Banks and the Circular Economy

A waste bank is defined as a site for the sorting and collection of recyclable or reusable waste that holds economic value, as regulated in the Regulation of the Minister of Environment No. 13 of 2012 (Peraturan Menteri Lingkungan Hidup No 13 Tahun 2012 Tentang Bank Sampah, 2012). Within the circular economy framework, waste banks serve as material collection nodes that enable valuable materials to re-enter the production chain, thereby reducing natural resource exploitation and carbon emissions (Trihapsari et al., 2025). A study in Bandung found that community-based waste management programs incorporating waste banks, composting, and recycling activities reduced the proportion of household waste sent to TPA, with only 32% of generated waste requiring final collection (Hadian Pratama Hamzah et al., 2022).

Korhonen et al. (Korhonen et al., 2018) further assert that digitalization is the primary catalyst in accelerating the transition toward a circular economy, particularly through material tracking capabilities, transaction automation, and data transparency. Consequently, developing a digital information system for waste banks not only improves operational efficiency but also strengthens the role of waste banks as key actors in the community-based circular economy ecosystem.

Management Information Systems for Community Institutions

Technology-based management information systems (MIS) can reduce recording errors, improve transparency, and facilitate report compilation across various types of organizations, including community-based institutions.(Laudon & Laudon, 2014). Nurul Chafid et al.(Chafid et al., 2023) demonstrated that implementing a web-based waste bank application at Bank Sampah Satya,, using the waterfall development method successfully replaced manual ledger-based recording that posed significant risks of data loss, and simplified customer data input, savings transaction management, and automated report generation, thereby improving operational efficiency and effectiveness..

Furthermore, Septiarini et al. (Septiarini et al., 2023) demonstrated that implementing the WM-Banking web-based system at Bank Sampah Ramli Graha Indah, Samarinda, successfully improved waste bank management and service transparency, leading to increased customer trust and active participation. This demonstrates that digitalization with a user-friendly interface is a critical success factor for technology adoption in community-based waste banks with limited digital literacy.

System Requirements Analysis

Requirements analysis is a crucial initial stage in information system development as it determines the functionality and quality of the system to be built (IEEE Recommended for Software Requirements Specifications, 1998). Sommerville and Sawyer emphasize that information system failures often have their root in inadequate requirements analysis rather than in technical implementation. Modern requirements analysis approaches integrate participatory observation techniques, semi-structured interviews, and stakeholder validation to ensure that the developed system truly meets user needs.

In the context of community-based digital transformation, Septiarini et al. (Septiarini et al., 2023) emphasize that effective digitalization of waste banks requires not only the development of the technology itself, but also knowledge transfer through socialization and training to ensure the system can be independently adopted by managers with limited technological literacy. This approach aligns with the PROFICIENT 2026 conference theme of digital transformation delivering sustainable impact.

III. METHODS

This study employs a qualitative descriptive approach using a system requirements analysis method based on the IEEE 830 standard. This approach was selected because it enables holistic identification of requirements, encompassing technical, organizational, and social aspects of the system to be developed. Data collection was conducted through three stages:

(1) Field observation to directly examine the operational processes of the SiBaSaRi Waste Bank over four weeks;
(2) In-depth interviews with managers and customers using semi-structured guidelines to identify real problems and needs;
(3) Documentation study of existing procedures, forms, and ledger books to understand the current workflow.

The collected data was analyzed using thematic analysis techniques to identify requirement patterns, then validated through a focus group discussion (FGD) with waste bank managers (Asyrafil Anam & Supriyanto, 2025) . The analysis process produced four main artifacts: (1) functional and non-functional requirements specifications, (2) problem-to-PKM-solution mapping, (3) a proposed relational database structure, and (4) measurable program success indicators. The PKM implementation method workflow is presented in Figure 1.

Figure 1. PKM Implementation Workflow for Situsari Village Waste Bank

III. RESULTS AND DISCUSSION

Functional and Non-Functional System Requirements Analysis

The requirements analysis results indicate that the Situsari Village Waste Bank requires an information system encompassing seven main functional modules. First, a customer data management module capable of centrally recording, displaying, updating, and deleting member data. Second, a waste type management module including price per kilogram. Third, a deposit transaction recording module that automatically calculates the total weight and economic value of waste. Fourth, a customer balance module managing savings and transaction history. Fifth, a balance withdrawal module with automatic updates. Sixth, a reporting module generating transaction reports and summaries. Seventh, a user management module with differentiated access rights between admins and operators. These requirements specifications align with the findings of Nurul Chafid et al. (Chafid et al., 2023), whose waste bank application at Bank Sampah Satya also encompassed modular functions covering customer data management, waste type and pricing, deposit transactions, savings balance, and automated report generation, confirming that modular system design is essential for operational effectiveness in community-based waste banks.

The non-functional system requirements encompass seven key quality attributes derived from the ISO/IEC 25010 standard. In terms of *usability*, the interface must be simple and use language easily understood by managers with limited technological literacy, consistent with human-centered design recommendations. *Reliability* requires the system to run stably with guaranteed data storage. *Security* is implemented through encryption-based user authentication. In terms of *performance*, the system must remain responsive as data volume grows. *Availability* is maintained even under limited internet connectivity due to its local-based architecture. *Scalability* allows for the addition of customers and features in the future. The *maintainability* aspect enables managers to perform regular data backups with ease.

Requirement Mapping and PKM Solutions

The requirement mapping identified 10 core partner problems with structured PKM solutions. Each problem was mapped to a specific system requirement, the PKM solution provided, and a concrete deliverable output, as presented in Table 1. This mapping is consistent with the recommendations of Anam and Supriyanto (Asyrafil Anam & Supriyanto, 2025), who stress that successful digitalization of community-based waste management requires a comprehensive approach encompassing not only technology development but also attention to user requirements, human resource capacity, and process standardization, as demonstrated through their User-Centered Design methodology applied in Caturharjo Village, Bantul Regency.

TABLE 1. Requirement Mapping and PKM Deliverables for Situsari Village Waste Bank

No	Partner Problems	System Requirements	Community Service Solution	Outputs
1	Waste collector data recorded manually	Centralized customer data system	Digitalization of customer records	Customer app, administration module
2	Waste type data not documented	Waste type and price management	Waste type and price database	Waste database, price SOP
3	Errors in deposit recording	Automated deposit transaction system	Implementation of transaction recording	Transaction app, transaction SOP
4	Customer balances frequently out of sync	Automatic balance calculation	Digitalization of waste savings	Digital savings feature, user guide
5	Transaction history difficult to trace	Transaction history system	Digital transaction storage	Transaction history report, report template
6	Balance withdrawals not documented	Balance withdrawal recording	Standardization of withdrawal process	Withdrawal SOP, recording feature
7	Monthly reports difficult to compile	Automated reporting system	Automation of waste bank reports	Transaction and financial reports
8	Insufficient staff understanding	Human resource capacity building	Training and mentoring	Training module, documentation
9	No clear operational standards	Standardization of operational processes	Development of waste bank SOPs	SOP management handbook

No	Partner Problems	System Requirements	Community Service Solution	Outputs
10	Program sustainability not guaranteed	User-friendly and maintainable system	Mentoring and knowledge transfer	Technical documentation, sustainability guide

The proposed relational database structure encompasses eight interrelated tables. This database architecture was designed following normalization principles up to Third Normal Form (3NF) to ensure data integrity and avoid redundancy. The inter-table relationships are designed to ensure data integrity and facilitate comprehensive customer transaction tracing, as detailed in Tables 3 through 10 below.

Program Success Indicators

Success indicators were established with measurable targets to ensure short-, medium-, and long-term impact on waste bank sustainability, as presented in Table 2. The establishment of data-driven indicators is essential to ensure that the PKM program not only produces technological outputs but also delivers tangible benefits for the community .

TABLE 2. Success Indicators for Situsari Village Waste Bank PKM Program

No	Aspect Evaluated	Success Indicator	Target Achievement	Measurement Method
1	Waste Bank Administration	Customer data digitalized	≥90% of customer data recorded	Database inspection
2	Transaction Recording	Deposit transactions recorded neatly	≥90% of transactions recorded	Transaction logs
3	Balance Accuracy	Customer balance matches transactions	≥95% accuracy rate	Data reconciliation
4	Reporting	Monthly reports compiled automatically	Available every month	Report documents
5	Human Resource Capacity	Managers understand the system	≥80% of managers competent	Pre-test & post-test
6	Process Standardization	SOPs applied	SOPs actively used	Field observation
7	Community Participation	Increase in number of customers	≥20% increase	Membership data

Projected Impact

The implementation of SiBaSaRi is projected to generate staged impacts across three time horizons. In the short term: waste bank administration becomes neater and more organized, managers are able to record transactions and balances independently, and management transparency improves. In the medium term: community trust in the waste bank increases, the volume of managed waste grows, and the waste bank begins to contribute more significantly to residents' livelihoods. In the long term: a self-sufficient and sustainable waste bank is realized, a circular-economy-based waste management culture is established, and the model can be replicated at other waste banks in the surrounding area.

From a circular economy perspective, the digitalization of waste banks supports material loop closure through accurate recording of the type and volume of waste successfully recycled (Korhonen et al., 2018). This data can be leveraged for further analysis regarding the waste bank's contribution to reducing waste sent to landfills and estimating carbon emission reductions, which are important indicators in village-level sustainability reporting.

Beyond environmental reporting, the social dimension of circular economy implementation is equally critical. The projected increase in customer participation of ≥20% is supported by evidence from prior PKM activities in the same village, where a composting training program successfully engaged 34 participants and catalyzed initiatives to form yard-farming community groups (Tachjar et al., 2025). SiBaSaRi is positioned as the digital backbone that can consolidate and scale these grassroots circular economy initiatives.

Proposed SiBaSaRi Database Structure

The SiBaSaRi relational database structure is designed with eight interrelated tables as follows:

1. Table: users

Stores data of waste bank system administrators.

TABLE 3. Users Table

Field	Data Type	Description
id_user	*INT (PK)*	User ID (auto increment)
full_name	*VARCHAR(100)*	Name of administrator
username	*VARCHAR(50)*	Login username
password	*VARCHAR(255)*	Password (bcrypt encrypted)
role	*ENUM*	Admin / Operator
created_at	*DATETIME*	Record creation timestamp

2. Table: customers

Stores data of waste bank members/customers.

TABLE 4. Customers Table

Field	Data Type	Description
id_customer	*INT (PK)*	Customer ID (auto increment)
full_name	*VARCHAR(100)*	Customer name
Address	*TEXT*	Customer address
Phone	*VARCHAR(15)*	Contact number
registration_date	*DATE*	Date of registration
status	*ENUM*	Active / Inactive

3. Table: waste_types

Stores waste category data and price per unit weight.

TABLE 5. Waste_types Table

Field	Data Type	Description
id_type	*INT (PK)*	Waste type ID
type_name	*VARCHAR(50)*	Waste category name
unit	*VARCHAR(20)*	Unit (kg)
price_per_kg	*DECIMAL(10,2)*	Price per kilogram (IDR)
notes	*TEXT*	Additional notes

4. Table: deposits

Stores waste deposit transactions from customers.

TABLE 6. Deposits Table

Field	Data Type	Description
id_deposit	*INT (PK)*	Deposit ID
id_customer	*INT (FK)*	Reference to customers table
deposit_date	*DATE*	Date of deposit
total_weight	*DECIMAL(10,2)*	Total weight (kg)
total_value	*DECIMAL(12,2)*	Total value (IDR)
id_user	*INT (FK)*	Recording officer

5. Table: deposit_details

Stores per-waste-type details within a single deposit transaction.

TABLE 7. Deposit_details Table

Field	Data Type	Description
id_detail	*INT (PK)*	Detail ID
id_deposit	*INT (FK)*	Reference to deposits table
id_type	*INT (FK)*	Reference to waste_types table
weight	*DECIMAL(10,2)*	Weight of waste (kg)
value	*DECIMAL(12,2)*	Value in IDR

6. Table: withdrawals

Stores customer balance withdrawal transactions.

TABLE 8. Withdrawals Table

Field	Data Type	Description
id_withdrawal	*INT (PK)*	Withdrawal ID

Field	Data Type	Description
id_customer	*INT (FK)*	Reference to customers table
withdrawal_date	*DATE*	Date of withdrawal
amount	*DECIMAL(12,2)*	Withdrawal amount (IDR)
notes	*TEXT*	Transaction notes
id_user	*INT (FK)*	Recording officer

7. Table: customer_balances

Stores the current balance of each customer in real-time.

TABLE 9. Withdrawals Table

Field	Data Type	Description
id_balance	*INT (PK)*	Balance ID
id_customer	*INT (FK)*	Reference to customers table
balance	*DECIMAL(12,2)*	Current balance (IDR)
last_updated	*DATETIME*	Last update timestamp

8. Table: activity_logs

Records all system activities for audit trail purposes.

TABLE 10. Activity_logs Table

Field	Data Type	Description
id_log	*INT (PK)*	Log ID
id_user	*INT (FK)*	User performing the activity
activity	*TEXT*	Activity description
timestamp	*DATETIME*	Time of activity

Figure 2 Community Service Activity Photos

IV. CONCLUSION

The system requirements analysis for the Situsari Village Waste Bank Management Information System reveals a genuine need for a comprehensive digitalization solution. The recommended SiBaSaRi system encompasses seven functional modules with eight interrelated relational database tables, developed based on IEEE 830 standards and human-centered design principles. Mapping of 10 core problems yielded PKM solutions with measurable deliverables in the form of an application, training modules, and SOPs. System implementation is projected to improve recording accuracy to ≥95% and increase customer participation by at least 20%. Beyond its role as an administrative tool, SiBaSaRi is positioned as digital infrastructure supporting circular-economy-based waste management, which in turn contributes to *sustainable community development* in alignment with the PROFICIENT 2026 conference theme. This program is expected to serve as a replication model for other waste banks in realizing digital transformation with sustainable impact.

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LIST OF PARTICIPANTS

DAFTAR HADIR PESERTA KEGIATAN PKM
PERBANAS INSTITUTE DAN DESA SITUSARI
RABU, 13 MEI 2026

\	NAMA LENGKAP	ALAMAT	NOMER HP	PARAF
1	Ade .Nm	Kp. Karet	085211969898	
2	Adhuwono	Bukit Putra	085779619328	
3	Alfa Riansyah	Kp Karet	0881010049884	
4	NIJAN	Kp. Karet	08309575626	
5	RUDI.Y	Kp. KARET	0821229242945	
6	SOMA	Kp Karet	0812878195 11	
7	Asep hadiansyah	Perum bukit Putra	0813192435051	
8	Herban Pratama	— 11 —	085813400306	
9	Mega Ishana	Permata Puri Harmoni	082384830830	
10	NOVRIYADI	Permata Puri Harmoni	08127700427	
11	Ii Wijaya	Kp Ciuncal	081395871409	
12	Muhammad Yusuf	PPH.1	081808852986	
13	Edaus	Kp. Karet		
14	Enuna	Kp Karet		
15	Asep. / Asbo .	Kp. Karet		
16				
17				
18				
19				
20				

DAFTAR ABSENSI KEGIATAN PKM
PERBANAS INSTITUTE DAN DESA SITUSARI

KELOMPOK : 20

JUDUL : Edukasi Bank Sampah

NO	NAMA LENGKAP	DOSEN / MAHASISWA	NIDN / NIM	PRODI	PARAF
1	Elly Gautama, S.Kom., M.Kom.	Dosen	0314096801	Sains Data	
2	Nani Krisnawaty Tachjar, S,Kom., M.T.	Dosen	0326057501	TI	
3	Drs. Dwi Atmodjo Wismono P., M.Kom.	Dosen	0317116501	TI	
4	Siti Rosmah	Mahasiswa Brunei	2516090002	Ekonomi syariah	
5	Nurraimi Batrisyia	Mahasiswa Brunei	2516090001	Ekonomi Syariah	
6	Raka Fahlevi	mahasiswa	2213000024	Sistem Informasi	
7	M. Hanis .A.	Mahasiswa.	2417000001	Sains Data.	
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