

WASTE BANK FOR COMMUNITY-BASED WASTE MANAGEMENT AND ITS TECHNOLOGY IMPLEMENTATION FOR BETTER PERFORMANCE: STATE-OF-THE-ART AND FUTURE RESEARCH DIRECTION

ELY SUFIANTI^{1*}, SUNARTI², CINTANTYA ANDHITA DARA KIRANA³, RONY SANDRA YOFA ZEBUA⁴ and SRI SURYANI⁵

^{1,3,5} Politeknik STIA LAN Bandung, Indonesia.

² School of Business and Management, Institute Technology Bandung, Indonesia.

⁴ Universitas Islam Bandung, Indonesia.

*Correspondence to ely.sufianti@poltek.stialanbandung.ac.id

Abstract

Purpose: This study provides some crucial insights into the research gaps in studies focusing on waste banks, including their relationship with behavioural factors that affect the sustainable participation of communities in the existing Waste Bank Program and technology involvement for waste bank management. **Methods:** This study uses the literature review method that involves the study of various journal articles that discuss waste banks as a form of community-based waste management, as well as the factors that influence its success and application in waste bank management, published between 2015–21, both in English and Indonesian. **Results:** Various efforts have been made to solve the waste management problem, including the implementation of community-based waste management. Community participation is very important in waste bank management. However, issues arise in the implementation of this initiative because of the unsupportive behaviour of the community. State-of-the-art technology has been implemented in waste bank management. **Conclusion:** These studies indicate that the role of social capital is very important to increase community participation in waste management. Regarding technology involvement in waste management, most studies were related to web or application development, while their evaluation was rarely done.

Keywords: waste bank management, technology implementation

Introduction

Background/Rationale:

Waste management is a big problem for all the countries of the world, especially developing countries. Waste handling requires the collaboration of various stakeholders, including the government, society, private sectors, colleges, and media (Ghazali et al., 2021). The government should play the role of a facilitator and leader and encourage its residents to reduce waste generation, practice better handling, and use technology for waste management (Ghazali et al., 2021; Tanuwijaya, 2016). It should also strengthen waste regulation, which involves the sorting and reduction of wastes, to help improve the current waste management system (Babalola, 2019). One of the methods of reducing municipal waste that is increasingly followed in many developing countries is a program called Waste Bank. This program was the result of a collaboration of various stakeholders and has been useful in waste reduction (Susilowati &

Herdiansyah, 2019). It involves including the community in waste recycling, and thereby generating economic benefits from wastes (Indartik et al., 2018; Prastiyantoro, 2017; Tanuwijaya, 2016; Yuliana & Wijayanti, 2019).

Waste offers economic value that can potentially generate income for people who can manage it well (Indartik et al., 2018; Sari & Fuad, 2018). As implied by the name, waste bank, economic value is one of the most attractive factors that encourages residents to participate in this program. Waste bank was developed to collect inorganic wastes that have economic value. This has made the waste bank system popular in many low- and middle-income countries such as Indonesia (e.g. Winarso & Larasati, 2011; Ramadhan, 2016; Wardhani & Harto, 2018; Warmadewanthi & Haqq, 2019; Yudiantmaja et al., 2021; Agustina et al., 2021), Malaysia (Alias et al., 2019), and Thailand (Aroonsrimorakot & Pradabphetrat, 2010; Suttibak & Nitivattananon, 2007). However, the primary values of this program as campaigned by the organizers are not only economic, but also social and environmental in nature (Ghazali et al., 2021; Sunarti et al., 2021). These values are expected to generate sustainable participation from the community. Thus, waste bank management embedded social capital in its implementation. Moreover, as a social business, the waste bank emphasizes social relationships among its organizers. Social capital, which includes trust, norms, social networks, and cooperation, coexisted and was implemented by the urban community in the waste bank (Yudiantmaja et al., 2021) to increase people participation (Tanuwijaya, 2016). The success of waste bank management requires collaboration from various parties; therefore, networking is something that encourages community participation in waste banks (Indrawati, 2019).

To improve their performance and ensure wider coverage, many waste banks utilize technology to support waste management. Besides being beneficial to internal performance in this digital era, technology also enables waste banks to attract community participation, as the financial system of this program is commonly managed by non-professionals (e.g. Ramadhan, 2016). The utilization of technology in the financial system will improve the trustworthiness of the program in the eyes of the community. The sustainability of community participation is key for the waste bank to reach its goal of reducing wastes to save the environment.

As the waste bank system started transforming into a community-based program in many countries, a considerable amount of literature started being published around the theme of waste bank studies (e.g. Bachtiar, 2015; Prastiyantoro, 2017). However, no study has provided a comprehensive picture of what has been found and studied on this topic. Therefore, the central thesis of this article is to provide the state-of-the-art recent studies focusing on the waste bank. Using the Literature Review method, this study provides a comprehensive review of what has been found in previous research related to waste banks. This includes the study of the approach and methodologies used by existing studies to investigate the waste bank program, what parties collaborated in the existing waste bank system, what underlying theories were studied related to waste bank, what social capital was involved to nurture community participation in the waste bank, and what technology was used to support their management.

Objectives

This study provides some crucial insights into the research gaps in studies focusing on waste bank, including its relationship with behavioural factors that affect sustainable participation of the community in existing waste bank programs in various countries and the role of technology in supporting the system. These findings are expected to assist other researchers to identify the topics that have been less investigated and require further investigation in future studies. It also offers key insights to help waste bank practitioners improve their waste bank and ensure better performance. Several directions for future studies are also given to help other researchers find their study's novelty in waste management and waste bank topics.

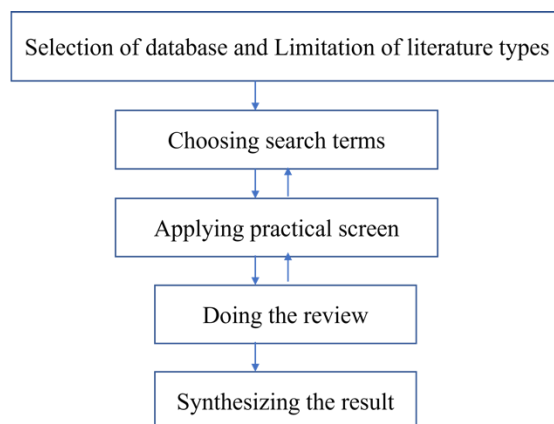
Methods

Study Design

This study is a literature review of studies that discuss waste bank as a part of community-based waste management and the use of technology in its implementation to improve the performance of waste management. The literature review process was conducted as presented in Figure 1. The units of analysis were waste banks, households, and the public community. The term "waste bank" refers to the concept of solid waste collection and sorting; waste banks operate like conventional banks, with the difference being that the savings are not financial but solid waste (Warmadewanthi & Haqq, 2019). The largest composition of waste is produced by households (United Nations, 2016). Whereas, the management of the waste bank is carried out by the public community (Samadikun et al., 2018; Yudiatmaja et al., 2021). Waste bank management is part of waste management. Therefore, the literature search was conducted using the keywords "waste bank", "bank sampah" (waste bank in Indonesian), "waste reduction", and "waste management". Waste management is an activity that involves households (Akil & Ho, 2014), and waste bank management is a community-based activity (Raharjo et al., 2017); so it requires community participation for its success. Therefore, the literature search also used the word "participation waste bank". Information technology has now become the main driver of business change (Apăvăloaie, 2014); therefore, technology implementation in waste bank is expected to improve its performance. Based on this aspect, literature search included the use of the keywords, "technology waste management", "technology information waste management", "Teknologi bank sampah", and "aplikasi bank sampah". Steps 2, 3, and 4 were conducted iteratively, by applying feedbacks to clarify the literature exploration and to define the inquiry (Zacho & Mosgaard, 2016).

After the completion of the selection process, the selected articles were analyzed based on their author, context, study approach, study methodology, and technology involvement. Furthermore, the analysis was carried out based on the condition of social capital in the waste bank and technology implementation in the waste bank.

Figure 1: Literature Review Process (Fink, 2014)



Data Sources

This study reviews various journal articles that discuss waste banks as community-based waste management systems, as well as the factors that influence their success and the use of technology in waste bank management, published between 2015–21, both in English and Indonesian. The database sources mainly used in this study were Science Direct, ProQuest, and others from Mendeley and Indonesian language journals, especially those related to waste bank management.

Results and Discussion

This section provides the findings from selected previous studies: the social capital involved to nurture community participation in the waste bank and the underlying theories, and the technologies used to support their management system. The discussion is sub-divided into three primary sub-sections: Descriptive Profile of Selected Studies on Waste Banks, Social Capital in Waste Bank, and Technology Adpotion in Waste Bank

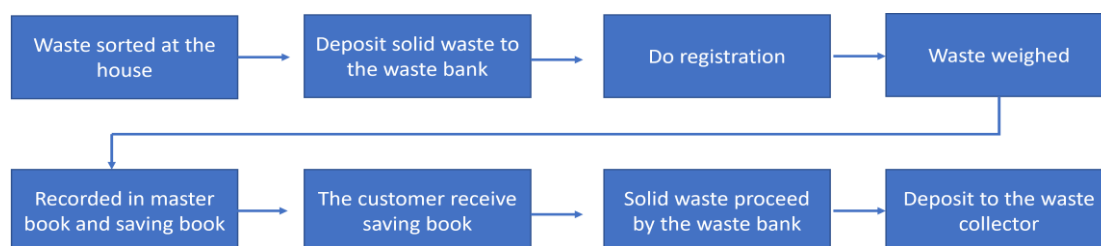
Operational System of Waste Banks in Indonesia

A waste bank is a place where recyclable and/or reusable wastes that have economic value are collected and sorted (Kementerian Lingkungan Hidup Republik Indonesia, 2013). Waste banks are referred using various terms such as Bank Sampah in Indonesia, Garbage Bank in Malaysia (Alias et al., 2019), and Waste Bank in Thailand (Aroonsrimorakot & Pradabphetrat, 2010). The waste bank collects waste from the people and then sells it to other parties. People who sell their waste to the waste bank are called customers. The waste bank will earn some money by selling these wastes. To attract more customers, some waste banks allow their customers to exchange their waste sale money for gold (Bandung City Public Relation Affairs, 2021), to pay public transportation fees (Laily, 2020), or pay tax (Bandung City Public Relation Affairs, 2020).

The waste bank operational process starts at home (Figure 2). Usually, housewives sort the wastes of the household (Kurniasih et al., 2017) as organic and inorganic waste. Organic waste

that has economic value is then brought to the waste bank. After the organic waste arrives at the waste bank, it is registered and then weighed according to the type of waste. Following this, official records are made in the master book and savings book. The savings book is handed over to the customer. The next step is further processing. The waste bank may use some waste to make handicrafts, and sort the remaining further to get a higher price. The final step is selling the waste to collectors. Collectors can be the main waste banks or individual collectors. The proceeds of the sale are shared between customers and waste banks (Saputro et al., 2015).

Figure 2: Waste Bank Operational Process (Suryani, 2014)



Waste handling involves some basic steps: the waste is first classified based on the type, and then weighed and recorded by the officer at the waste bank. After this, the manager will sell the waste to collectors. The profit from the sale will be shared between the manager and the customer (Ramadhan, 2016). The waste may be classified as plastic pet bottles, mixed plastics (cups, plastic bottles, broken plastic buckets, etc.), cardboard, cans, aluminum cans, glass, etc. (Fatkhayah & Utami, 2016; Kurniasih et al., 2017; Saputro et al., 2015). While some wastes will be sold, some will be reused for different purposes or used to make crafts such as bags, stationary, artificial flowers, or slippers (Astheria & Heruman, 2016; Fatoni et al., 2017). The management officers in waste banks are mainly the women who are actively involved in the Family Welfare Empowerment group that is established in each neighborhood or environmental community (Ramadhan, 2016).

Descriptive Profile of Selected Studies on Waste Banks

Studies related to waste bank management may differ based on the context of the study, the research methodology, the technology used in waste management, and the social capital in society. The profile drawn from the selected articles showed that the context of studies includes technology system development, technology system evaluation, waste bank management, community, institution, and participation. Table 1 provides more details on the context. The studies mostly used qualitative approach, while some used mixed methods (Budihardjo et al., 2022; Destriana et al., 2020; Dhokhikah et al., 2015; Fatimah, Govindan, et al., 2020; Fatimah, Widiyanto, et al., 2020; Singhirunnusorn et al., 2012). The study methodologies included survey, case study, descriptive analysis, literature review, focus group discussion, observation, interview, and system development methods. The Waste Bank Applications were developed using JAVA, PHP, MySQL (Unified Modeling Language (UML), etc., and were either web-based or android-based. The context also included social capital such as participation, social networks, cooperation, trust, norms, and empowerment.

Study Context

Most of the research in the selected articles had been conducted in Indonesia, while few others had been conducted in Malaysia (Alias et al., 2019) and Thailand (Aroonsrimorakot & Pradabphetrat, 2010). Waste banks are mostly operated in Indonesia as the government supports the community to develop it. The research topics were mostly related to technology involvement, but some were also about waste management (Alias et al., 2019; Aroonsrimorakot & Pradabphetrat, 2010; Setiawan & Rohmat, 2021; Yudiatmaja et al., 2021), involvement of community in waste bank activities (Aroonsrimorakot & Pradabphetrat, 2010; Pradhipta et al., 2017; Tanuwijaya, 2016; Yuliana & Wijayanti, 2019), strengthening institution (Nurjanah Adhianty; Sakir, 2019), and community participation (Indrawati, 2019b; Prastiyantoro, 2017; Tanuwijaya, 2016; Yuliana & Wijayanti, 2019). Technology involvement refers to the utilization of technology to ensure efficient waste management. Furthermore, in term of technology involvement, most researches focused on information system development, while others discussed about its evaluation (Yunita et al., 2021; Purwaningtias et al., 2020). Technology involvements in waste banks need to be evaluated as well.

Table 1: Context of Research about Waste Bank

Authors	Country	Technology System Development	Technology System Evaluation	Waste Management	Community	Institution	Participation
Julianto et al., (2019)	Indonesia	√	-	-	-	-	-
Pradhipta et al., (2017)	Indonesia	√	-	-	√	-	-
Alias et al., (2019)	Malaysia	-	-	√	-	-	-
Aroonsrimorakot & Pradabphetrat, (2010)	Thailand	-	-	√	√	-	-
M. E. Prasetyo et al., (2017)	Indonesia	√	-	-	-	-	-
Marali et al., (2018)	Indonesia	√	-	-	-	-	-
Fadlilah et al., (2021)	Indonesia	√	-	-	-	-	-
Firmansyah et al., (2019)	Indonesia	√	-	-	-	-	-
R. Firmansya et al., (2019)	Indonesia	√	-	-	-	-	-
Wardhana et al., (2019)	Indonesia	√	-	-	-	-	-
Aslamiyah & Kusumas Sita, (2019)	Indonesia	√	-	-	-	-	-
Kaburuan & Heriyati, (2019)	Indonesia	√	-	-	-	-	-
A. Prasetyo, (2021)	Indonesia	√	-	-	-	-	-
Ardiantoro & Rohmah, (2019)	Indonesia	√	-	-	-	-	-
Mardinata & Khair, (2017)	Indonesia	√	-	-	-	-	-
Fatkhiyah & Utami, (2016)	Indonesia	√	-	-	-	-	-

Authors	Country	Technology System Development	Technology System Evaluation	Waste Management	Community	Institution	Participation
Kamil et al., (2019)	Indonesia	√	-	-	-	-	-
Pamungkas et al., (2020)	Indonesia	√	-	-	-	-	-
Purwati et al., (2021)	Indonesia	√	-	-	-	-	-
Nurjanah & Sakir, (2019)	Indonesia		-	-	-	√	-
Saptadi et al., (2020)	Indonesia	√	-	-	-	-	-
Bakti et al., (2020)	Indonesia	√	-	-	-	-	-
Andriyanto & Wansen, (2020)	Indonesia	√	-	-	-	-	-
Soegoto et al., (2018)	Indonesia	√	-	-	-	-	-
Taufiq et al., (2016)	Indonesia	√	-	-	-	-	-
Aminy, (n.d.)	Indonesia	√	-	-	-	-	-
Agustin et al., (2020)	Indonesia	√	-	-	-	-	-
Yunita et al., (2021)	Indonesia		√	-	-	-	-
Aziz & Gumilang, (2018)	Indonesia	√	-	-	-	-	-
Purwaningtias et al., (2020)	Indonesia		√	-	-	-	-
Wikusna et al., (2018)	Indonesia	√	-	-	-	-	-
Sansprayada & Mariskhana, (2020)	Indonesia	√	-	-	-	-	-
Lidimilah & Hermanto, 2018	Indonesia	√	-	-	-	-	-
Ridha et al., 2021	Indonesia	√	-	-	-	-	-
Ulinuha et al., 2016	Indonesia	√	-	-	-	-	-
Abdullah & Widhiyanta, 2019	Indonesia	√	-	-	-	-	-
Kusuma et al., 2020	Indonesia	√	-	-	-	-	-
Widaningsih & Suheri, 2019	Indonesia	√	-	-	-	-	-
Destriana et al., 2020	Indonesia	√	-	-	-	-	-
Bin Tahir, 2018	Indonesia	√	-	-	-	-	-
Prastiyantoro, 2017		-	-	-	-	-	√
Yuliana & Wijayanti, 2019	Indonesia	-	-	-	√	-	√
Indrawati, 2019	Indonesia	-	-	-	-	-	√
Tanuwijaya, 2016	Indonesia	-	-	-	-	-	√
Yudiatmaja et al., 2021	Indonesia	-	-	√	-	-	-

Study Approach and Study Methods

Most of the selected studies used a qualitative approach. However, some studies also used quantitative approach (Aroonsrimorakot & Pradabphetrat, 2010; Yuliana & Wijayanti, 2019) and mixed methods (Destriana et al., 2020). Waste bank management in Indonesia is still conducted manually, with respect to finance and waste recording (Salim et al., 2017a). Therefore, studies regarding system development were conducted quite frequently. This had an impact on the selection of study methods. The selected studies used study methods such as

prototype method (Yunita et al., 2021; Destriana et al., 2020; Julianto et al., 2019; Purwaningtias et al., 2020), system development life cycle (Kamil et al., 2019; Lidimilah & Hermanto, 2018; Pradhipta et al., 2017; Wardhana et al., 2019), waterfall method (Ardiantoro & Rohmah, 2019; Fadlilah et al., 2021; Firmansyah et al., 2019; Kamil et al., 2019; Lidimilah & Hermanto, 2018; Marali et al., 2018b; Mardinata & Khair, 2017; M. E. Prasetyo et al., 2017; Ulinuha et al., 2016; Widaningsih & Suheri, 2019; Wikusna et al., 2018), MySQL AB & PHP (Fatkhayah & Utami, 2016; Saptadi et al., 2020), and other system developing methods. Some other researches explored waste bank from perspectives other than system development. They used approaches such as community development approach (Abdullah & Widhiyanta, 2019), object oriented methods (Aziz & Gumilang, 2018), PIECES (performance, information, economy, control, efficiency, and service), analysis (Kusuma et al., 2020), or case study/descriptive analysis. The studies used quantitative approach and cross-sectional methods to explore communities' attitude towards separating waste (Yuliana & Wijayanti, 2019). One study used both quantitative and qualitative approaches (Destriana et al., 2020) to explore waste bank application use in waste banks.

The approach and methods used in the selected studies show that technology is highly involved in waste banks. Technology has mostly been used to develop web-based information systems or android-based applications; one study revealed the use of technology in a desktop-based application (Abdullah & Widhiyanta, 2019). The development of information system is certainly very useful for waste bank management, so it is expected to increase public trust.

Social Capital in Waste Bank

Even though the initial goal of waste bank is to generate economic benefits for the participants, in practice, many other factors were involved to encourage the community to join the programs. Social capital played a crucial role in encouraging community participation (Tanuwijaya, 2016; Indrawati, 2019a). Several social capital factors shape the business process of waste banks, including trust, norms, social networks, and gotong royong (Indrawati, 2019b; Yudiantmaja et al., 2021). Various factors affect community participation, such as economic motive, social motive of creating harmony, psychological motive of achieving residence, and self-satisfaction of the environment becoming clean (Tanuwijaya, 2016). Knowledge regarding waste problems and management, confidence to participate in creating change, as well as incentives and benefits are also some principle social factors that encourage communities to participate in waste management (Prastiantoro, 2017).

People's actual behavior is affected by their intentions, and their intention is affected by their attitude toward their behavior, subjective norms, and perceived behavioral control (Ajzen, 2012). The theory of planned behavior provides a useful conceptual framework for studying the complexities of human social behavior. Knowledge and attitude are related to each other. There is a positive relationship between knowledge, attitude, and behavior (Pradiko et al., 2021; Prastiantoro, 2017). There is also an association between knowledge, attitude, sorting behavior, waste sorting facilities, waste bank benefits, and community participation (Yuliana & Wijayanti, 2019). The studied researches show that households' knowledge about solid waste recycling is good and positive (Akil & Ho, 2014). The six critical types of knowledge in

this regard include technical experience, knowledge about waste management performance, perception of benefits, environmental awareness, understanding of individual and social responsibilities, and understanding of social norms and regulations (Sunarti et al., 2021). Furthermore, in waste bank implementation, education, income, and knowledge about waste banks are related to participation in the waste bank (Maryati et al., 2018).

In addition to technology, social capital is also very important for waste bank management, to maintain community involvement in the operation of waste banks (Table 2). In this context, several studies show that trust is very important (Destriana et al., 2020; Indrawati, 2019b; Widaningsih & Suheri, 2019; Yudiatmaja et al., 2021). Other important factors are social networks (Abdullah & Widhiyanta, 2019; Yudiatmaja et al., 2021), participation (Indrawati, 2019b; Kusuma et al., 2020; Tanuwijaya, 2016; Yuliana & Wijayanti, 2019), and cooperation. Other important social capital factors in waste management are behavior (Destriana et al., 2020), habit (Setiawan & Rohmat, 2021), and attitude in sorting waste (Yuliana & Wijayanti, 2019). Other social factors that encourage people to participate in waste banks are norms (Indrawati, 2019b), motive (Tanuwijaya, 2016), and belief in contributing to a change (Prastiyantoro, 2017). Local wisdom also plays an important role in waste bank management (Bin Tahir, 2018). These studies show that social capital cannot be ignored in waste management. Social capital factors, such as motive, habits, attitude, trust, and belief in contributing to a change, come from within individuals; factors such as networks, cooperation, and norms result from the relationships existing between individuals who are part of a group. All these factors improve participation.

Table 2: Social Capital Factors that Affect Waste Bank Management

Authors	Social Capital
Ardiantoro & Rohmah, 2019	Cooperation
Mardinata & Khair, 2017	Cooperation
Nurjana & Sakir, 2019	Stakeholder interest
Saptadi et al., 2020	Networks
Abdullah & Widhiyanta, 2019	Social networks, cooperation
Kusuma et al., 2020	Trust
Widaningsih & Suheri, 2019	Trust
Destriana et al., 2020	Trust, behaviour
Bin Tahir, 2018	Local wisdom
Setiawan & Rohmat, 2021	Good habits in disposing of garbage
Prastiyantoro, 2017	Partnership, belief in contributing to a change
Yuliana & Wijayanti, 2019	Attitude towards separating waste
Indrawati, 2019	Norm, trust, network
Tanuwijaya, 2016	Social motive, psychology motive
Yudiatmaja et al., 2021	Norms, trust, network, cooperation
Budihardjo et al., 2022	Empowerment, community development
Singhirunnusorn et al., 2012	Community empowerment
Fatimah et al., 2020	Community development

Technology Adoption in Waste Bank

Considering the important role of waste bank in waste management, its sustainability is crucial. Social sustainability is important for institutions that are integrated into urban policies and become a very important aspect of a sustainable future in addition to the economic and environmental dimensions (Shirazi & Keivani, 2017). In the internet of things era, digitizing the financial administration of waste banks is an effort that can help maintain its sustainability, as it will enable effective waste bank administration.

A waste bank is an institution that collects, sorts, and manages solid waste just as a conventional bank does with finance (Warmadewanthi & Haqq, 2019). As a waste bank is a “bank” that has customers who save, it is important to record its financial data and the amount of waste managed. Therefore, it is important to increase customer security and the trust in waste banks, and achieve safer transactions without data error (Prima Kusuma & Astuti, 2017). Financial recording is a kind of financial accountability of the bank towards its customers and managers. A good financial record will increase customer trust. Much like conventional banks, waste banks also conduct saving and loan business (Asteria & Heruman, 2016).

In addition to generating financial reports, recording the amount of inorganic waste that is managed by waste banks is also very important. This data is required by the government. Although the Indonesian government has developed an information system in the solid waste sector, the existing information system is still sectoral, the published data is incomplete and not up-to-date, the data sources collected are still dominated by government institutions, and are not even open to the public (A. Prasetyo, 2021). Information on the amount and type of waste that is managed will help in determining the effectiveness of the role and existence of waste bank. Further, knowing the amount of waste being managed will help in reducing the amount of waste that is disposed of in the final landfill area.

Currently, financial and waste recording is still done manually at most waste banks (Salim et al., 2017a). Waste banks record the weight of waste per type and the amount of money generated by it into a master book, and then transfers the data to a savings book. The master book is held by the waste bank and the passbook is held by the customer (Suryani, 2014). Android-based computer applications help waste banks to manage their administration, record junk data, and enable customers to access their savings balance data anywhere and anytime, using smartphones (Destriana et al., 2021).

There were some previous studies on waste banks, which identified the use and/or design of technological products to support waste bank management. Detailed information about the studies, their research dimensions, and their research methods are presented in Table 3.

Table 3: Research Focus of Studies that Considered Technology Development in Waste Management

Authors	Research Focus	Technology Development Methods
Taufiq et al., 2016	- System analysis - Software design	Extreme Programming (XP)
Mardinata & Khair, 2017	- Needs analysis - System design - Program code writing - Program testing - Program implementation	Waterfall software development methods
M. E. Prasetyo et al., 2017	- System design - Program implementation - Black Box testing - Questionnaire testing	Waterfall system development methods
Soegoto et al., 2018	System development: - System design - Database design - Interface design	Structured methods
Bin Tahir, 2018	- System development tools - System design	Research and Development (RnD) and the type of research software engineering using model development
Widaningsih & Suheri, 2019	- Software engineering - Construction - Deployment	QR code for the waste management system Waterfall model for software engineering
Kaburuan & Heriyati, 2019	- Needs analysis - System design - Testing	Design model for apps and business model for waste management
Kamil et al., 2019	- Database design - Application - Architecture design - System design - Coding implementation - UI implementation	Waterfall method for system development Black box testing and User Acceptance Testing (UAT)
Saptadi et al., 2020	- System analysis - System design	System analysis method with a spiral model approach in system design
Purwaningtias et al., 2020	- CPI (Composite Performance Index) - Systems development	CPI (Composite Performance Index) method Prototype for the system development
Agustina et al., 2021	Electronic financial system application development	Development and socialization and assistance to waste bank managers
Humaira et al., 2021	System development: - System design - Database design - Interface design	Codeigniter dan DBMS MySQL framework
Nasution, 2019	Core banking system	Waterfall model for software engineering
Salim et al., 2017	System design	User testing Black Box testing

According to Table 3, digital management has been implemented in some waste banks, such as the web-based information management system in a waste bank in Cianjur Regency (Widaningsih & Suheri, 2019), the application of the waste management transaction system that allows digital savings in Makassar City (Salim et al., 2017c), the electronic financial administration system in Probolinggo Regency (Agustina et al., 2021), the Goni-goni system that connects waste management with the community (Nasution, 2019), and an integrated and computerized desktop information system for the waste bank management business in Bandung City (Soegoto et al., 2021).

There is also an online waste management system called Smash 2015, that claims to connect all parties that play a role in waste management, including waste managers, communities, waste banks, and government, in a transparent, safe, easy, and nationally integrated manner, through www.banksampah.id. Mobile apps are also being designed to provide an integrated waste management system that is proposed to be implemented in Indonesia and other developing countries (Kaburuan & Heriyati, 2019).

Some studies show that waste banks gain benefits from digitizing. This web-based information system records credit and debit transactions of buying and selling waste (Agustina et al., 2021; M. E. Prasetyo et al., 2017; Taufiq et al., 2016), which reduces the incidence of human error in data input (M. E. Prasetyo et al., 2017; Saptadi et al., 2020).

This technology can be used to control clients' data on cooperative institutions, thereby accelerating the process of customer statistics management (Mardinata & Khair, 2017). This, of course, will help improve the performance of waste management. However, the use of online-based waste management systems is not optimal because the online system does not accommodate activities and problems faced by the waste bank (Wulandari & Fajar Alam, 2018).

Conclusion

Various researches have studied the utilization of technology in waste banks. Selected studies indicate that social capital is an important factor that should be considered in waste banks management. These include motive, habits, attitude, trust, and belief in contributing to a change, networks, cooperation, and norms. These aspects help improve community participation in waste banks. Most researches have studied web or application development, while the evaluation of technology use in waste management is still rarely done. Activities in waste bank management require community involvement. Therefore, social capital becomes very important.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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