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Digital-based Plastic Waste Collection System in the Context of Sustainable Development Goals

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Abstract: An effective waste collection system is an essential step in plastic waste handling and impacts positively on recycling rates. In the era of digital technology transformation, digital-based plastic waste collection and recycling have emerged to offer innovative solutions for more effective plastic waste management from upstream to downstream which contribute to the Sustainable Development Goals target. However, this solution has not been widely implemented in Indonesia. Therefore, this study aims to synthesize the role of digitalization of waste collection in accomplishing the Sustainable Development Goals. This study employed with a qualitative approach through semi-structured interviews. Bibliometric analysis using VOSviewer version 1.6.20 was conducted to map prior studies on the digitalization of waste collection in the context of achieving the Sustainable Development Goals. This study confirms that the digitalization of waste collection contributes to the achievement of the three pillars of the Sustainable Development Goals, example economics, social, and environmental pillar.

Keywords: Digital-Based Collection, Economic Pillar, Environmental Pillar, Social Pillar, Sustainable Development Goals, Waste Collection

Introduction

The development of technology and information systems has influenced the lifestyle of society recently, including in terms of plastic waste management. The emergence of digital-based plastic waste collection platform is an example of technology and information system being applied to support plastic waste management. This study was

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conducted to determine the extent to which a digital-based waste collection system has supported the achievement of Sustainable Development Goals (SDGs).

Gao et al. (2020) and Ranjbari et al. (2021) affirmed that a bibliographic analysis is a tool to analyze the main ideas of former studies. Identification of the main ideas of research in a particular field of study can be done by analyzing the co-occurrence of keywords in an article. Therefore, the bibliometric analysis conducted using VOSviewer version 1.6.20 to map research on the digitalization of waste management in supporting the achievement of the SDGs over the past decade, specifically from 2014 to 2024. The result of bibliometric analysis highlighted the most frequent ones, including "sustainable development", "waste management", "recycling", and "digitalization" as seen in Figure 1. The analysis indicated a strong focus on environmental and economic aspects of sustainability, but notably, no keywords related to social sustainability were identified. However, Blewitt (2018) stated that the preservation and protection of the earth's natural environment and the promotion of social justice and economic equality within and among countries are the cornerstones of sustainable development. It is also multi-faceted, embracing social, environmental, and economic goals and perspectives (Arushanyan et al., 2017; Blewitt, 2018). These three components are often depicted as three circles intersecting with sustainability as the intersection as in Figure 2. (Purvis et al., 2019). Furthermore, the another study suggests that digitalization in waste management is underutilized in Indonesia, despite its potential benefits for sustainability and efficiency (Morseletto, 2020). For that reason, this study emphasizes the need to explore digital-based plastic waste collection systems to enhance the three pillars of sustainable development goals, namely economics, social, and environmental pillar. Besides, this study demonstrates its novelty by presenting digital-based plastic waste collection support that considers all three pillars of the SDGs: the economic, environmental, and social pillars. Previous studies have only considered the economic and environmental aspects.

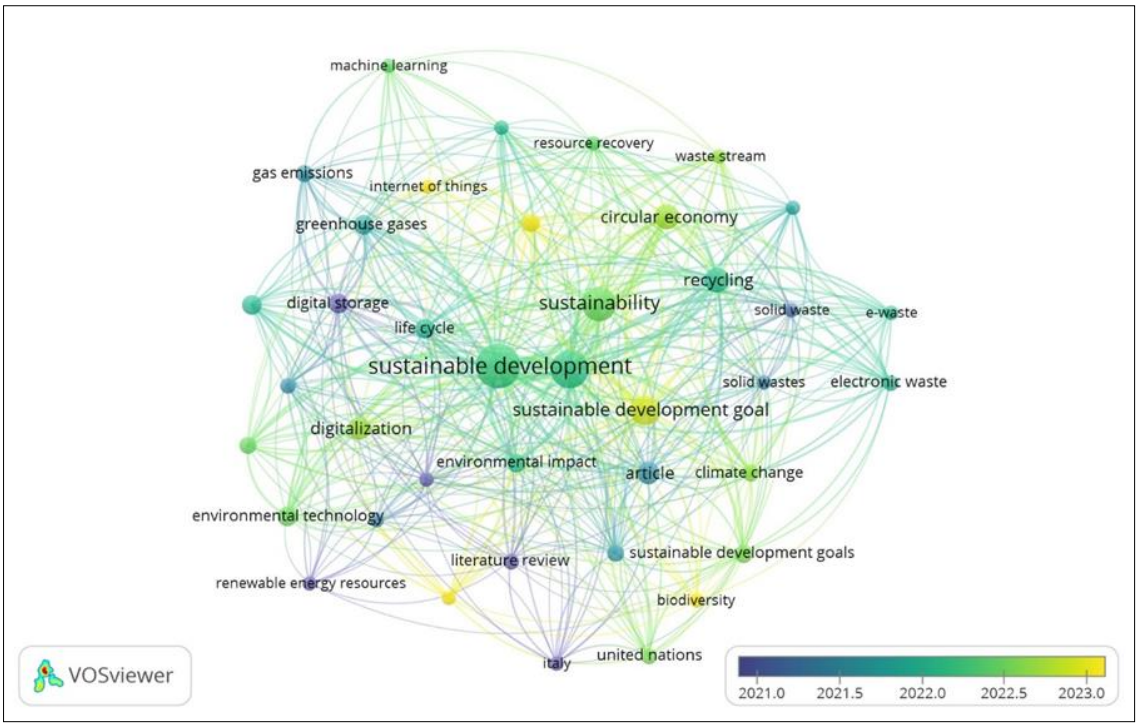
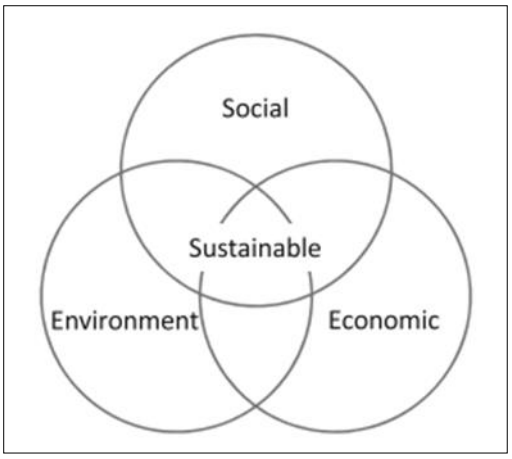


Figure 1. Network Visualization of Keywords Occurrence and Co-occurrence

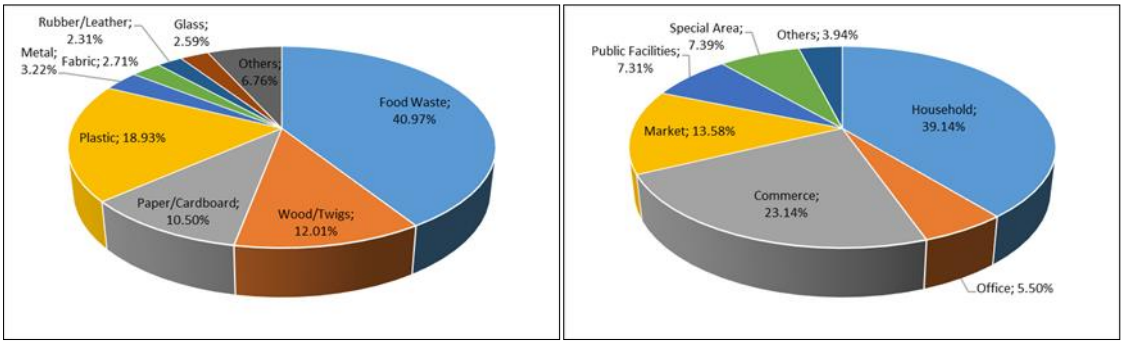
Overproduction and overconsumption of plastic has caused the global challenge of plastic waste pollution (Dermawan et al., 2019; Huang et al., 2020; Andeobu et al., 2022). Many countries in Southeast Asia and the East Asia region are facing the major challenge of plastic waste pollution. China is the world's largest producer of plastic waste (Luan et al., 2022), followed by five countries in Southeast Asia, namely Indonesia, the Philippines, Vietnam, Thailand, and Malaysia. Collectively, the five Southeast Asian countries produce 8.9 million tons of plastic waste annually (Gong & Trajano, 2019).



Source: Purvis et al., 2019

Figure 2. The Three Intersecting Pillars of Sustainable Development

The Ministry for the Environment and Forestry of the Republic of Indonesia (KLHK) through the National Waste Management Information System (SIPSN) released data that plastic waste is the second largest type of waste produced in Indonesia in 2022, which is 18.93% (Figure 3. (a)). Meanwhile, the largest source of waste comes from households at 39.14% (Figure 3. (b)). Plastic waste is a major concern because the increase in plastic production every year is considered a long-term threat to living things and can threaten environmental security (Dermawan et al., 2019) because of the characteristics of plastic which are difficult to decompose naturally (Rapada et al., 2023).



(a) (b)

Source: SIPSN KLHK, 2024

Figure 3. National Waste Composition Based on (a) Type of Waste and (b) Source of Waste

Problems related to plastic waste management comprise littering, open burning, landfilling, high waste collection costs, and low recycling rates (Bernat, 2023; Maitlo et al., 2022). Waste management regulations in Indonesia stipulate that one of the waste management strategies is to implement waste reduction through waste recycling. Recycling must be carried out using raw materials that can be reused or by taking back

used packaging for recycling. Producers that produce waste can delegate this responsibility to a licensed third party to take-back their post-consumer packaging waste (Setiadi et al., 2020). Separate waste collection is a top priority in plastic packaging waste recycling (Schuch et al., 2023). Sorting at source, which is intended to segregate recyclable plastics before they are discarded into the environment as landfill waste, can help reduce contaminants and increase material recovery in the recycling process (Benyathiar et al., 2022; Samarasinghe et al., 2021).

Setiadi et al. (2020), through his study on waste recycling in Semarang (Indonesia), revealed that in general, the legal and policy frameworks governing the roles and responsibilities of waste management and recycling in particular have been implemented by all parties with varying degrees of compliance. One example is the emergence of private sector participation, albeit still limited, such as that carried out by PT Indofood in collaboration with the Indonesian Indomie Stalls Association (WARMINDO) in Semarang, which take-back used Indomie packaging. Setiadi et al. (2020) urged that policies to encourage plastic waste take-back programs, including the participation of producers and consumers, need to be further improved. In line with that statement, an effective waste collection system is an essential step in plastic waste handling and impacts positively on recycling rates (Bernat, 2023; Maitlo et al., 2022).

Waste collection and recycling digitalization can promote the upstream-to-downstream efficiency of the waste management system. This statement is supported by a study conducted by Kurniawan et al. (2022b), which shows how the Rapel application installed on mobile phones can play a role in reducing waste and promoting the recycling industry in Yogyakarta. Through the use of the Rapel application, both users and recyclable waste collectors are encouraged to sort waste at the source, collect, and sell it for recycling. From each recycled waste transaction, both users and waste collectors will earn points. Furthermore, the study of Kurniawan et al. (2022b) reveals that the digitalization of non-biodegradable waste management encouraging a 65% reduction in waste generation and 0.2 million Mt of greenhouse gas emissions sourced from landfills each year. To this point, waste segregation will be better carried out through digital transformation so that the waste recycling rate can be more optimal, and ultimately less will end up in landfills. In this way, urban areas will live the benefits of technological advances for society, the environment as well as the economy in the long term (Kurniawan et al., 2022b).

The Ministry for National Development Planning of the Republic of Indonesia (Kementerian PPN/Bappenas) classifies five economic pillars of SDGs that consist of Sustainable Development Goal 7, namely affordable and clean energy, Sustainable Development Goal 8, namely decent work and economic growth, Sustainable Development Goal 9, namely industry, innovation, and infrastructure, Sustainable Development Goal 10, namely reduced inequalities, and Sustainable Development Goal 17, partnerships for the goals. The social pillar of SDGs involves Sustainable Development Goal 1, namely no poverty, Sustainable Development Goal 2, namely zero hunger, Sustainable Development Goal 3, namely good health and well-being, Sustainable Development Goal 4, namely quality education and Sustainable Development Goal 5, namely gender equality (Kementerian PPN/Bappenas, 2023c). Meanwhile, the environmental pillar of SDGs consists of Sustainable Development Goal 6, namely clean water and sanitation, Sustainable Development Goal 11, namely sustainable cities and communities, Sustainable Development Goal 12, namely responsible consumption and production, Sustainable Development Goal 13, namely climate action, Sustainable Development Goal 14, namely life below water and Sustainable Development Goal 15, namely life on land (Kementerian PPN/Bappenas, 2023b).

Research Method

This study was conducted using a qualitative approach through semi-structured interviews with two key persons from a digital-based waste collection startup operating in the Jakarta area, namely Duitin. Those two key persons are a Founder of Duitin and a Waste Picker who works for Duitin. Duitin's Jakarta service area also covers several areas around Jakarta including South Tangerang, Tangerang, Bekasi, and Depok. Interviews were conducted online using the Zoom Meeting application. Interview recordings have obtained permission from the interviewee. The research data consists of primary data in the form of information obtained through interviews and secondary data obtained from Duitin reports. Additional information about other digital waste collection platforms operating in Jakarta was obtained through the platforms' websites and social media.

Results and Discussions

Waste Management Approach by Digital Platform

One of the digitalization of post-consumer waste collection systems operating in Jakarta is a mobile app-based platform, namely Duitin. The Duitin application can be downloaded on Playstore for Android mobile users or Appstore for iPhone mobile users. Duitin serves the collection of several types of recyclable waste including plastic, PET plastic, instant noodle packaging plastic, mixed paper, cardboard, glass, aluminum cans, cans, multilayer boxes, used baby diapers, used cooking oil, wooden chopsticks as shown in Figure 4. The waste generator classifies the waste produced based on the type of waste available on the mobile app and then requests the waste to be picked up via the application to the waste source location. Duitin also provides a Duitin WhatsApp center. If it is difficult for waste producers to get a picker via the application, they can request waste pickup via the WhatsApp center. Duitin provides waste collection services from various sources including households, small and medium businesses, educational institutions, companies, and government offices.

Source: Duitin, 2024

Figure 4. Types of Recyclable Waste Collected by Duitin

Duitin representative in interviews revealed that Duitin has partnered with several manufacturers to collect post-consumer waste. This partnership is a commitment from producers to implement Minister of Environment and Forestry Regulation Number 75 of 2019 concerning a road map for reducing waste by producers. Partner manufacturers support taking back post-consumer waste through the Duitin application to minimize the adverse impact on the environment that can arise from the company's products. Product users who are also waste producers can return post-consumer product packaging waste via the Duitin application and earn rewards. Duitin provides a platform for offices to

collect, track and manage recyclable waste generated from offices. Regular reports regarding the collection and management of recyclable waste and the positive impact on the environment generated will be submitted to offices that use Duitin services.

> *"We have partnered with companies to take back post-consumer waste. For example, we partnered with an FMCG company to take back a particular type of waste from consumers. Then we make a report to our partner company regarding the waste that has been successfully collected by our picker. The partner company can track every progress of the waste that has been collected from consumers and handed over to the next stage of waste management for recycling. This is the benefit of digitalization, we can provide data quickly and accountably to our partners. Partner companies certainly provide compensation for any waste that is successfully collected from consumers. That compensation is given to consumers in the form of Duitin coins and Duitin points when returning product waste or product packaging waste through our application"* (AS, representative of Duitin, 2024).

Collection of recyclable waste is carried out by 'Pickers' and 'Picker Partners' to the location of the waste source. 'Picker' is a waste collector who is specially recruited and is an internal Duitin employee, while 'Picker Partner' is an informal waste collector who has the status of a registered freelance employee. After the recyclable waste is taken from the source, the 'Picker' takes the waste to the Material Recovery Facility (MRF) center to be cleaned and sorted based on type, color, and material. 'Picker Partners' are not required to bring and deposit the collected waste at the MRF. 'Picker Partners' can sell the collected waste to any recycling business. Duitin does not charge any service fee to 'Picker Partners' who collect waste even though they do not deposit the collected waste at the MRF. Waste that has been cleaned and sorted at the MRF is then sent to a further recycling site. The recycling industries that have partnered with Duitin will purchase recyclable waste that has been cleaned and sorted at the MRF. The business process of Duitin is seen in Figure 5.

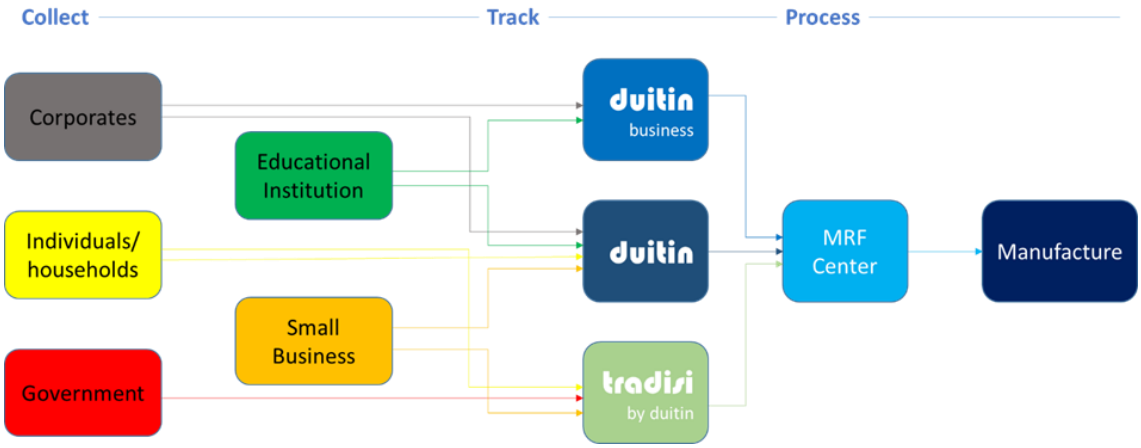


Figure 5. Waste Management Approach by Duitin

The Contribution of Digital-based Waste Collection System to the Economic Pillar of SDGs

The Duitin initiative has stimulated the economy and opened new jobs for informal workers by becoming 'Picker Partners'. Registration to become a 'Picker Partner' can be done via the Duitin application which has been downloaded on mobile phones by filling in the form provided in the application. There is no specific time to recruit 'Picker Partners'. Registration can be done at any time and is open to anyone who wishes to become a 'Picker Partner' and carry out waste pickup at the waste source location. Duitin equips its 'Picker Partners' with an understanding of the goals, roles, values, duties, and responsibilities involved in the work of picking up trash. 'Picker Partners' can choose to

sell the collected waste to Duitin or other recyclable waste businesses. 'Picker Partners' can choose the recycling trade that provides the highest price. One of the 'Picker Partners' who had been recruited to become Duitin's internal 'Picker' revealed through an interview that the company rewarded him for his good performance when he became a 'Picker Partner' by providing a career path to become Duitin's internal 'Picker'. The ever-increasing consumer demand for waste pick-up at waste source locations (households, offices, companies) is creating employment opportunities for informal waste pickers.

> *"I used to be a 'Picker Partner'. Maybe the company saw that my performance was good so I was recruited as an internal 'Picker'. Thank God, that working here has a career path. Now there are more orders than in the beginning. Trash pick-up is divided per region according to the schedule, for example, Monday in the South Jakarta area, meaning that waste collection is carried out in the South Jakarta area only"* (K, Picker, 2024).

> *"We do not require 'Picker Partners' to take the collected waste to the MRF center and sell to Duitin, but specifically for internal 'Pickers' they are required to bring the waste collected from consumers to Duitin's MRF. 'Picker Partners' are free to sell to recycling businesses that provide the best prices. Duitin does not deduct service fees if the 'Picker Partner' does not proceed the collected waste to the MRF center"* (AS, representative of Duitin, 2024).

This experience shows that mobile app-based waste collection initiative participates in supporting entrepreneurship, innovation, and the creation of decent jobs through technological improvements and innovations which ultimately have implications for reducing the open unemployment rate. This is in accordance with one of the targets of Sustainable Development Goal 8 set by the Government of Indonesia, namely development policies that support productive activities, decent job creation, entrepreneurship, creativity, and innovation (Kementerian PPN/Bappenas, 2023a). The creation of new jobs can further impact population income growth. Increasing employment opportunities and reducing open unemployment are expected to contribute to reducing the poor population.

Hence, the result of this study enhances the prior research conducted by Kurniawan et al. (2022b) that claimed that the presence of a mobile application-based digital platform for recyclable waste collection has created new jobs for around 780 scavengers in Yogyakarta (@20 scavengers/sub district). The digital-based waste collection activity that took place in Yogyakarta also implemented a point system for users and waste collectors. Digital transformation in waste management, particularly recyclable waste, is projected to create 120,000 new jobs by absorbing around 3.3 million informal workers such as scavengers. Kurniawan et al. (2022b) recommended that all stakeholders must work together and collaborate in implementing digital transformation in waste management. The government, private sector, academics, and the public must collaborate to discuss the digital transformation of the waste recycling industry.

The other previous studies also proclaimed that providing incentives or rewards for people's participation in the digitalization of plastic waste collection and recycling is the best alternative for plastic waste management (Liang et al., 2021). The presence of mobile app-based digital platforms creates new jobs through the informal waste management sector, thereby reducing unemployment (Kurniawan et al., 2022b; Maiurova et al., 2022). Another thing is that the acceptance of digital technology in the waste management sector also creates new jobs in the fields of data analysis, cybersecurity, and technology (Zhang et al., 2021).

In addition, this initiative also empowers and increases social and economic inclusion for all, despite of age, gender, race, ethnicity, origin, and religion. Thus, the use of digital technology in waste management in terms of mobile app-based recyclable waste

collection is also beneficial to achieving Sustainable Development Goal 10 to reduce inequalities.

> *"There are no requirements related to ethnicity, tribe, religion, or race for people who want to become partners at Duitin. Anyone from any region in Indonesia can work with Duitin"* (AS, representative of Duitin, 2024).

The Contribution of Digital-based Waste Collection System to Social Pillar of SDGs

The representative of Duitin in the interview defined that 'Picker Partner' is not only intended for men but women are also given the same opportunity. There is no difference in treatment for male and female pickers. Duitin is committed to providing equal opportunities for women and empowering them in the digitalization process of waste management. In addition, picking up recyclable waste from homes provides an opportunity for housewives to be involved in the household waste management process by segregating post-consumer waste at the household level. This practice proclaims the role of digital-based businesses in driving and promoting gender equality and women's empowerment. Mobile app-based waste collection initiatives open up opportunities for women to increase their use of information and communication technology in the context of empowerment. Thus, this good involvement also supports the achievement of one of the targets of Sustainable Development Goal 5 set by the Government of Indonesia, increasing the use of enabling technology, especially information and communication technology to increase women's empowerment (Kementerian PPN/Bappenas, 2023c).

> *"I am touched today. This morning two women came to our office and expressed their desire to register as 'Picker Partners'"* (AS, representative of Duitin, 2024).

The Contribution of Digital-based Waste Collection System to Environmental Pillar of SDGs

In the period July 2020 to March 2024, Duitin has successfully served ± 29,000 orders for pick-up of recyclable waste to waste source locations with a total amount of recyclable waste of ± 1,100,000 kg. Calculations through a study conducted by Duitin reveal that the digitalization of recyclable waste collection has had an impact on reducing carbon emissions by 4.3 million kg CO2eq. The study stated that 4.3 million kg CO2eq is similar to 369 flights from Jakarta to Singapore using Boeing 737s. Other positive impacts include saving 11,200 trees from cutting down, saving a landfill area of 6,000m3, and saving water use of 18.5 million liters (Table 1).

Table 1. The Performance of Duitin in Digital-Based Recyclable Waste Collection

Total Order Served	Total Recyclable Waste Recovered	Prevented CO_2eq Emissions	Amount of Trees Saved	Landfill Space Saved	Water Saved
29,000	1,100,000 kg	4.3 million kg	11,200	6,000 m^3	18.5 million liters

(Source: Duitin, 2024)

This result shows that the digital initiative of collecting post-consumer waste through the Duitin application contributes to the environmental pillar of Sustainable Development Goal 13, namely climate action. Based on the data provided in the Table 1, Duitin has contributed to reducing waste ending up in final processing sites or landfills as well as contributing to reducing carbon emissions that can arise from waste in landfills. This performance strengthens the previous research that has also claimed that the digitalization of non-biodegradable waste management intensifies a reduction in waste generation and greenhouse gas emissions originating from final disposal sites or landfills (Kurniawan et al., 2022b). The application of digitalization of waste management shows

that raw material extraction can be minimized through resource recovery and has implications for reducing carbon emissions (Kurniawan et al., 2022a; Maiurova et al., 2022; Fan et al., 2023; Kurniawan et al., 2023; Kurniawan et al., 2024).

Besides, waste management from the source has prevented waste from being thrown into the waters and protects living creatures in the waters. Reducing waste on land has a major role in significantly reducing waste in the sea. Reducing waste in the sea is one of the targets of Sustainable Development Goal 14, namely life below water, to preserve marine resources for sustainable development (Kementerian PPN/Bappenas, 2023b). Segregating and collecting post-consumer waste from the source increases the economic value of recyclable waste because it is not mixed with other types of waste. This facilitates the subsequent recycling process as disclosed in the previous study that the implementation of circular economy digitalization has succeeded in increasing the recycling of non-biodegradable waste and reducing the daily waste generation rate per capita (Kurniawan et al., 2022a). This reduces the amount of waste thrown into landfills as well as reduces the need for new landfills (Kurniawan et al., 2022a; Maiurova et al., 2022). Thus, this digital innovation provides benefits for achieving a substantial reduction in waste generation through recycling, which is one of the targets of Sustainable Development Goal 12 (Kementerian PPN/Bappenas, 2023b).

> *"Picking up post-consumer waste directly to the source prevents the mixing of organic waste with recyclable inorganic waste. Recyclable inorganic waste that has been mixed with organic waste is more difficult to recycle so it ends up in the final disposal site"* (AS, representative of Duitin, 2024).

Effective and efficient handling of municipal waste through mobile app-based waste collection contributes to supporting the achievement of one of the targets of Sustainable Development Goal 11 to reduce adverse urban environmental impacts (Kementerian PPN/Bappenas, 2023b). Mobile app-based waste collection system expands access for households to obtain waste collection services, thus having positive implications for increasing municipal waste collection rates. Effective and efficient management of municipal waste ultimately enhances the achievement of national waste management targets. Maiurova et al., (2022) in the former study affirmed that digital transformation in the waste recycling system makes the municipal waste management system more efficient, responsive, safe, and sustainable. Digitalization adjusts the waste management sector shift to a circular economy which can save municipal waste management budgets (Kurniawan et al., 2023).

In the end, it can be declared that the digitalization of waste collection contributes to the three pillars of sustainable development goals as shown in Figure 6.

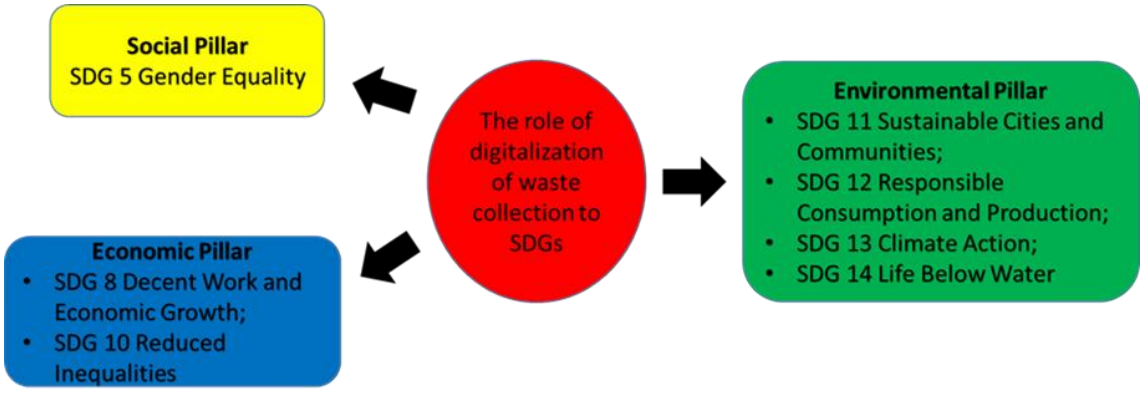


Figure 6. The Contribution of Digital-based Waste Collection System to SDGs

Future Perspective

Duitin 'Picker' through an interview revealed that currently, the demand for recyclable waste pick-up has increased. The current challenge is how to arrange for consumers not to wait too long for waste pick-up. Waste pick-up at the waste source location sometimes takes up to two weeks or one month to be scheduled for pick-up. This can be a consideration for Duitin in developing future services because not all people have enough space in their homes to accommodate recyclable waste piling for a long time. The availability of adequate waste transportation and pickers needs to be considered by Duitin for the sustainability of this digital-based waste collection service. Promotion and socialization of the use of digital-based waste collection systems must be followed by the readiness of service providers in terms of the availability of waste pick-up transportation and pickers.

Other digital-based waste collection services operating in Jakarta include Rekosistem and Plasticpay. Rekosistem encourages waste producers to bring their waste to Rekosistem waste stations or drop points and do a 'drop-in' by downloading the Rekosistem application on their mobile phones. Waste producers who deposit their waste at Rekosistem waste stations or drop points will get a reward, namely Rekopoints, which can be exchanged for vouchers or Gopay e-wallets. Rekosistem also provides household waste pick-up services, but only in certain areas. Plasticpay provides an application that can be downloaded from a mobile phone and provides a plastic bottle waste collection service. Waste producers bring their plastic bottle waste to Plasticpay's Dropbox location and write the user ID obtained when registering on the Plasticpay application on the waste packaging. Points will automatically be added to the user's application when the Plasticpay team picks up the waste. Plasticpay also provides Reverse Vending Machines (RVM) in several locations. Waste producers can return plastic bottle waste through this RVM. Points will be obtained by scanning a QR code using the Plasticpay application that has been downloaded on the user's mobile phone.

Recycling program is one of the strategies to reduce waste ending up in landfills. A digital-based waste collection system that emphasizes waste sorting at the source supports the implementation of more efficient and effective recycling programs. Sorting waste at the source lightens the workload and helps workers in the waste recycling industry avoid contamination from hazardous materials or substances that may be present in mixed waste. The presence of a digital-based waste collection system can encourage the informal sector, such as scavengers, to utilize mobile application-based information and technology systems to collect recyclable waste at the source. Digital-based waste collection can be an alternative for sustainable waste management in urban areas that have internet access and more advanced information technology infrastructure. The government may encourage the use of a digital-based collection system at waste banks to make it easier for urban communities to actively participate in sorting and collecting household waste. Alternatively, the government could collaborate with private parties such as business initiatives engaged in digital-based waste collection to assist in the development of the digitalization of waste banks. Cooperation and active participation from all elements involved are needed to sit together in making better policies for effective and efficient sustainable waste management.

Conclusion

Sustainable waste management that integrates the economic pillar, the social pillar, and the environmental pillar is a challenge as well as a potential opportunity in plastic waste management. Digital-based recyclable waste collection is an innovative solution for sustainable waste management. Mobile app-based waste collection contributes to the achievement of the economic pillar of SDGs 8, promoting inclusive and sustainable

economic growth, productive and comprehensive employment opportunities, and decent work for all, and SDG 10s, reducing inequality. The achievement of the social pillar of SDG 5s, gender equality is supported by providing opportunities for women to increase the use of information and communication technology in the context of women's empowerment. Meanwhile, to achieve the environmental pillar, this study indicates that the mobile app-based waste collection directly contributes to addressing climate change and its impacts (SDG 13s). In addition, it may indirectly support SDGs 11, SDGs 12, and SDGs 14. Proactive participation and cooperation of all key waste management stakeholders covering the government, the private sector, as well as the community are essential for effective and efficient sustainable waste management.

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Daftar Pustaka

Andeobu, L., Wibowo, S., & Grandhi, S. (2022). Artificial intelligence applications for sustainable solid waste management practices in Australia: A systematic review. *Science of the Total Environment*, *834*(April), 155389. https://doi.org/10.1016/j.scitotenv.2022.155389

Arushanyan, Y., Ekener, E., & Moberg, Å. (2017). Sustainability assessment framework for scenarios – SAFS. *Environmental Impact Assessment Review*, *63*, 23–34. https://doi.org/10.1016/j.eiar.2016.11.001

Benyathiar, P., Kumar, P., Carpenter, G., Brace, J., & Mishra, D. K. (2022). Polyethylene Terephthalate (PET) Bottle-to-Bottle Recycling for the Beverage Industry: A Review. *Polymers*, *14*(12). https://doi.org/10.3390/polym14122366

Bernat, K. (2023). Post-Consumer Plastic Waste Management: From Collection and Sortation to Mechanical Recycling. *Energies*, *16*(3504). https://doi.org/https://doi.org/10.3390/e n16083504

Blewitt, J. (2018). *Understanding Sustainable Development* (3rd Editio). Routledge.

Dermawan, W., Vieri, C., Gusti, P., & Alam, B. (2019). Environmental Security and Plastic Waste Pollution. *Central European Journal of International and Security Studies*, *13*(4), 191–207. https://doi.org/10.51870/CEJISS.XKVV3716

Duitin. (2024). *Towards Restorative and Regenerative Future* (Issue April).

Fan, Q., Fu, P., Song, C., & Fan, Y. (2023). Valorization of waste biomass through hydrothermal liquefaction : A review with focus on linking hydrothermal factors to products characteristics. *Industrial Crops & Products*, *191*(November 2022). https://doi.org/10.1016/j.indcrop.2022.116017

Gao, H., Ding, X., & Wu, S. (2020). Exploring the domain of open innovation : Bibliometric and content analyses. *Journal of Cleaner Production*, *275*, 122580. https://doi.org/10.1016/j.jclepro.2020.122580

Gong, L., & Trajano, J. C. (2019). *Tackling East Asia's New Environmental Challenge* (Issue June).

Huang, Q., Chen, G., Wang, Y., Chen, S., Xu, L., & Wang, R. (2020). Modelling the global impact of China's ban on plastic waste imports. *Resources, Conservation and Recycling*, *154*(May 2019), 104607. https://doi.org/10.1016/j.resconrec.2019.104607

Kementerian PPN/Bappenas. (2023a). *Metadata Indikator Edisi II Tahun 2023 Pilar Pembangunan Ekonomi Pelaksanaan Pencapaian Tujuan Pembangunan Berkelanjutan Indonesia*.

Kementerian PPN/Bappenas. (2023b). *Metadata Indikator Edisi II Tahun 2023 Pilar Pembangunan Lingkungan Pelaksanaan Pencapaian Tujuan Pembangunan Berkelanjutan Indonesia*.

Kementerian PPN/Bappenas. (2023c). *Metadata Indikator Edisi II Tahun 2023 Pilar Pembangunan Sosial Pelaksanaan Pencapaian Tujuan Pembangunan Berkelanjutan Indonesia*.

Kurniawan, T. A., Maiurova, A., Kustikova, M., Bykovskaia, E., Othman, M. H. D., & Goh, H. H. (2022).

Accelerating sustainability transition in St. Petersburg (Russia) through digitalization-based circular economy in waste recycling industry: A strategy to promote carbon neutrality in era of Industry 4.0. *Journal of Cleaner Production*, *363*(December 2021), 132452. https://doi.org/10.1016/j.jclepro.2022.132452

Kurniawan, T. A., Meidiana, C., Dzarfan Othman, M. H., Goh, H. H., & Chew, K. W. (2023). Strengthening waste recycling industry in Malang (Indonesia): Lessons from waste management in the era of Industry 4.0. *Journal of Cleaner Production*, *382*(May 2022), 135296. https://doi.org/10.1016/j.jclepro.2022.135296

Kurniawan, T. A., Meidiana, C., Goh, H. H., Zhang, D., Othman, M. H. D., Aziz, F., Anouzla, A., Sarangi, P. K., Pasaribu, B., & Ali, I. (2024). Unlocking synergies between waste management and climate change mitigation to accelerate decarbonization through circular-economy digitalization in Indonesia. *Sustainable Production and Consumption*, *46*(January), 522–542. https://doi.org/10.1016/j.spc.2024.03.011

Kurniawan, T. A., Othman, M. H. D., Hwang, G. H., & Gikas, P. (2022). Unlocking digital technologies for waste recycling in Industry 4.0 era: A transformation towards a digitalization-based circular economy in Indonesia. *Journal of Cleaner Production*, *357*(April), 131911. https://doi.org/10.1016/j.jclepro.2022.131911

Liang, Y., Tan, Q., Song, Q., & Li, J. (2021). An analysis of the plastic waste trade and management in Asia. *Waste Management*, *119*, 242–253. https://doi.org/10.1016/j.wasman.2020.09.049

Luan, X., Kou, X., Zhang, L., Chen, L., Liu, W., & Cui, Z. (2022). Estimation and prediction of plastic losses to the environment in China from 1950 to 2050. *Resources, Conservation & Recycling*, *184*(May), 106386. https://doi.org/10.1016/j.resconrec.2022.106386

Maitlo, G., Ali, I., Maitlo, H. A., Ali, S., Unar, I. N., Ahmad, M. B., Bhutto, D. K., Karmani, R. K., Naich, S. ur R., Sajjad, R. U., Ali, S., & Afridi, M. N. (2022). Plastic Waste Recycling, Applications, and Future Prospects for a Sustainable Environment. *Sustainability (Switzerland)*, *14*(18). https://doi.org/10.3390/su141811637

Maiurova, A., Kurniawan, T. A., Kustikova, M., Bykovskaia, E., Othman, M. H. D., Singh, D., & Goh, H. H. (2022). Promoting digital transformation in waste collection service and waste recycling in Moscow (Russia): Applying a circular economy paradigm to mitigate climate change impacts on the environment. *Journal of Cleaner Production*, *354*(March), 131604. https://doi.org/10.1016/j.jclepro.2022.131604

Morseletto, P. (2020). Targets for a circular economy. *Resources, Conservation & Recycling*, *153*(October 2018). https://doi.org/10.1016/j.resconrec.2019.104553

Purvis, B., Mao, Y., & Robinson, D. (2019). Three pillars of sustainability : in search of conceptual origins. *Sustainability Science*, *5*, 681–695. https://doi.org/10.1017/s0376892900011449

Ranjbari, M., Saidani, M., Shams, Z., Peng, W., Lam, S., Aghbashlo, M., Quatraro, F., & Tabatabaei, M. (2021). Two decades of research on waste management in the circular economy : Insights from bibliometric , text mining , and content analyses. *Journal of Cleaner Production*, *314*(June), 128009. https://doi.org/10.1016/j.jclepro.2021.128009

Rapada, M. Z., Yu, D. E., Janairo, J. I., & Yu, K. D. (2023). Impact of online-based information and interaction to proenvironmental behavior on plastic pollution. *Cleaner and Responsible Consumption*, *9*(December 2022), 100126. https://doi.org/10.1016/j.clrc.2023.100126

Samarasinghe, K., Kumar, S. P., & Visvanathan, C. (2021). Evaluation of circular economy potential of plastic waste in Sri Lanka. *Environmental Quality Management*, *31*(January), 99–107. https://doi.org/10.1002/tqem.21732

Schuch, D., Lederer, J., Fellner, J., & Scharff, C. (2023). Separate collection rates for plastic packaging in Austria – A regional analysis taking collection systems and urbanization into account. *Waste Management*, *155*(September 2022), 211–219. https://doi.org/10.1016/j.wasman.2022.09.023

Setiadi, R., Nurhadi, M., & Prihantoro, F. (2020). Idealisme dan Dualisme Daur Ulang Sampah di Indonesia : Studi Kasus Kota Semarang. *Jurnal Ilmu Lingkungan*, *18*(1), 48–57. https://doi.org/10.14710/jil.18.1.48-57

Zhang, C., Chen, Y., & Chen, H. (2021). Industry 4 . 0 and its Implementation : a Review. *Information Systems Frontiers*. https://doi.org/10.1007/s10796-021-10153-5