Integrating Circular Economy and Green Logistics Through ReCircle: A Conceptual Framework for Sustainable Waste Management in the FMCG Industry

Titik Djumiarti, Adelta Purnama Sari, Muhammad Iqro Al Bahri Darussalam, Mifftavadine Naomiasyiffa

Logistics Management and Administration Study Program, Public Administration Study Program, Vocational School, Universitas Diponegoro, Semarang, Indonesia
titikdjumiarti@gmail.com

Abstract. Objective of the research: the aim of this study is to create a circular supply chain to solve the problem of packaging waste in the Fast Moving Consumer Goods (FMCG) industry. The model use waste management, green logistic and the principal of cicular economy. Method: qualitative research with document analysisi was used in this study. The data collected from reports, polices and prevoius studies. Then the data analysed to find the idea and develop the solution. Pentahelix approach which involves the govermentuniversities, industries, communities and media was use to create the proposed model. Result of this study: ReCicle is a digital platform that connect with FMCG companies, waste bank, consumers and recycling SMEs in one circular system. ReCircle have four main features such as Smart Drop to identify and collect waste package, Recycle Hub to check and process the reusable part, Circular Market to sell the recycle product and ESG-based Impact Dashboard to monitor the performance. This study found that this model can help to increase recycling, reduce wasting, lower the carbon emission, imrpove the activities og logistic and make the benefits for local communities through recycling program. Pracrical/Theoritical contribution of this study: this study give a framework that combine circular economy in the FMCG indistsry and green logistic. The improving of waste management can be realized through this model. This is also support the implementation of Extended Producer Responsibility (EPR) and ESG reporting. This model also can help to develop collaborative circular supply chain system and support green skill in vocational education and industry.

Keywords: Circular economy; Extended Producer Responsibility; FMCG industry; green logistics; pentahelix collaboration; sustainable waste management

© The Author(s) 2026
P. N. G. Akbar and K. A. Safitri (eds.), *Proceedings of the 8th International Conference of Vocational Education, Applied Science and Technology (ICVEAST 2026)*, Advances in Social Science, Education and Humanities Research 1034,
https://doi.org/10.2991/978-2-38476-620-8_43

1 Introduction

Every year, the Fast Moving Consumer Goods produces a large amount of waste packaging. This is because the high production, the quick use and most of the product using single use packaging.

Around one-fift of public waste come from product and packaging. Only a small amount of the waste is collected and recycled [33].

The gap between the amount of packaging that sold and the packaging that recycled showed that there is still a problem in waste management at the downstream stage of FMCG supply chain.

Not only an environmental problem, packaging waste is also the logistic problem. The packaging can fo to landfill, waste pickers, waste bank or recyling fasilities after the product sold. Waste goes depend on the collection system, sorting process and whether there is a buyer for the recycle material.

Packaging waste will continue accumulate if the waste collection and transportation system is not well organized. This problem can be solve by green logistic by environmental goals in transportation, storage and distribution activities. To achieve all of this, the movement of waste for recycling should be planned carefully as delivery of final product [4].

Not just something that should throw away, but circular economy sees waste as a resource at the same time. The main idea is to keep materials, product and packacing as long as possible. To make all of this idea happen is by reducing waste, reusing product and recyling before it finally dispose [1], [2]. This means changing froam a linear system, make and dispose to a circular system for FMCG sector. To make a new packaging and other product, the waste package is collect from the customers [3].

To support this change, Indonesia is starting with the government regulation. Producers in manifacturing, food and baverage and also retail sectors is regulated in Ministry of Environment and Forestry Regulation No.P.75/2019 by 30 percent by 2009. In this regulation also encourages company to make collecting and recycling system [5], [29]. FMCG company need to work with other part outside the company to achieve all of this. This is including waste bank, waste collector and recycling SMEs. They can help achieve national recycling target. But the problem is, most if them are still not connected with the producers [25].

Similar finding shown by other prevoius studies in Indonesia. Waste bank, informal waste collectors and local recycling bussines has an important part in collecting and processing the waste. Replace and ignore all of them is not an effective way. A better solution is to involve them through cooperation, support and also well organized system [37].

Technology can help to improve the informal recycling system based on several Indonesian digitak initiatives. Record and track can be more easier to do with digital waste bank platform. Digital waste bank platform also create more income for collectors and reduce administrative work for waste bank operators [17], [18], [21]. Most of this paltform work as saparate system and only focus on consumers. They are not designed to connect recycling activities back to FMCG companies that produce the packaging. Recovery data that can be use for reporting is also not provide on the

platform. There is still a gap between company's sustainability goals and actual process of collecting, sorting and recycling the waste package.

The aim of this study is to solve this problem by proposing ReCirle. This platform is connect FMCG companies, consumers, waste bank and recycling SMEs in one system. Pentahelix collaboration approach which involve the goverment, industry, universities, communities and media used to develop this platform.

The aim of this study: (1) identify the main problem that make packaging waste difficult to recycle in FMCG industry. (2) explain the role of each pentahelix in a technology based circular system. (3) design the main features of ReCirle and prove how it can support green logistic, economy and Extended Producer Responsibility (EPR).

2 Literature Review

2.1 Circular Economy and Green Logistics in FMCG Supply Chains

In academic literature, the circular economy have many different definition. Most of them have similar idea which to reduce the use of new resources and recycle the waste so that less waste is produce [2]. Circular economy is a system that designed to reuse, repair and recyle materials [3]. Circular economy can help companies to reduce cost, imrove brand image and make a new business opportunities by using recyclle material. Expensive and complicated in changing packaging and supply chain are the challanges that still face by the companies [6].

The focuses of green logistic is how goods and materials move in more friendly way. Reverse logistic is one important part in green logistic. This part is process if collecting and packaging product after they are used [4]. Reverse logistic help to make sure waste package is collected and send back to recycling facilities. The waste packaging will end up in landfills without a good collection system.

A better green logistic perfomance is usually can be found in the company that have better reverse logistic and packaging recovery system. In their daoly operation, this company also more prepared to apply circular economy [34]. Reverse logistic and remanufacturing have a strong positive effect on economy and environment [35]. Circular economy can be more effective by goodgreen logistic management [36].

2.2 Packaging Waste and Extended Producer Responsibility in Indonesia

The meaning of Extended Producer Responsibility is the products responsibility from the waste packaging of their product afrer consumers use them. This is regulated in Law No. 18/2008 on Waste Management and also explain in Ministry of Environment and Forestry Regulation No. P.75/2019. The regulation required companies to prepare a waste reduction plan. The record amount of waste they produce must be recorded and report their progress to achieve 30% reduction target [5], [29], [32]. Based on this regulation, producers allow to work with other parties to collect and recycle tha waste

packages. Because the formal collection system is still limited, many companies work with waste bank and waste pickers [25].

When companies improve their packaging and logistic system, EPR will works better. Using recycable packaging, recycled material and reusable packaging system give better environmental than encouraging people to reduce waste [8].

Consumers behavoir is also important, circular packaging system will only work if consumers are willing to saparate and return their use packaging [10]. This is means that FMCG companies need a better packaging system and encourage their consumers to join the recycling process.

Double reporting is another problem in Indonesia. When FMCG company and packaging supplier report the same recycle material, the data will be inaccurate sustainability report may be less reliable [7]. A digital tracking system can help to solve this problem by record each item only once until it reach the recycling SME. The data will be more easier to track and more reliable.

2.3 Digital Platforms for Circular Waste Ecosystems

A study in Yogyakarta about digital platform found that mobile application connecting household with waste bank. It helps to reduce waste, create a new jobs in waste collection and increase the income for waste bank. It means that digital technology can increase the value if waste that usually will be thrown away [17]. The other similar platform in Jakarta and other cities can record routes, waste collection and transaction in real time. This is help strengthen the waste pickers role and the recycling process more transparent [18], [21].

Infromal waste collector and buyers can also connected by other digital platform. This improves the accuracy of waste data and easier to track than fully informal recycling system [22], [24].

FMCG companies that produce the packaging not connected directly by most of these platforms. It also do not have a standart way to convert recycling data into ESG reports. One platform should connect all the main process to solve this problem. The main process are collecting, checking, selling and reporting.

2.4 Pentahelix Collaboration in Sustainability Governance

Five groups are collaborate in the pentahelix model. They are government, industrym universities, communities and media. At the previous collaboration, media wad added because public awareness is one of the important thing to solve environmental problem [12], [16]. Government makes the regulation and support the program. Technology, funding and operational support provides by industry. Research and new ideas contribute by university. Waste bank and collect the waste everyday are include in communities. Media help to share the information and encourages people to participate [14], [16]. The theory that use in reverse logistic in Indonesia is also have similar way of working. Involvement, collaboration and empowerment are the best way to build long-term cooperation based on the theory. This is worl better than only sharing information or making business agreement [37].

The sucessful of pentahelix depend on clear roles and good coordination between all the skateholders. A study in South Tangerang found that the biggest role in making the regulation is the government where the coordination between oribat sectors and local communities are still weak. The coordination was not well organized including media which only involved after the problem happen [14]. A study in Kupang also found that the waste cannot manage only by the government. To make the waste and recycling system work well, good cooperation between all of the skateholders is needed [13]. It means that pentahelix model need a clear way to make a good coordination between all of the skateholders. Digital platform is one of the possible solution.

3 Research Method

This study used a qualitative research method based on document analysis. Document analysis was chosen because the objective of the study is conceptual: to design an integrated platform model rather than to test a hypothesis on primary respondents. Data were drawn from three categories of secondary sources: (1) national and sectoral policy documents, including Law No. 18/2008 on Waste Management and Ministry of Environment and Forestry Regulation No. P.75/2019 on the Roadmap for Waste Reduction by Producers [5]; (2) industry and multilateral reports on FMCG packaging waste, EPR implementation, and Indonesian waste bank digitalization [16], [11], [12]; and (3) peer-reviewed literature on circular economy, green logistics, packaging design, pentahelix collaboration, and sustainable reverse logistics [1]-[4], [6]-[10], [13]-[15], [34]-[37].

Data collection proceeded through purposive document selection, prioritizing sources published within the last decade and sources directly relevant to Indonesia's regulatory and waste-management context. Selected documents were read in full and coded thematically around four recurring categories: causes of packaging-waste leakage, existing collection and recycling arrangements, digital-platform design elements, and multi-stakeholder collaboration roles.

The coded material was then processed through the standard qualitative sequence of data reduction, data display, and conclusion drawing. Data reduction narrowed the coded material to the challenges and design elements most directly relevant to FMCG packaging circularity. Data display organized these elements into the structures shown in Section 4, including the stakeholder role matrix and the platform component matrix. Conclusion drawing synthesized the display into the ReCircle model and its supporting rationale.

The pentahelix framework, comprising government, industry, academia, community, and media, was used as the organizing structure for stakeholder analysis, following its established application in Indonesian waste-governance research [13], [14], [16]. Each stakeholder group's documented role, incentive, and constraint were mapped against the platform's four functional components to check that every component had a clear stakeholder owner and that no pentahelix actor was assigned a role beyond its documented capacity.

Because this is a conceptual, document-based study, the resulting ReCircle model is a design proposal rather than a tested system; its purpose is to give FMCG companies, policymakers, and researchers a coherent starting point for pilot development, and the study's limitations and suggested next steps are addressed in Section 6.

4 Results and Discussion

4.1 Packaging Waste Challenges in the FMCG Industry

The document analysis identified four recurring structural challenges behind persistent packaging-waste leakage in the FMCG sector. First, collection fragmentation: consumers, informal waste pickers, waste banks, and recycling SMEs each operate largely independent collection channels, so a package discarded by a household does not reliably reach a facility capable of processing it [17], [22], [24]. Second, verification and traceability gaps: because material recovery is rarely recorded through a single, auditable system, the same recovered material can be reported by more than one actor, weakening the credibility of company-level EPR and ESG claims [7]. Third, limited design-for-recyclability: much FMCG packaging continues to use multilayer or mixed materials that are technically difficult and commercially unattractive for informal recyclers to process, which reduces the volume that is economically worth collecting [8], [9]. Fourth, weak downstream demand signals: recycling SMEs often lack a stable, visible market for the material they recover, so recovered material accumulates or is sold at low value instead of being reintroduced into FMCG packaging supply chains [6].

These four challenges point to the same underlying diagnosis as the EPR literature: Indonesia's constraint is less about the absence of recycling capacity and more about the absence of a coordinating layer that connects the actors who already perform collection, sorting, and processing functions [25]. A platform-based intervention is therefore positioned to add the most value not by creating new physical recycling infrastructure, but by making the existing informal and semi-formal infrastructure visible, traceable, and connected to FMCG demand.

4.2 Document Analysis Framework

Table 1. Conceptual framework derived from document analysis

Element	Description
Goal	Develop an integrated circular supply chain model that connects FMCG packaging waste to recovery, recycling, and reuse pathways through green logistics and pentahelix collaboration
Core problem	Packaging waste generated by FMCG products is not systematically routed back to producers or recyclers because collection, validation, and reporting functions are fragmented across separate actors and platforms

Analytical framework	Thematic document analysis of policy, industry, and academic sources, structured around the pentahelix model (government, industry, academia, community, media)
Output	ReCircle: a four-component digital platform (Smart Drop, Recycle Hub, Circular Market, ESG-based Impact Dashboard) connecting FMCG companies, consumers, waste bank communities, and recycling SMEs

Table 1 summarizes the goal, core problem, analytical framework, and intended output that emerged from the thematic coding described in Section 3. This framework served as the reference point against which the pentahelix role matrix and the platform component design, presented next, were developed.

4.3 Pentahelix Stakeholder Roles in ReCircle

Table 2. Roles of pentahelix stakeholders within the ReCircle ecosystem

Pentahelix Actor	Role in the ReCircle Ecosystem
Government	Sets and enforces EPR targets under Regulation No. P.75/2019,
Pentahelix Actor	Role in the ReCircle Ecosystem
	accredits waste bank and recycling-SME partners, and provides regulatory incentives for verified recovery volumes
Industry (FMCG companies & recyclers)	Funds and operates the platform, supplies packaging and material specifications to Recycle Hub, purchases recovered material or recycled-content credits through Circular Market, and reports outcomes for ESG disclosure
Academia	Designs the material-validation and impact-measurement methodology, audits data quality, and studies platform outcomes to refine the model and to develop green-skill curricula for logistics and waste-management graduates
Community (consumers & waste banks)	Sorts and deposits packaging waste through Smart Drop, operates local collection points, and receives direct or point-based incentives for verified deposits
Media	Promotes consumer participation, publicizes verified impact results from the dashboard, and supports behavior-change campaigns around packaging separation and return

Consistent with prior pentahelix waste-governance studies, the analysis found that government's contribution is primarily regulatory rather than operational, while industry and community actors carry most of the day-to-day functional load [13], [14], [16]. Government's clearest lever is Regulation No. P.75/2019 itself: because the regulation already obliges producers to reduce and recover packaging waste, it gives FMCG companies a direct incentive to fund a platform such as ReCircle rather than treating it as a discretionary corporate-social-responsibility expense [5]. Academia's role centers on methodology and verification, an area repeatedly identified as weak in existing Indonesian EPR reporting [7]. Media's role, informing and mobilizing consumer participation, addresses the demand-side behavior gap that packaging-design literature identifies as decisive for whether a circular system actually functions [10].

4.4 ReCircle Platform Architecture

Table 3. Components of the ReCircle platform

Component	Function in the Circular Ecosystem
Smart Drop	Lets consumers and waste banks identify packaging type via barcode or image recognition, locate the nearest drop-off point, and log the deposit in real time
Recycle Hub	Validates the material composition and condition of collected packaging against FMCG-company specifications and routes accepted material to the appropriate recycling SME
Circular Market	Provides a marketplace where validated recycled material and recycled-content products are listed, priced, and purchased by FMCG companies and other buyers
ESG-based Impact Dashboard	Aggregates verified recovery, recycling, and emission-reduction data into indicators aligned with ESG and EPR reporting requirements for participating companies

Consistent with prior pentahelix waste-governance studies, the analysis found that government's contribution is primarily regulatory rather than operational, while industry and community actors carry most of the day-to-day functional load [13], [14], [16]. Government's clearest lever is Regulation No. P.75/2019 itself: because the regulation already obliges producers to reduce and recover packaging waste, it gives FMCG companies a direct incentive to fund a platform such as ReCircle rather than treating it as a discretionary corporate-social-responsibility expense [5]. Academia's role centers on methodology and verification, an area repeatedly identified as weak in existing Indonesian EPR reporting [7]. Media's role, informing and mobilizing consumer participation, addresses the demand-side behavior gap that packaging-design literature.

4.5 Smart Drop: Real-Time Waste Identification and Collection

Smart Drop is the consumer- and community-facing layer of the platform. Drawing on the design pattern already proven by Indonesian waste-bank applications, it allows a user to scan or photograph a package, receive an automatic material classification, and locate the nearest participating waste bank or collection point [17], [18]. Each deposit is logged with a timestamp, material type, and estimated weight, generating the traceable record that later stages of the pipeline depend on. Community-based waste banks retain their existing role as the physical collection point; Smart Drop's contribution is to standardize what is recorded and to make that record visible to the rest of the ecosystem, rather than to replace the waste bank itself [22].

4.6 Recycle Hub: Material Validation and Recovery

Recycle Hub is where a Smart Drop record is checked against the material specification that a participating FMCG company has registered for its packaging, and where the validated material is matched to a recycling SME with the appropriate processing capability. This validation step directly targets the design-for-recyclability gap identified in Section 4.1: by making material specifications visible to collectors before deposit, Recycle Hub creates a commercial incentive for packaging designers to favor mono-material or otherwise easily separable formats, consistent with recommendations from the circular-packaging design literature [8], [9]. For recycling SMEs, Recycle Hub functions as a standing demand signal, since it tells them in advance which materials have a validated buyer, addressing the weak downstream-demand problem identified earlier.

4.7 Circular Market: Recycled-Product Commercialization

Circular Market is the transactional layer where validated recovered material, and recycled-content packaging or products made from it, are listed and purchased. FMCG companies can source recycled content directly from the recycling SMEs already validated through Recycle Hub, closing the loop back to their own production; other buyers, including packaging manufacturers outside the immediate FMCG partner group, may also participate, which gives recycling SMEs more than one potential buyer and reduces their dependence on a single company relationship. This design mirrors the marketplace function already demonstrated by independent Indonesian recycling platforms, extended here specifically to serve FMCG recycled-content sourcing [22].

4.8 ESG-Based Impact Dashboard

The Impact Dashboard aggregates data from Smart Drop, Recycle Hub, and Circular Market into indicators that map directly onto ESG and EPR reporting categories: total packaging volume recovered by material type, the share of a company's own packaging recovered against its EPR baseline, recycled-content volume purchased, and an estimate of avoided landfill and transport-related emissions from shorter, better-matched collection routes. Because every indicator traces back to a single validated transaction record rather than to a separately submitted figure, the dashboard is designed to reduce the double-reporting risk identified in the FMCG packaging literature and to give companies auditable evidence for their sustainability reports [7].

4.9 Discussion: Bridging Green Logistics and Circular Economy through ReCircle

Taken together, the four components address the same structural gap from two directions at once. From a green-logistics perspective, ReCircle organizes the reverse flow of packaging waste, from consumer to waste bank to recycling SME to FMCG buyer, so that material moves along a planned, visible route rather than an ad hoc one, which is the operational condition that reverse-logistics research identifies as necessary for environmentally efficient recovery [4]. From a circular-economy perspective, the platform keeps packaging material inside a closed loop by giving recovered material a validated buyer, which is the condition circular-economy theory identifies as the difference between recycling in principle and recycling in practice [1], [2], [3]. This dual function is consistent with recent survey-based evidence from the logistics sector, where reverse logistics was found to be a crucial factor for improving environmental, economic, and social sustainability performance simultaneously, while green logistics practices more broadly were shown to strengthen circular-economy outcomes through their effect on sustainable production [34], [35], [36].

The pentahelix structure is what allows these two functions to operate without requiring any single actor to build capacity it does not already have: government continues to regulate and accredit, community actors continue to collect, industry continues to fund and to buy, academia continues to verify, and media continues to mobilize participation. This division of labor is consistent with the finding from Indonesian pentahelix case studies that fragmented collaboration, not a lack of individual actor capability, is the more common point of failure in waste governance [13], [14]; it also echoes the conclusion from Indonesian reverse-logistics research that eradicating or competing with existing informal actors is counterproductive, and that a defined engagement model, rather than ad hoc cooperation, is what makes multi-actor recovery systems function [37]. ReCircle's single shared data pipeline is intended specifically to remove that coordination failure rather than to add a new actor to the system.

The model also responds directly to Indonesia's EPR timeline. Because Regulation No. P.75/2019 requires producers to plan, implement, monitor, evaluate, and report their waste-reduction activities on a recurring basis, a platform that automatically generates monitoring and reporting data as a byproduct of ordinary transactions lowers the administrative cost of compliance compared with manual audits of separate collection

5 Practical/Theoretical Contribution

For industry practice, this study offers FMCG companies a conceptual, technology-enabled pathway to meet Regulation No. P.75/2019 obligations without depending solely on manual audits of scattered collection partners. By consolidating identification, validation, commercialization, and reporting into one traceable pipeline, the ReCircle model gives sustainability and supply-chain teams a single source of verified data for EPR filings and ESG disclosures, addressing the double-reporting weakness identified in current FMCG sustainable-packaging practice [7].

For waste bank communities and recycling SMEs, the model formalizes their existing role in Indonesia's recycling economy by giving them a standing, visible demand channel rather than requiring them to independently negotiate with individual producers, extending the economic-inclusion outcomes already observed in Indonesian waste-bank digitalization initiatives [17], [18], and operationalizing the empowerment-oriented engagement that Indonesian reverse-logistics research recommends as the appropriate model for integrating informal and semi-formal recyclers into a producer-led recovery system, rather than treating them as a compliance risk to be regulated away [37].

Theoretically, this study contributes a conceptual bridge between green logistics and circular economy scholarship in the specific context of FMCG packaging, showing how a reverse-logistics coordination problem and a material-circularity problem can be addressed by the same platform architecture rather than by separate interventions [1], [4], and adds Indonesian, FMCG-specific evidence to a literature in which reverse logistics and remanufacturing are already established as the circular-economy practices most consistently linked to sustainable logistics performance, though firm size and resource capacity have been shown to condition how fully those practices are realized [35]. It also extends pentahelix collaboration theory from its established application in municipal waste governance [13], [14], [16] and reverse-logistics engagement theory developed for Indonesia's informal recycling economy [37] to a producer-driven, EPR-compliance context, illustrating how the model can be adapted when industry, rather than government, is the primary coordinating and funding actor.

From an educational perspective, operating and auditing a system such as ReCircle requires data literacy, environmental-regulation literacy, and applied logistics-planning skills, competencies that align closely with the green-skill priorities of vocational and applied higher education in logistics and supply-chain management. Embedding case

material based on this model into vocational curricula could give students direct exposure to the intersection of digital monitoring, circular economy practice, and regulatory compliance that FMCG and logistics employers increasingly require.

6 Conclusion

This study set out to develop an integrated circular supply chain model addressing packaging waste challenges in the FMCG industry by aligning waste management with green logistics and circular economy principles. Document analysis identified four structural challenges behind persistent packaging leakage, collection fragmentation, verification and traceability gaps, limited design-for-recyclability, and weak downstream demand signals, and showed that these challenges stem more from a lack of coordination among existing actors than from a lack of underlying recycling capacity.

Using a pentahelix collaboration framework, the study proposed ReCircle, a digital platform connecting FMCG companies, consumers, waste bank communities, and recycling SMEs through four integrated components: Smart Drop, Recycle Hub, Circular Market, and an ESG-based Impact Dashboard. Each component was mapped to the pentahelix actor best positioned to operate it, so that government continues to regulate, community actors continue to collect, industry continues to fund and to buy, academia continues to verify, and media continues to mobilize participation, while the platform's shared data pipeline supplies the coordination that prior pentahelix waste-governance studies identify as the more common point of failure.

Because this study is conceptual and document-based, its main limitation is the absence of field testing: the ReCircle model has not yet been piloted with an actual FMCG company, waste bank network, or recycling SME cluster, and its projected benefits for material recovery, landfill diversion, and emission reduction are derived from the literature rather than from measured outcomes. partners [5]. For FMCG companies still building their EPR roadmap, ReCircle offers a practical way to reach verified recovery volumes without first constructing physical collection infrastructure of their own, since the platform is designed to work with the collection capacity that waste banks and recycling SMEs already provide [25].

References

1. M. Geissdoerfer, P. Savaget, N. M. P. Bocken, and E. J. Hultink, "The Circular Economy - A new sustainability paradigm?," Journal of Cleaner Production, vol. 143, pp. 757-768, 2017, doi: 10.1016/j.jclepro.2016.12.048.
2. J. Kirchherr, D. Reike, and M. Hekkert, "Conceptualizing the circular economy: An analysis of 114 definitions," Resources, Conservation and Recycling, vol. 127, pp. 221-232, 2017, doi: 10.1016/j.resconrec.2017.09.005.
3. Ellen MacArthur Foundation, Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition. Cowes, UK: Ellen MacArthur Foundation, 2013.

4. D. S. Rogers and R. Tibben-Lembke, "An examination of reverse logistics practices," Journal of Business Logistics, vol. 22, no. 2, pp. 129-148, 2001, doi: 10.1002/j.2158-1592.2001.tb00007.x.
5. Indonesia, Ministry of Environment and Forestry, Regulation No. P.75/2019 on the Roadmap for Waste Reduction by Producers. Jakarta: Ministry of Environment and Forestry of the Republic of Indonesia, 2019.
6. U. S. Nwabekee, O. Y. Abdul-Azeez, E. E. Agu, and T. I. Ijomah, "Challenges and opportunities in implementing circular economy models in FMCG industries," International Journal of Frontline Research in Science and Technology, vol. 3, no. 2, pp. 73-91, 2024.
7. F. Misopoulos and P. Bajiraj, "Shared producer responsibility for sustainable packaging in FMCG: The convergence of SDGs, ESG reporting, and stakeholder engagement," Sustainability, vol. 17, no. 14, art. 6654, 2025, doi: 10.3390/su17146654.
8. A comprehensive and multidisciplinary framework for advancing circular economy practices in the packaging sector: A systematic literature review on critical factors, Sustainability, vol. 18, no. 1, art. 192, 2026, doi: 10.3390/su18010192.
9. W. Liu, Z. Zhu, and S. Ye, "A framework towards design for circular packaging (DfCP): Design knowledge, challenges and opportunities," Circular Economy and Sustainability, vol. 3, no. 4, pp. 2109-2125, 2023, doi: 10.1007/s43615-023-00264-3.
10. F. Poças and M. do Céu Selbourne, "Drivers, advances, and significance of measures for effective circular food packaging," Frontiers in Sustainable Food Systems, vol. 7, art. 1140295, 2023, doi: 10.3389/fsufs.2023.1140295.
11. T. A. Kurniawan, M. H. Dzarfan Othman, G. H. Hwang, and P. Gikas, "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, vol. 357, art. 131911, 2022, doi: 10.1016/j.jclepro.2022.131911.
12. United Nations Development Programme, "Digitizing waste banks to keep plastic out of the ocean," UNDP Indonesia, 2025. [Online]. Available: https://www.undp.org/indonesia/stories/digitizi ng-waste-banks-keep-plastic-out-ocean
13. Fry Loli Keluli, Y., Djani, W., & Pradana, I. P. Y. B. (2025). Pentahelix Collaboration in Waste Management: A Case Study of the Roles of Government, Academia, Business, Community, and Media in Kupang City. *Jurnal Ilmu Administrasi Negara AsIAN (Asosiasi Ilmuwan Administrasi Negara)*, 13(1), 29–49. https://doi.org/10.47828/jianaasian.v13i1.306
14. Collaborative waste management through pentahelix stakeholder participation: A qualitative study from South Tangerang City, Indonesia, Social Sciences Insights Journal, 2025.
15. A limiting integrative effort plastic waste in the sea of Indonesia and China: The Penta Helix model perspective, Journal of Infrastructure, Policy and Development, vol. 8, no. 12, art. 8962, 2024.
16. WWF Indonesia, Extended Producer Responsibility Guideline on Plastic Products and Packaging. Jakarta: WWF Indonesia, 2022.
17. Systemiq, Producer Responsibility in Indonesia: What to Know, What Stakeholders Think. 2022. [Online]. Available: https://www.systemiq.earth
18. Indonesia, Government Regulation No. 81 of 2012 on Household Waste and Household-like Waste Management. Jakarta: Government of the Republic of Indonesia, 2012.
19. Indonesia, Law No. 18 of 2008 on Waste Management. Jakarta: Government of the Republic of Indonesia, 2008.
20. E. D. de Souza, J. C. Kerber, M. Bouzon, and C. M. T. Rodriguez, "Performance evaluation of green logistics: Paving the way towards circular economy," Cleaner Logistics and Supply Chain, vol. 3, art. 100019, 2022, doi: 10.1016/j.clscn.2021.100019.

21. C. Ji-Hyland, D. White, and R. Khaydarov, "The impact of circular economy practices on sustainable logistics performance," International Journal of Logistics Research and Applications, vol. 28, no. 10, pp. 1220-1246, 2025, doi: 10.1080/13675567.2025.2465579.
22. Y. Cheng, M. Masukujjaman, F. A. Sobhani, M. Hamayun, and S. S. Alam, "Green logistics, green human capital, and circular economy: The mediating role of sustainable production," Sustainability, vol. 15, no. 2, art. 1045, 2023, doi: 10.3390/su15021045.
23. H. Maheswari, G. Yudoko, and A. Adhiutama, "Government and intermediary business engagement for controlling electronic waste in Indonesia: A sustainable reverse logistics theory through customer value chain analysis," Sustainability, vol. 11, no. 3, art. 732, 2019, doi: 10.3390/su11030732.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

