

Integration of Circular Economy and Sustainable Waste Management as a Best Practice for Sustainable Waste Governance: A Case Study of the PRIMADONA BERDAYA CSR Program of PT Pertamina Patra Niaga IT Balongan

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Abstract. This study aims to examine how the PRIMADONA BERDAYA Program has successfully integrated the concepts of circular economy and sustainable waste management in fostering sustainable waste governance in Sliyeg Lor Village, Indramayu Regency. The method applied in this research was qualitative descriptive with a case study design. Primary data were collected through participatory observation, in-depth interviews, and Focus Group Discussions (FGDs), while secondary data were obtained from program documentation, corporate CSR reports, relevant literature, and journal articles. The findings reveal that through four innovative subprograms, including Griya Kreasi, SERASA, SITOPANG, and BIONA, the PRIMADONA BERDAYA program has emerged as a best practice in sustainable waste governance. This is reflected in its multidimensional impacts: economic impacts in the form of increased income among millennial farmer groups by 30–40% and the reduction of greenhouse operational costs through the optimization of solar power plants (PLTS) by 100%; environmental impacts including a 10% reduction in household waste and a 100% reduction in company seal waste; social impacts through strengthened cohesion and solidarity, as well as expanded access to environmental education (including primary schools); and sustainability impacts through program replication in Tegalurung Village with strengthened collaboration with educational institutions.

Keywords: CSR, Circular Economy, Sustainable Waste Management.

A. INTRODUCTION

The global waste problem has now evolved into a multidimensional crisis threatening environmental, health, and socio-economic conditions. The United Nations Environment Programme (2024) recorded that global waste volume is projected to nearly double by 2050 if current consumption patterns remain unchanged. Kaza et al. (2018), in *What a Waste 2.0*, further confirmed that global municipal solid waste production has reached 2.01 billion tons annually, with over 33% not managed in an environmentally appropriate manner. These findings suggest that without systemic transformation in waste governance, the increasing trend of waste generation will continue to burden infrastructure and accelerate environmental degradation. This condition is also evident in rural areas. According to Ferronato and Torretta (2019), rural regions generate waste with distinct characteristics, predominantly organic, yet management remains underdeveloped due to limited facilities and infrastructure access. Such conditions are projected to impose significant socio-economic burdens in the coming decades if no integrated intervention is undertaken.

Plastic waste constitutes the most persistent and widespread threat. Cottom et al. (2024) estimate global macroplastic emissions to reach tens of millions of tons annually, while

Thompson et al. (2024) show that microplastics are now present in nearly all ecosystems, including air, freshwater, and marine environments. Jambeck et al. (2015) had previously warned that around 4.8–12.7 million tons of plastic enter the oceans annually. More recent data by Lau et al. (2020) in *Science* stress that without radical intervention, the volume of plastic waste polluting oceans will triple by 2040. This underscores the urgency of cross-scale plastic waste management policies from upstream to downstream. The challenges are even more complex in developing countries. Zhang et al. (2024) identified infrastructure, regulatory, and financial limitations as the primary barriers hindering the implementation of integrated waste management in Asia and Africa. Accordingly, Pottinger et al. (2024) emphasized the need for circular system-based strategies that combine waste prevention, eco-friendly product design, and integration of informal workers to sustainably reduce negative impacts.

As a developing country, Indonesia is currently facing a serious waste management crisis. Globally, Indonesia ranked fifth among the world's largest waste producers in 2020, with an estimated 65.2 million tons of waste generated (World Bank, 2023). More specifically, the World Bank (2021), in *Plastic Waste Discharges from Rivers and Coastlines in Indonesia*, reported that Indonesia produces approximately 7.8 million tons of plastic waste annually, of which about 4.9 million tons are mismanaged (uncollected, openly dumped, or leaked from disposal sites). Furthermore, Hilal et al. (2025) noted that household and food waste in Indonesia also contribute significantly, reaching approximately 29.28 million tons per year, with organic waste dominating at 40%. Not only as one of the largest waste producers globally, but Indonesia is also recorded as one of the countries with the weakest waste management systems. The Environmental Performance Index (2024) reported that Indonesia ranks as the poorest performer in waste management among ASEAN countries, scoring only 26.7 out of 100. This figure is far below Singapore, the region's leader in waste governance, which scored 75.5 out of 100. Waluyo's (2023) study, citing data from *Sistem Informasi Pengelolaan Sampah Nasional* (SIPSN), further confirms that food waste poses one of the greatest pressures in Indonesia's waste management challenges.

The condition in Indonesia essentially reflects the poor waste governance at the regency/city level, one of which is in Indramayu. Data from the Environmental Agency of Indramayu Regency (2021) reported an annual waste generation of approximately 402,455 tons in 2021, with a tendency to increase in 2022. Of this total waste generation, Soleh (2025) noted that 38.49% remained unmanaged formally, posing risks of environmental pollution and public health problems. Furthermore, Ibrahim et al. (2025) explained that although regulations are in place, supporting facilities such as TPS 3R, waste banks, and sorting infrastructure in Indramayu Regency remain insufficient. Additionally, weak community awareness and law enforcement hinder the effectiveness of waste management. Meanwhile, at the final facility level, TPA Pecuk, which has served as the primary receiving center since 2021, has faced issues including limited capacity and technical problems, particularly ineffective leachate management, which has resulted in air pollution around the landfill (Dhamayanthie, 2021). Moreover, field research by Lutfi et al. (2023) showed that at the village scale, waste governance in Indramayu still demonstrates low levels of public awareness and participation in sorting and inconsistent disposal practices, exacerbating operational pressures and service disparities across sub-districts. Hilmansyah et al. (2024) emphasized the need for a community empowerment approach that does not solely rely on the government as a solution to the waste problem in Indramayu.

In response to this issue, PT Pertamina Patra Niaga Integrated Terminal Balongan introduced a CSR program called PRIMADONA BERDAYA (*Pertanian Mandiri, Inovatif, dan Berkelanjutan – Bersinergi Demi Aksi Nyata*) as an alternative solution for sustainable waste governance in Indramayu. This program was initiated by PT Pertamina Patra Niaga

Integrated Terminal Balongan in 2021, with its initial focus on addressing the socio-economic challenges of mango farmers in Sliyeg Lor Village, Indramayu Regency. However, in 2024, the program's focus shifted towards environmental issues due to the increasing volume of waste (household and mango waste) in Sliyeg Lor Village, which reached 1.7 tons per day without the presence of either TPS 3R facilities or TPA. Several environmental innovations were subsequently initiated under PRIMADONA BERDAYA, including Griya Kreasi, SERASA (*Sekolah Ramah Sampah*), SITOPANG (*Sistem Tong Sampah Organik*), and BIONA (Bioaktivator Primadona). These innovations were based on the integration of the circular economy concept and the principles of sustainable waste management. Kirchherr et al. (2017) stated that without efficient waste management, the circular economy risks being trapped in partial recycling practices that do not significantly reduce natural resource extraction. In line with this, Pires et al. (2011) emphasized that sustainable waste management requires the integration of technical, institutional, and social aspects, thereby establishing a foundation for the implementation of the circular economy at both urban and national levels.

Drawing from this review, the present study aims to further investigate how the PRIMADONA BERDAYA Program is able to integrate the concept of the circular economy with sustainable waste management in fostering sustainable waste governance in Sliyeg Lor Village, Indramayu Regency. Through a case study approach, this research is expected to provide academic contributions by enriching the literature on the importance of integrating the circular economy and sustainable waste management as a comprehensive strategy to enhance the effectiveness of sustainability-oriented waste governance. Moreover, the study is expected to have practical implications for the development of innovative community-based waste management models that not only improve the socio-economic welfare of rural residents but can also be replicated in other regions in Indonesia in response to increasingly complex environmental challenges.

B. METHODS

This study employed a descriptive qualitative approach with a case study design. This approach was chosen as it enables an in-depth and comprehensive exploration of social phenomena, particularly regarding environmental innovations introduced by PT Pertamina Patra Niaga Integrated Terminal Balongan through the PRIMADONA BERDAYA CSR program in addressing waste management challenges in Indramayu Regency. According to Creswell and Poth (2018), qualitative research focuses on exploring meanings and understanding social experiences, making it relevant for analyzing community dynamics in confronting environmental issues. In line with this, Denzin and Lincoln (2018) asserted that qualitative research allows researchers to interpret phenomena contextually from participants' perspectives. In terms of design, a case study was selected because it enables the researcher to holistically understand the process of program implementation and the involvement of multiple actors (Yin, 2018).

The research location was in Sliyeg Lor Village and Tegalurung Village, Indramayu Regency, which were selected due to their agrarian socio-economic characteristics and their serious waste management issues. Primary data were collected through participatory observation, in-depth interviews, and Focus Group Discussions (FGDs), while secondary data were obtained from program documentation, corporate CSR reports, and relevant literature and journal articles. The analysis was conducted descriptively through the stages of data reduction, classification, and categorization to construct systematic descriptive patterns (Miles et al., 2014). Data credibility was tested using source and method triangulation, ensuring that the research findings are academically reliable (Nazir, 2014).

C. RESULT AND DISCUSSION

PRIMADONA BERDAYA stands for Pertanian Mangga Mandiri, Inovatif, dan Berkelanjutan – Bersinergi Demi Aksi Nyata. The program is a CSR initiative of PT Pertamina Patra Niaga Integrated Terminal Balongan, launched in 2021 in Sliyeg Lor Village, Indramayu Regency. Initially, this program was designed as a response to the declining productivity of mango farming. However, in 2024, with the increasing volume of household waste and mango production waste in Sliyeg Lor Village, the program's focus shifted towards sustainable waste and by-product management. PRIMADONA BERDAYA adopts an approach that combines technological innovation, social strengthening, and community-based environmental management. The program's targets include conventional farmers, millennial farmers, former migrant women, the elderly, and elementary school students. With this cross-group coverage, the program demonstrates systematic efforts to build village sustainability. After its successful implementation in Sliyeg Lor, the program was subsequently replicated in Tegalurung Village with the integration of agriculture, livestock, and waste management. In terms of waste governance, PT Pertamina Patra Niaga Integrated Terminal Balongan, through PRIMADONA BERDAYA, integrates the concept of the circular economy with sustainable waste management.

The initial idea of the circular economy originates from Herman Daly (1996) through the concept of a steady-state economy, which explains that unlimited economic growth is incompatible with and tends to contradict the constraints of ecological systems. This argument simultaneously critiques the growth paradigm that disregards sustainability. According to Daly, a sustainable economy is characterized by the stability of population stocks and physical artifacts, with low levels of material and energy outputs aligned with ecosystem capacity. Sustainable economy, as Daly (1996) asserted, emphasizes the importance of maintaining a balance between the rate of resource extraction and the regenerative capacity of nature so that economic activities do not exceed the carrying capacity of the environment (Costanza et al., 2014). These concepts and ideas are regarded as the foundational basis for the emergence of alternative, environmentally friendly economic approaches, later known as the circular economy.

From this standpoint, the circular economy was popularized by the Ellen MacArthur Foundation (2013), which defines it as an economic system that is restorative and regenerative by design, aiming to eliminate waste, maintain materials within cycles, and regenerate natural systems. The circular economy emphasizes the shift from the linear model of “take–make–dispose” toward a closed-loop material cycle that minimizes resource exploitation (Geissdoerfer et al., 2017). The operational principles of the circular economy include durable product design, business models based on reuse, repair, remanufacturing, and recycling (Bocken et al., 2016). This approach is not only considered capable of reducing environmental pressures but also of creating new economic opportunities rooted in innovation and resource efficiency (Kirchherr et al., 2017).

Furthermore, Um (2025) stated that sustainable waste management is an instrument that enables the circular economy to be operationalized; hence, the integrative approach of both is crucial so that waste is viewed as a valuable resource rather than an environmental burden. Historically, the concept of sustainable waste management emerged and developed as a response to complex waste management challenges that involved not only technical aspects but also social, economic, and institutional dimensions (Wilson et al., 2012). Sustainable waste management is grounded in the waste hierarchy, which emphasizes prevention, reduction, reuse, recycling, and resource recovery before the final option of disposal to landfills or incineration (Pires et al., 2011). Guerrero et al. (2013) asserted that the implementation of sustainable waste management must take into account local contexts, technology, and

stakeholder participation. In the digital era, this concept has been strengthened by innovations such as community-based waste banks, the use of the Internet of Things (IoT), and circular economy schemes to reduce landfill burdens and maximize material recovery (Sharma et al., 2020). Therefore, sustainable waste management is not only a technical strategy but also an instrument for advancing the broader transition toward a circular economy.

PRIMADONA BERDAYA: A Best Practice of Circular Economy and Sustainable Waste Management Integration in Sustainable Waste Governance

The PRIMADONA BERDAYA program encompasses four sub-programs of environmental innovation that represent the tangible integration of the circular economy and sustainable waste management, namely: Griya Kreasi, SERASA (Sekolah Ramah Sampah), SITOPANG (Sistem Tong Sampah Organik), and BIONA (Bioaktivator Primadona). First, Griya Kreasi can be regarded as a practical manifestation of the circular economy by involving young (millennial) farmers in agricultural technology innovations and plastic waste management. Through technological innovation in the form of climate-resilient mango greenhouses powered by solar power plants (PLTS) and IoT systems, Griya Kreasi demonstrates how renewable technology can reduce dependence on fossil resources while increasing agricultural production efficiency.

This strategy aligns with the Ellen MacArthur Foundation's (2013) idea that the circular economy is not only about materials but also about designing production systems to be regenerative and low-pollution. Murray et al. (2017) also emphasized that the circular economy requires fundamental changes in production system design by prioritizing clean energy and smart technologies, consistent with what has been applied in the Griya Kreasi program. By involving rural youth, Griya Kreasi also strengthens the social dimension of the circular economy, which, according to Hobson (2016), is a key factor ensuring that the circular transition is not solely technology-oriented but also focused on shaping community behavior and capacity.

In addition to the technological innovation of building climate-resilient mango greenhouses powered by solar energy and IoT systems, Griya Kreasi also introduced the Suryaplas innovation, which processes plastic waste into furniture using solar energy. This innovation is a clear embodiment of the circular economy and sustainable waste management. From the perspective of the circular economy, it reflects Bocken et al.'s (2016) argument that such innovation represents a product life extension strategy, reducing the need for new raw materials while lowering emissions from linear systems. This innovation is also consistent with Kirchherr et al. (2017), who argued that the circular economy can open up new economic opportunities rooted in local creativity, particularly when driven by community participation.

From the perspective of sustainable waste management, Suryaplas embodies the waste hierarchy principle by prioritizing recycling and resource recovery before final disposal. Wilson et al. (2012) emphasized that sustainable waste management requires the integration of technical, social, and economic dimensions. In this regard, Griya Kreasi provides not only a technical solution for plastic recycling but also empowers the community, especially millennial farmers, as key actors. As explained by Guerrero et al. (2013), the participation of local communities (in this case, the Salam Tani farmer group consisting of millennial farmers) is a key factor for the success of sustainable waste management systems in developing countries, thereby aligning Griya Kreasi with these empirical findings.

Second, the SERASA (Sekolah Ramah Sampah) innovation focuses on instilling environmental awareness from an early age at SDN 02 Sliyeg Lor through activities such as waste sorting, composting, and crafting from used materials. These activities clearly reflect the implementation of circular economy principles at the educational level. As noted by Lewandowski (2016), the circular economy emphasizes extending the life cycle of materials

by maintaining product value for as long as possible. By repurposing plastic bottles into bookshelves or processing organic waste into compost, students directly learn how waste is not an endpoint but rather a new input into the material cycle.

This practice aligns with Prieto-Sandoval et al.'s (2018) assertion that the transition toward a circular economy requires education and behavioral change from a young age to shape long-term circular awareness. From the perspective of sustainable waste management, SERASA functions as a social instrument to strengthen household-level waste management behaviors. According to Alam and Ahmade (2013), the success of sustainable community waste management is largely determined by education and community involvement. By making schools centers of environmental education, this program has the potential to extend its impact to students' families, thereby building a more inclusive waste management ecosystem. Furthermore, this initiative strongly supports the hierarchy of sustainable waste management, which emphasizes prevention, reuse, and recycling before final disposal (Hoornweg & Bhada-Tata, 2012).

Subsequently, the third environmental innovation in the PRIMADONA BERDAYA program is SITOPANG (Sistem Tong Sampah Organik). SITOPANG, as a simple innovation for processing household organic waste, has exemplified circular economy practices at the micro level. By utilizing aeration pipes to decompose organic waste into odorless compost, this system demonstrates how waste can be transformed into a new, valuable resource. This aligns with the concept introduced by the Ellen MacArthur Foundation (2013) regarding the biological cycle within the circular economy, where organic waste must be returned to the biosphere in the form of safe and productive nutrients.

According to Ghisellini et al. (2016), the implementation of the circular economy in the context of organic waste is highly strategic, as it not only reduces dependence on chemical fertilizers but also improves soil quality and lessens the environmental impact of agricultural systems. Korhonen et al. (2018) further emphasize that the success of circular economy transition largely depends on local innovations that bridge the macro vision of sustainability with everyday community practices. Moreover, SITOPANG strengthens the argument of Murray et al. (2017) that the circular economy is not solely a macroeconomic framework but can also be operationalized through small-scale innovations that deliver direct impacts on local communities and households. To date, SITOPANG has been implemented by 36 households in RT 005/RW 002, Blok Senibah, Sliyeg Lor Village, Indramayu Regency. From the perspective of sustainable waste management, Taherzadeh and Rajendran (2015) argue that source-based organic waste processing models, such as SITOPANG, are among the most effective strategies to reduce the volume of waste sent to landfills, thereby lowering waste management costs. With the adoption of SITOPANG by dozens of families, it becomes evident that sustainable waste management is not confined to municipal or national policy levels but can also be realized through simple, affordable, and easily implementable local innovations.

The final environmental innovation within the PRIMADONA BERDAYA program, which also concretely illustrates the integration of the circular economy and sustainable waste management, is BIONA (Bioaktivator PRIMADONA). Organic waste in the form of mango peels, initially perceived as valueless, can be transformed into a substance that accelerates the composting process, reduces odors, and enhances the quality of fertilizers, commonly referred to as a bioactivator. This transformation process clearly corresponds with the circular economy framework, which emphasizes the importance of maintaining material flows within a closed-loop system so that they can be reused in value-added forms (Geissdoerfer et al., 2017). In the context of sustainable waste management, BIONA contributes to waste minimization by reducing the volume of mango waste ending up in landfills, while simultaneously reinforcing the principle of resource recovery. This aligns with Wilson et al. (2012), who stress that the

success of modern sustainable waste management is not only measured by waste reduction but also by the extent to which resources can be recovered from waste streams. Consequently, BIONA has proven to serve as a meeting point between local innovation and the global sustainability vision by synergizing waste utilization with the needs of the agricultural sector. Furthermore, the close interconnection between mango farming and waste management through BIONA demonstrates how the concept of industrial symbiosis can be realized at the community level. Chertow (2000) noted in his work that industrial ecology is a crucial element of the circular economy, wherein material flows are organized to resemble natural ecosystems with minimal residuals.

The four environmental innovation programs initiated and implemented by PT Pertamina Patra Niaga Integrated Terminal Balongan through the CSR program PRIMADONA BERDAYA (ranging from plastic waste management through Griya Kreasi, environmental education via SERASA, household organic waste management with SITOPANG, to the utilization of mango peel waste in BIONA) demonstrate the practical integration of circular economy and sustainable waste management. These four programs are not solely focused on waste reduction, but also on creating new value through a closed-loop system that keeps materials productive and beneficial. By prioritizing community participation from farmer groups, simple technologies, and the use of local resources, PRIMADONA BERDAYA presents a best practice model affirming that the transition toward sustainability can begin at the village level. This initiative simultaneously shows that the integration of circular economy and sustainable waste management is not entirely dependent on large-scale policies or technologies, but can emerge from grassroots innovations that are adaptive, contextual, and deliver direct impacts to society.

Impacts of the PRIMADONA BERDAYA Program

The PRIMADONA BERDAYA program, with its four subprograms of environmental innovation, including Griya Kreasi, SERASA, SITOPANG, and BIONA, has demonstrated significant impacts across various dimensions, including economic, environmental, social, and sustainability aspects. First, economically, the program's innovations have successfully improved the welfare of beneficiary groups through various innovative and productive activities. The production of plastic waste-based furniture under the Griya Kreasi program, involving the village's millennial farmer group known as Kelompok Tani Salam Tani, has increased group income by 30–40%. Moreover, the use of renewable energy in the PLTS-based greenhouse has successfully reduced operational costs by up to 100%, thereby enhancing the efficiency of agricultural cultivation. Beyond farmers, housewives have also benefited from processing agricultural products and plastic waste-based goods. This underscores that circular economy-based programs can foster inclusive local economic growth while remaining environmentally friendly.

Second, environmentally, the program's innovations have significantly reduced waste generation and increased the use of renewable resources in Sliyeg Lor Village. The SITOPANG program has effectively reduced household waste by 10% through direct processing of organic waste at the source, while also producing compost for agricultural cultivation. Additionally, corporate seal waste management has reached 100%, reflecting the effectiveness of zero-waste strategies. The utilization of organic waste through innovations such as BIONA and SITOPANG demonstrates how biological materials can return safely and productively to ecosystems. Solar energy utilization via PLTS also contributes to carbon footprint reduction and strengthens the village's energy resilience. Overall, this dimension demonstrates that PRIMADONA BERDAYA not only reduces landfill burdens but also strengthens village ecology through resource recovery and clean energy approaches.

Third, socially, the program's innovations have directly benefited 183 individuals, including 36 households implementing SITOPANG. Cross-group participation involving farmers, women, the elderly, students, and academics has strengthened social cohesion and fostered collaborative networks supporting program sustainability. Furthermore, the integration of educational programs such as SERASA in elementary schools has expanded access to environmental education by instilling early awareness and fostering intergenerational sustainability culture. Additionally, the program has served as a learning hub referenced by academics and research institutions, such as visits by lecturers from FTP UGM for doctoral research at Wageningen University, visits by BRIN through DFNet III, and internship programs for students from SMKN 1 Terisi. Such broad involvement illustrates that PRIMADONA BERDAYA is not merely a technical project but also a social empowerment instrument that enhances solidarity, awareness, and the community's collective capacity.

Finally, in terms of sustainability, the successful implementation of program innovations in Sliyeg Lor Village has driven replication in Tegalurung Village. The replication's primary focus is on integrating agriculture, poultry farming, and organic waste management through maggot cultivation as an innovative solution for waste management and alternative feed provision. Collaboration with Politeknik Negeri Indramayu has further strengthened group capacities through the provision of pellet production machines, thereby integrating the circular economy value chain. This fact illustrates that the PRIMADONA BERDAYA model is adaptive and scalable, capable of adjusting to diverse local contexts, and holds the potential to serve as a community-based sustainable development model. Moreover, the involvement of educational and research institutions demonstrates that PRIMADONA BERDAYA is not only successful at the community level but is also recognized as a model of learning and research that can support long-term sustainability.

D. CONCLUSION

The problem of waste, both globally and nationally, including in Indramayu Regency, demonstrates that ineffective waste governance has created serious pressures on the environment, public health, and the socio-economic fabric of communities. In response to these challenges, PT Pertamina Patra Niaga Integrated Terminal Balongan, through its CSR program PRIMADONA BERDAYA, has emerged as an alternative solution for sustainable waste management by integrating the concepts of the circular economy and sustainable waste management. The findings of this study indicate that through four innovative subprograms, including Griya Kreasi, SERASA, SITOPANG, and BIONA, PRIMADONA BERDAYA has successfully realized tangible practices of sustainable waste governance, as evidenced by reduced waste generation, resource recovery, and the creation of new added value.

Furthermore, the impacts of the program can be observed across multiple dimensions. From the economic aspect, it has increased the incomes of farmers and housewives; from the environmental aspect, it has significantly reduced household waste generation, optimized organic waste processing, and promoted the use of renewable energy. From the social perspective, PRIMADONA BERDAYA has strengthened community cohesion across groups, expanded access to environmental education, and served as a learning hub for academics, research institutions, and students. In terms of sustainability, the success achieved in Sliyeg Lor Village has encouraged replication in Tegalurung Village through strengthened collaboration with educational institutions, thereby demonstrating the scalability and adaptability of the program in various local contexts. Accordingly, PRIMADONA BERDAYA may be regarded as a best practice that underscores how the integration of circular economy and sustainable waste management does not necessarily depend on large-scale interventions but can emerge from simple, contextual, and participatory community innovations. This model

is not only relevant to addressing the waste problem in Indramayu but also holds broader potential for replication as a strategic pathway toward sustainable development in Indonesia.

Nevertheless, this study still encounters several challenges in the context of sustainable waste governance. The absence of longitudinal data on long-term economic, social, and environmental impacts renders the evaluation of program sustainability less comprehensive. Moreover, the research focus is limited to a single area constrains the generalizability of the findings to broader contexts. More systematic quantitative measurements regarding the effectiveness of waste reduction, greenhouse gas emissions mitigation, and contributions to community welfare are also needed. Another challenge lies in the sustainability of circular product markets derived from waste processing, which remain highly dependent on purchasing power, consumer preferences, and the availability of supportive distribution networks.

Therefore, further research is recommended to expand the analysis to the political economy dimensions of circular economy and sustainable waste management integration at the village level, to assess the effectiveness of regional policies in supporting community innovation, and to explore the potential integration of digital technologies for program monitoring and evaluation. Additionally, strengthening market-based circular economy mechanisms is necessary to ensure that waste-derived products possess competitiveness and sustainable added value. It is hoped that future studies will not only measure economic, environmental, and social impacts more comprehensively and longitudinally but also explore the integration of digital technologies for program monitoring and evaluation. In this way, the development of the PRIMADONA BERDAYA model can evolve beyond a local best practice to provide theoretical contributions to the literature on circular economy and sustainable waste management within the context of developing countries.

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