SUSTAINABILITY OF CO-PRODUCTION IN WASTE MANAGEMENT: EXPLORING WASTE BANKS AND TPS3R IN SEMARANG CITY

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Highlights

Promoting sustainable co-production in waste management.

Abstract

Collaboration with the community in waste management has become crucial amidst the limited resources available to the government. However, such collaboration does not always endure. Understanding the sustainability of this collaboration within the framework of co-production is essential to enhance the effectiveness of waste management. Unfortunately, research on the factors influencing the sustainability of co-production in waste management remains very limited. This study aims to explore the sustainability of co-production practices in waste management through Waste Banks and TPS3R in Semarang City. Data collection was conducted through in-depth interviews, documentation, and observation. Community-based waste management practices were analyzed using the concept of co-production sustainability. The findings reveal that the implementation of existing regulations is not yet robust, resource-sharing remains focused on inputs for service production, and the unique characteristics of waste management compared to other public services influence the sustainability of co-production.

Keyword

co-production; waste managemen; sustainability.

Introduction

The increasing amount of waste as a result of population growth is an issue that not all cities are able to respond to effectively, particularly in developing countries [1]. The pace of urbanization has outpaced the government's ability to meet the needs for waste management infrastructure [2]. Indirectly, population growth will burden urban areas and directly contribute to environmental degradation [84] and increasing waste generation [4], [5]. Indonesia is the largest waste producing country in the ASEAN region with 64 million tons/year [85] and most of them end up in landfills, where 56% of landfills in Indonesia are operated using an open dumping system [7]. The open dumping disposal pattern will have an impact on environmental pollution and health issues through

groundwater contamination and gas emissions [8]**.** As is the case in developing countries, the open dumping system is chosen due to its low investment and operational costs [1] and 80-90% of the budget is allocated for collection and transportation [9].

Reducing waste at its source is a crucial step, considering the continuously increasing amount of waste [10]. Limitations in infrastructure, human resources, and funding are obstacles for the government in addressing the problem [86]–[13], therefore, involving actors outside the government, particularly from the community, is important.[3]. Collaboration and cohesion between the government and the community play an important role in the success of waste management [14]. The success of waste management is closely related to the role of the government and the involvement of citizens in providing quality services [15]**.** Community involvement in the provision of public services is referred to as co-production in the public administration literature [87]–[18]. In public administration, co-production is seen as a strategy to address complex social issues [19],[30] and limited resources [88] and is therefore considered a means to solve problems in new and more effective ways by leveraging civil society resources [21], [22]. From a public service perspective, it has also been proven to improve the quality and efficiency of public services [23].

Co-production studies have been conducted on many public services, such as in child services [24], [89], climate services [26], [27] disaster risk management [28], [29], sanitation and clean water [90], [31], environmental pollution [32] and urban park management [33]. In waste management, co-production has also been applied, such as in waste collection [34] and waste transportation [92]–[37]. Waste management itself includes activities such as waste generation, sorting, processing at the source, collection, transfer, and disposal [38]. However, with regard to the sustainability of co-production, particularly in waste management, it has not been found, and this remains an important starting point to begin the discussion.[11][12].

In Indonesia, the complex waste management described above has been carried out by Waste Banks and Reduce, Reuse, and Recycle Waste Management site (TPS 3R).[20]. These two entities are established and run by the community as part of government programs to address waste issues through the 3R principles (Reduce, Reuse, Recycle).[16][17]. Through this program, the target is to achieve a 30% reduction and 70% handling of waste by 2025.[35][36]. This target is outlined in the national policy and strategy for household waste management as stated in Presidential Regulation No. 97 of 2017, which also applies at the regional level. According to the National Waste Management Information System (SIPSN), in 2022, Central Java Province, the largest waste producer in Indonesia, generated 5.9 million tons per year [39]. Meanwhile, Semarang is the largest waste producer among the 35 districts or cities in Central Java, generating 431,085.22 tons per year.[6].[40]. However, the numerous Waste Banks and TPS 3R in Semarang have not made a significant contribution to waste reduction. Based on the Semarang City Environmental Service (DLH), with 574 Waste Banks contributed only 1.1%, and 22 TPS 3R centers contributing 7.6% of the 60,774.89 tons per year of waste reduction efforts. As stated in the Semarang City waste management masterplan document, the low contribution is due to the large number of entities that are inactive and poor management [91]. Based on this condition, Semarang is considered an appropriate case study for this research, exploring the sustainability of co-production in waste management.[25][41].

Material and Methods

A qualitative method with a case study approach was employed in this research to explore co-production practices in waste management, focusing on specific cases with rigorous and in-depth data collection using diverse sources of information such as observations, interviews, audiovisual materials, documents, and reports (Creswell, 2013). The researcher worked with data previously collected by the researcher themselves, referred to as primary data, and data previously generated by others, referred to as secondary data, which, although gathered for different purposes, remain relevant to the research objectives [42][82].

Non-participant observation was conducted on waste management activities at five selected Waste Banks and four TPS 3R facilities. In-depth interviews were carried out with the managers of the five Waste Banks, managers of the four TPS 3R facilities, two employees DLH, and two facilitators from the Bintari Foundation. These informants were selected using purposive sampling based on the criteria of having knowledge of waste management and being directly involved in waste management activities. Lastly, documentation was conducted on both archived documents and records of field activities related to the two entities. A literature review was also performed using both national and international journal articles [83].

The collected data were analyzed through five stages: Compiling, Disassembling, Reassembling, Interpreting, and Concluding [43]. A crucial aspect of these stages is organizing the data according to the themes: regulatory framework, resources, and service complexity, followed by elaborating on relevant literature related to the concept of co-production.

Results

Case Description 1: Waste Banks

Although the community is required to participate in waste management, as outlined in various regulations from the central government to the regional level, the implementation stage remains very weak, resulting in low household participation in waste processing [44]. As is also the case in other developing countries, weak implementation can be caused by limitations in infrastructure, human resources, and funding [11], [13], [45]. Amid the Indonesian government's limitations in waste management, with households being the largest source of waste, Waste Banks have become a relevant program continuously promoted by the government as an effort to manage waste at the household and community levels. A Waste Bank is a facility for waste management based on the 3R principles, serving as an educational tool, a means to change behavior in waste management, and a practice of circular economy, managed by community groups. In general, Waste Banks are managed by women from various backgrounds, such as housewives, teachers, lecturers, civil servants, and entrepreneurs.

Based on the research findings, there are at least three main activities in a Waste Bank. First: facilitating residents to save waste, which is then converted into monetary value based on the weight and type of waste. The types of waste that can be saved include inorganic materials such as plastic, paper and cardboard, glass, and used cooking oil. After weighing and recording by the Waste Bank staff, the monetary value is then entered into a savings book, similar to a conventional bank. Despite their busy schedules, they use their free time every Sunday for 2-3 hours each month to engage in this activity without expecting compensation. The waste collected from the community is then sold to waste collectors and sent to processing industries to be turned into raw materials. Second: Education is also conducted once a month, utilizing meetings of the Family Empowerment and Welfare Organization (PKK), a community organization consisting of women aimed at improving community welfare through families. Education on environmental issues, household waste management, and the use of plastic waste for handicrafts are common topics disseminated during these meetings. Since the Waste Bank is located within the community, it can more directly reach households. Unlike the government's appeals, which are mostly in the form of suggestions, the community can see firsthand how waste management is carried out.

Finally, Waste Banks serve as a crowdsourcing tool for the government in terms of collecting data related to managed waste. Every month, they provide data to the government on the amount of waste managed, which then becomes part of the National Waste Management Information System. This data is used for monitoring and evaluating policies related to waste management achievements, which is one of the responsibilities of local governments.

In Semarang, there are currently 574 Waste Bank units spread across 16 sub-districts. Despite the large number, unfortunately, their contribution to waste reduction is still very low, amounting to only 643 tons per year, or 0.15% of the total waste generation of 431,534.65 tons per year in 2023. This is due to the fact that many Waste Banks have become inactive, as seen from the Waste Banks that have reported waste management data over the past three years (Table 1).

Table 1. Contribution of Waste Bank to Waste Reduction

Year	Number of Waste Banks	Waste managed (tons/year)
2021	104	1,374
2022	129	662
2023	87	645

Source: [46]

The government has not only provided guidance but also assistance in the form of waste weighing scales, savings books, and for a small number of Waste Banks, support in the form of buildings and three-wheeled vehicles. In addition to the government, Bintari, a local NGO implementing the Clean City Blue Ocean program funded by

USAID, has also provided guidance and assistance. While it has had a positive impact on the supported Waste Banks, unfortunately, it has not been able to reach a large scale and has operated within a limited timeframe. Based on observations and interviews, several factors have been identified that make Waste Banks vulnerable to sustainability, including: 1) Waste Banks are voluntary and social in nature, making it difficult to ensure their long-term operation. 2) The neighborhood head (RT) does not support community activities related to waste issues, leading to a lack of importance placed on waste sorting within the community. 3) The low price of waste discourages people from remaining active in sorting, as they need a place to store sorted waste before delivering it to the Waste Bank, which can make their homes appear untidy. 4) The government focuses on providing input resources for the production of services by the Waste Banks but has yet to address post-production services.

Case Description 2: TPS 3R

The operation of TPS 3R is directed towards serving a community group. The TPS 3R program aims to reduce the quantity and/or improve the characteristics of waste, which will be further processed at the Final Disposal Site (TPA) and plays a role in ensuring a reduced need for land for waste disposal sites in urban areas (TPS 3R guideline book). The process of establishing TPS 3R begins with a proposal from the local community to build TPS 3R facilities, funded by the central government, which includes a building and facilities such as waste shredding and screening machines, and waste collection vehicles. After construction is completed, the facility is handed over to the community, which then uses it to manage waste. The scope of TPS 3R activities includes serving residents by collecting waste from house to house, sorting waste, processing organic and inorganic waste to produce compost and recyclable raw materials. Finally, the residues from the waste being managed are transported by the government to the TPA for further processing.

In Semarang, there are 18 TPS 3R facilities managed by the community. However, in 2023, only 9 TPS 3R facilities were active and reported their waste management activities to DLH. These 9 active TPS 3R facilities contributed to waste collection, handling 2,933.14 tons per year, with the capacity to process 1,971.02 tons per year into recyclable raw materials and compost. This means that with a total waste generation of 431,534.65 tons per year in Semarang, TPS 3R facilities only handled 2.01% of the waste collection and processed 0.46% of the waste annually. The small contribution is due to the large number of inactive TPS 3R facilities and the low processing capacity, which is only 23% of the waste that enters the 9 active TPS 3R facilities (Table 2).

Table 2. TPS 3R contribution to waste management

Year	Number of 3R TPS	Waste Input Tons/Year	Managed Waste Ton/Tahun	Managed Waste (%)
2021	6	2,933.14	1,971.02	67
2022	9	2,396.54	1,668.95	70
2023	9	8,670.09	1,988.62	23

Source: [47]

The large number of non-operational TPS 3R facilities is due to difficulties in financing the operational activities, including waste collection, sorting, and processing. Operational financing includes worker wages, fuel costs, transportation vehicle maintenance, and electricity. According to field findings, only the Pedalangan Bersinar TPS 3R, which serves 350 customers, is able to finance its operations, allowing waste collection, sorting, and processing to take place, though not optimally. Meanwhile, other TPS 3R facilities primarily focus on providing waste collection services without further processing, resulting in a very low percentage of waste being managed. This is due to the inability to pay workers to proceed to the waste processing stage. The main income sources for TPS 3R come from local residents who pay for waste collection services, as well as the sales of sorted recyclable waste and compost. Compost, which is the product of organic waste processing, does not have a stable market, making it economically unpromising. Additionally, the government provides no incentives for operations; after the establishment of the TPS 3R, all operational costs are borne by the facility managers.

Based on the research findings, similar to the first case, sustainability remains a major issue in waste management by TPS 3R. Their involvement in waste management actually holds significant potential to contribute to waste reduction. For example, the contribution of TPS 3R Pedalangan Bersinar in waste reduction can be seen in the table below;

Table 3. TPS 3R Pedalangan Bersinar Contribution in Waste Processing Efficiency

Waste Category	Amount of Waste (Tons/Year)	Container Requirements (1 container = 2 tons)

		Year	month	week
Waste in	338.08	169	14	4
Managed waste	258.13	129	11	3
Residue	79.95	40	3	1
Efficiency gained through waste management at TPS 3R			**3 Containers/Week**	

Source: Researcher's Process, 2024

Table 3 shows that TPS 3R Pedalangan Bersinar provides an efficiency of 3 waste containers every week for the government in terms of transportation, reducing the need for 4 containers for waste transport to just one trip each week after the waste is processed by TPS 3R. However, common issues faced include: 1) The weak ability of TPS 3R to compete for or gain customers compared to existing waste collectors. These collectors operate independently and have no formal connection with the government. They provide transportation services from households to the TPS without sorting or processing the waste, thus contributing no reduction in waste. Additionally, there are no regulations governing this practice. Although efforts were made by the NGO Bintari to integrate independent waste collectors into the TPS 3R system, these attempts were unsuccessful. 2) The government focuses solely on the input, which is the provision of TPS 3R facilities, but does not give attention to the operations of TPS 3R. Furthermore, the government does not facilitate the marketing of processed products, such as compost, which could serve as a source of income for TPS 3R to support its operations.

Discussion

Based on the description of the two cases presented above, both waste banks and TPS 3R are forms of co-production. As previously defined, residents, through these two entities, participate in service production in the form of waste management services and create public value through participation and inclusivity by allowing anyone to be involved. However, the findings above indicate that the practice of co-production is vulnerable to sustainability challenges. Sustainability can be equated with Durability, which is understood as something that continues without failure [48]. In relation to sustainability in co-production, it is understood as the continuous involvement of service users in public service processes [49] as well as long-term, professional, and consistent relationships between professional actors and laypersons [93]. Thus, the sustainability of co-production relates to the ongoing co-production activities amidst challenges and constraints faced by both professionals and lay actors. Through the following discussion, the author analyzes the sustainability of co-production in waste management from the aspects of regulatory framework, resources, and service characteristics. [50].

Regulatory Framework

To sustain the practice of co-production, a regulatory framework is essential [51], [52], as such instruments are highly useful for promoting co-production [53]. In the context of waste management in Indonesia, public involvement is clearly regulated and even mandated for handling and reducing household waste. These regulations are outlined in Law of the Republic of Indonesia Number 18 of 2008 concerning waste management, Government Regulation of the Republic of Indonesia Number 81 of 2012 on household waste, and the Regional Regulation of Semarang City Number 6 of 2012 on waste management. These regulations aim to encourage residents to sort, recycle, and reuse waste so that it does not impact public health and the environment. Research findings reveal that the low public awareness of waste sorting affects the willingness to become a customer of waste banks. This aligns with previous studies showing that waste-sorting behavior in Indonesia remains low [54], making the primary challenge for waste banks the low community participation, aside from financial and product marketing issues [55]. In this regard, the biggest challenge is changing the public mindset in waste management [56]. Thus, these policies have not yet proven effective in raising public awareness, as evidenced by the continuous increase in waste generation in Semarang City each year.

In general, poor waste management is caused by poor policy implementation, low public awareness [2] and policy consistency [57]. This study reveals that active waste banks are supported by the government at the lowest levels such as the urban village administration up to neighborhood association levels, as evidence shows that successful waste management is influenced by leaders embedded within the community [58]. Raising individual or community awareness is influenced by their immediate social environment, while formal encouragement from the government is less effective [59]. Individual participation can be enhanced through empowerment and the organization of various grassroots social activities [94][95] dan and this role can be fulfilled by government representatives at the lowest levels. Although previous researchers have stated that a regulatory framework

promotes co-production practices, in this case, the regulatory framework does not provide tangible support for the sustainability of waste bank co-production.[60].

The regulations for TPS 3R are generally the same as those for Waste Banks. However, TPS 3R has additional regulations stipulated in the Regulation of the Minister of Public Works of the Republic of Indonesia Number 03/Prt/M/2013 concerning the Provision of Waste Infrastructure and Facilities for the Management of Household Waste and Waste Similar to Household Waste, as well as technical guidelines for TPS 3R. The construction of TPS 3R is funded by the central government, while the local government acts as a supervisor or facilitator of TPS 3R activities. However, these technical guidelines do not mandate local governments to provide funding for the operational activities of TPS 3R. Previous research has revealed similar findings, stating that a crucial issue in sustaining TPS 3R is operational funding, the character of leaders and managers, as well as the availability of markets for TPS 3R products [61]. It can be concluded that regulations related to TPS 3R do not bind local governments to have responsibility for ensuring the sustainability of TPS 3R through financial support.

Resource

In public management, co-production is seen as a strategy or means to solve problems more effectively through new approaches by utilizing the resources of civil society [21], [22]. This is in line with with the New Public Governance paradigm, where services are often provided through horizontal networks, with the government no longer being the primary actor, but rather the perspectives and experiences of citizens-users being involved in the service delivery process alongside public agencies that regularly produce services [62]. Resources in this context are defined as anything provided or utilized by various actors, whether individuals, organizations, or communities, to co-create or produce certain value or output [63][64]. The community, the government through the DLH, and the Bintari Foundation are key actors in this context. The resources owned by actors can include time, knowledge, skills, labor, facilities, assets, and finances (Benjamin & Brudney, 2018; Khine et al., 2021; Mangai & Vries, 2018). Through resource-sharing among these actors, services are produced to create more optimal public services [67]. Service production in co-production through Waste Banks and TPS 3R will not occur without the resource input from the actors involved. Research findings indicate that citizens, both as managers of Waste Banks and TPS 3R, possess resources such as time and labor. The distinguishing factor between these two entities is the more complex and demanding service production of TPS 3R, which involves processes from waste collection to waste processing.

The resources from the government are financial resources used for providing supporting facilities, training, and assistance. The Bintari Foundation also provides similar support to what the government offers, albeit on a smaller scale, but with the advantage of more intensive and high-quality assistance. The integration of resources from these three actors results in the capacity of Waste Banks and TPS 3R in the form of knowledge, technical, and administrative skills. However, this capacity is insufficient, as the financial capacity of these two entities remains very weak. Funding allocation is a crucial element to ensure project success [24][66], but local governments often have limited resources and finances [20] or prioritize other issues. It should be noted that the budget allocation for waste management programs in Indonesia is still minimal. The funding issue is not only experienced by the city of Semarang but, based on local government budget data (APBD) in Indonesia, the budget allocation for waste management programs in the Environmental Agency averages only 0.7% of the total budget [68].

Based on the research findings, the resources provided by the government are not sufficient to sustain these two entities. Resources in the form of equipment assistance and training are inadequate if not accompanied by a supportive environment [69]. This includes support from the lowest levels of government, the effective implementation of waste management policies, the presence of informal waste management actors such as household waste collectors, and the sale of recycled waste products. As experienced by TPS 3R, the availability of markets for TPS 3R products like compost is another issue faced [61]. In addition to financial resources, the government holds authority as an official body that can be leveraged to facilitate co-production, such as providing access, collaborating with other agencies and non-governmental actors, and coordinating efforts [70]. The government plays a central role encompassing mobilization and support [71]. It seems that the DLH has not fully exercised its authority to address the marketing of compost from TPS 3R by coordinating with other agencies, such as the parks department, to utilize the compost. This situation is not new, as government institutions are

often fragmented in terms of function, duties, and development planning (Putra et al., 2022) as well as lacking coordination among stakeholders [72].

Service Characteristics

In general, co-production provides benefits such as improving the efficiency and quality of public services [23], and fostering innovation in public services [16]. In the case of waste management, collaboration and cohesion between the government and the community play a significant role in the success of waste management [14][65]. Thus, co-production becomes highly relevant, as waste management cannot solely rely on the efforts of local governments or the private sector [73]. However, not all co-production can be successful and sustainable. Based on the findings of this study, community involvement through Waste Banks and TPS 3R is vulnerable to sustainability, as discussed in the previous subchapter. Previous researchers have revealed that community involvement will be active and continuous when there are facilities available for service production [74]. However, this does not apply to Waste Banks and TPS 3R. Although these two entities have sufficient supporting facilities, they remain vulnerable in terms of sustainability. When viewed from the level of technical difficulty and knowledge intensity, activities in these two entities are not difficult and do not require specific expertise. Specifically, TPS 3R activities require more time and labor compared to Waste Banks due to the scope of activities that range from waste collection to waste processing. Again, this does not align with previous research, which stated that citizen involvement is influenced by relatively simple service production [97], [76], that does not require a high level of specialization [77] and knowledge intensity [78]. The ease of involvement also affects citizen participation in co-production [97], [76].). Regarding the ease of involvement, it is easier for citizens to become Waste Bank managers because the waste processed is generally inorganic, which does not require complex or heavy facilities or special buildings.[96]. On the other hand, it is more difficult for citizens to become TPS 3R managers because the waste handled is diverse, including both inorganic and organic waste, requiring special equipment and buildings due to the potential impact. Apart from that, it also requires approval from the sub-district government up to the local regional government as one of the requirements for proposing the establishment.

From the aspects influencing citizens to participate and remain engaged in the framework of co-production as discussed above, we conclude that the characteristics of public services greatly impact the sustainability of co-production practices, considering the complexity of service production and its ecosystem. One aspect may be suitable for a particular type of service but may not apply to other types of services.[75]. In the context of waste management, we observe that the fulfillment of resources used in service production is not sufficient to ensure the sustainability of both Waste Banks and TPS 3R. Co-production is not only about meeting current needs but also future needs [79]. This implies that post-service production, such as the marketing of processed waste products, needs attention as these products significantly contribute to the income of both entities.[80][81]. In waste management, economic incentives for citizens are an influential factor in encouraging participation and sustained involvement [98-83]. Because the co-production concept emphasizes citizen involvement, the aspect of direct and indirect benefits obtained by citizens must be a concern in this case, the management of waste banks and TPS3R.

Conclusion

Based on the research findings and discussions presented in the previous subchapter, we conclude that, first; existing regulations are not strong enough to encourage and ensure the sustainability of co-production. Second; regarding resource sharing, government resources focus only on input for service production but overlook the needs of post-service production. Finally, co-production in public services related to waste management has specific characteristics compared to other types of public services, encompassing the service production process, post-service production, and the existence of other actors whose activities are not part of the co-production framework. Our recommendations are, first, to strengthen government commitment in implementing waste management regulations down to the lowest level of government that interacts directly with citizens. Second, government resources should also be directed toward post-service production, such as product marketing. Lastly, expand co-production by integrating other informal waste actors.

Author Contributions

IYP: Writing, compiling and designing concepts, collecting data, conducting analysis. IRP: compiling and designing concepts, Supervision. TY: compiling and designing analysis. BPP: compiling and designing methodology.

Conflict of Interest

We declare that there is no conflict of interest whatsoever related to financial and personal with other people or organizations related to the discussion of the material in the manuscript.

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