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Circular Economy Adaptation by Creating Small Business Based on Agri-Food Waste in Rural Enterprises in East Java, Indonesia

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Abstract

Indonesia's circular economy (CE) faces challenges like lack of information exchange, inadequate material flow, and inadequate regulations. Agri-food waste is crucial for implementing circular economy, but lack of government support, regulations, and infrastructure hinders its development. This research aims to develop macroeconomic strategies to strengthen agri-food waste management businesses in Kerto Rahardjo and apply circular economy approaches. The research object lies in Kerto Rahardjo, a part of the village tourism institution with the potential for agri-food waste. However, there have yet to be sustained efforts to manage this agri-food waste in this area. Thus, the circular economy is one option in Kerto Rahardjo since circular economy emphasizes closed-loop material flows and efficient resource utilization and brings economic benefits in advance. Since this program will be a pilot project, the approach method used is Strengths, Weakness, Threats, and Opportunities (SWOT) analysis and IFAS and EFAS methods. The result reveals that the total EFAS is 2,89 and the IFAS is 2,70. Kerto Rahardjo falls in quadrant 1, signifying progress in implementing a circular economy business model through agri-food waste. Implementing supportive regulations aligned with circular activities can facilitate the sustainability of business models, including empowering women, establishing formal institutions, and supporting technological innovation.

Keywords: Agri-Food Waste, Circular Economy, IFAS EFAS Methods, SWOT Analysis, Village-Owned Enterprises.

Introduction

Circular Economy (CE) is a sustainable development strategy emphasizing closed-loop material flows and efficient resource utilization through several stages, aiming to reduce conflicts between rapid economic growth and limited raw materials and energy (1). CE addresses global issues, such as environmental protection, improved health, reduced social inequalities, and enhanced social protection (2, 3). In its implementation, CE will serve as a substitute for the linear economy process that only applies three stages: produce, use, and dispose (4). Strategic issues at the global level concerning the environment, health, and socio-economic aspects are encapsulated in the 17 Sustainable Development Goals (SDGs) initiated by the United Nations (5). Achieving these goals requires integrating economic, environmental, and social dimensions within the context of sustainable development (6-8). Thus, in its implementation, Circular Economy aims to align business and the environment to work sustainably (7, 8). CE can be seen as a transformative economic system that encompasses paradigm shifts in the way society socializes and interacts with nature to prevent resource depletion and scarcity, utilize renewable natural resources, and facilitate sustainable development through implementation at the micro level (firms and consumers) (9), micro or meso level (economic actors acting through symbiotic integration (10), and macro level (cities, regions, governments) (8, 9). From the micro perspective, companies play an essential role in the transition towards CE. It aligns with their responsibility and implementation of innovative strategies to plan waste, reuse materials and products, and influence consumer awareness and demand for environmentally friendly products (11), or it can also be seen as a transition at the micro-organizational level from a linear model to a

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closed-loop or circular model (12). In supporting the Sustainable Development Goals, the Indonesian government has initiated collaborations to implement Circular Economy (CE) with entities such as the United Nations and other stakeholders. Furthermore, the government of Indonesia has encouraged all levels of governance, from regional administrations to the smallest administrative units (The head of village), to foster business innovations guided by CE principles to achieve sustainable development. These businesses take the form of Village-Owned Enterprises, focusing on harnessing the potential of their respective villages. However, this endeavour presents challenges, as not all village heads possess adequate human resources. Moreover, these challenges are compounded by the lack of harmony among stakeholders (13), financial and budgetary arrangements in the implementation of circular economy practices (14), and supply-chain issues (15).

However, given the complexity of the existing issues, the implementation of Circular Economy (CE) in Indonesia is exemplified, in part, by a specific activity within the circular economy framework: agri-food waste management. This waste is reprocessed by applying the closed-loop principle (12), thereby reducing the hazardous environmental impact of waste disposal and enabling its reuse as new products or raw materials for other products (16). The management of agri-food waste serves as a primary source for the maggot cultivation enterprise conducted by Kerto Rahardjo village-owned enterprise, representing one of the activities that embody the concept of the circular economy.

Several obstacles need to be overcome to achieve successful adoption of CE Kerto Rahardjo, such as a lack of clear business cases, administrative burdens in transitioning to circular economy business models, poor support from the supply chain, limited technical and technological knowledge, a lack of environmental culture within companies, lack of information, and insufficient support from the government and legislative bodies (17).

Based on the prior case studies conducted among SMEs, it can be concluded that despite existing policies and initiatives to enhance the circular economy (CE), several significant barriers necessitate additional policy interventions. These barriers include a lack of information exchange, inadequate material flow and transportation, and a dearth of regulations, incentives, and infrastructure required to facilitate resource exchange, which hinders the successful implementation of CE activities (18). Furthermore, the complexity of CE implementation challenges in Indonesia requires internal and external support as well as strengthened government regulations (13-15, 19). In line with UNDP in 2022 (20), there are several barriers to circular economy implementation in Indonesia, including the difficulty in changing habits or traditions, resistance to the consequences of existing regulations, lack of infrastructure, implementation failures, unclear objectives and definitions, lack of profitability in conducted activities, limited markets and funding, and insufficient information dissemination.

The concept of the CE model is aimed at optimizing resource usage and reducing waste by promoting the concept of reduce, reuse, and recycle (2, 4), agri-food waste, which includes agricultural and food waste, plays a crucial role in the implementation of the circular economy. Agri-food waste represents a potential source for creating added value in various industries, including maggot cultivation. By processing agri-food waste into maggots, waste can be transformed into high-value economic products such as animal feed or organic fertilizers. It reduces the negative environmental impact of waste, alleviates pressure on natural resources, and promotes sustainable resource utilization (15, 21).

The exemplary case study which analyzes the enterprise of *Omah Magot Warna Warni* (a maggot cultivation business owned by Mr. Kholis Akbar) located in the village of Puntir Martopuro, Purwosari, Pasuruan, East Java, the Maggot Cultivation stands based on agri-food waste (21). This small business manages organic and food waste from households, markets, or nearby food industries. The resulting maggots can be sold as nutrient-rich animal feed or used as raw material for other industries. Thus, this maggot business reduces waste in final disposal sites and the sustainable utilization of natural resources.

In its implementation, there are challenges and obstacles in running an agri-food waste-based business, such as the maggot business, which holds

significant potential for waste management and resource utilization (19). One of the challenges faced is the lack of understanding and support from the government, inadequate supporting regulations, limited infrastructure, and limited market access (19). To address these issues, a supportive macro policy strategy is needed to promote the development of agri-food waste-based businesses. Macro policies may include fiscal incentives for entrepreneurs, improvements in supporting infrastructure, the establishment of clear and supportive regulations, and educational campaigns to raise public awareness about the benefits of a circular economy and agri-food waste-based waste management (19, 22, 23). This macro policy strategy is crucial in creating a conducive and sustainable business environment, allowing small businesses to contribute maximally to implementing circular economy principles and sustainable resource management.

Despite facing numerous challenges, the potential of managing agri-food waste as the main source for maggot cultivation in Kerto Rahardjo cannot be underestimated. Unfortunately, this potential has not been fully optimized to address environmental, economic, and social issues. Therefore, adequate macro-level strategies are needed to tackle these issues. Previous research has primarily focused on feasibility studies or risk assessments rather than the sustainability of Circular Economy (CE) concepts in managing small businesses (24, 25). However, the main focus of this study is to develop macroeconomic strategies to examine the sustainability of CE adaptation and strengthen agri-food waste management businesses carried out in Kerto Rahardjo. Thus, the findings of this research are expected to provide macro-level strategies that bolster agri-food waste management businesses and apply CE approaches in Kerto Rahardjo.

Methodology

Study Area

The research area analyzed in this study is Desa Sanankerto, explicitly focusing on the Village-Owned Enterprises of Kerto Rahardjo, located in the Turen sub-district, Malang Regency. Geographically, Sanankerto Village comprises residential areas, dryland farming, smallholder plantations, and paddy fields, covering 363.00 hectares. Sanankerto Village is an autonomous village area with demographically 4085 individuals, comprising 2074 males and 2011 females. The village's strength lies in its status as a tourist destination managed by Kerto Rahardjo, specifically the Boonpring tourism site (see Figure 1), which has been nominated as one of the top 5 finalists in the RDPE Leadership Award Program at the ASEAN level. It presents a significant potential for implementing Circular Economy (CE) practices, both in managing household food waste and dealing with the food waste generated from the existing tourism activities in Sanankerto Village.

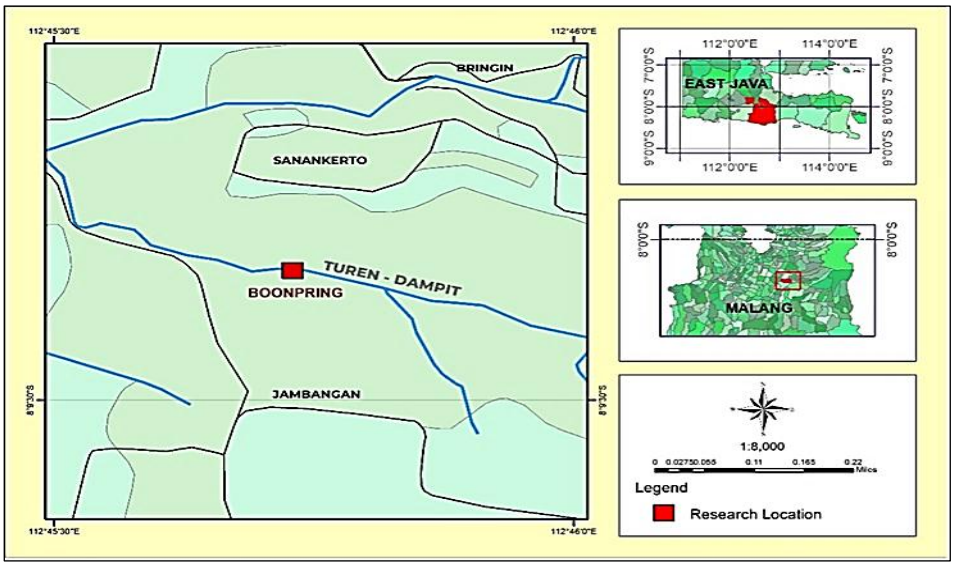

Figure 1: Study Area

Research Design

This study employs a participatory approach. It is recognized for sustainable circular economy implementation which requires active community engagement. The participatory approach is chosen due to several reasons. First, the engaging community members in identifying relevant research questions and designing methods. Participatory research enhances data quality and ensures that findings are more likely to be utilized by community to promote social action. The CE implementation requires the involvement of various stakeholders, including local communities, business, and policymakers. Participatory frameworks facilitate collaboration and co-construction of knowledge, ensuring that diverse perspective is considered and integrated into CE strategies.

Research Sampling

This research use purposive sampling targeted key informants involved in the zero waste activity at micro and meso level in the local community network of Sanankerto Village, East Java, Indonesia. The majority is the head of household who live within 1 km from Village-Owned Enterprises of Kerto Rahardjo. They were chosen due to their knowledge and experience in waste separation in meso level. The sample size is 93 households that divided into 10 teammates for focus group discussion. The average number of each groups consist of 9-10 persons with diverse representation across age, gender, education, and income levels. Additional stakeholders included village enterprise managers, local government representatives, women's group leaders, and waste collectors.

The data was collected over 3 months, from April to June 2023. In detail, the data collection using multiple participatory methods: 1) focus group discussions with 10 sessions exploring waste management practices, barriers, and willingness to participate in circular economy initiatives; 2) participatory observation; 3) community mapping; and 4) in-depth interviews with the key informants. This process is followed with a systemic validation process ensured data quality through content validity with expert panels review by circular economy researchers, practitioners, and government representatives. The face validity is conducted by pre-testing with 10 households for clarity and cultural appropriateness. The construct validity is alignment with circular economy principles and SWOT categories. Then the reliability and validation of instruments is tested using inter-rater reliability assessments from experts.

Research Methods

The analytical method employed in this paper is the SWOT analysis, in line with the literature review conducted by the scholars (26-28). Subsequently, the analysis is supplemented with the IFAS and EFAS matrices. The SWOT analysis aims to identify the strengths, weaknesses, opportunities, and threats in the agri-food waste management business as the main material for maggot cultivation in Kerto Rahardjo. Analyzing the internal and external aspects through the IFAS and EFAS matrices helps identify key factors influencing the success and failure of CE implementation in agri-food waste management. The data from this analysis provides valuable insights into design development strategies focused on efficient resource utilization and addressing potential barriers (29). Through the SWOT analysis can be identified method aspects such as innovative technology in agri-food waste management, limited access to potential markets, and government regulatory support (28, 29).

Additionally, the IFAS and EFAS matrices will depict internal factors such as expertise in agri-food waste management and existing infrastructure and external factors such as the global market, climate change, and government policies related to the environment. By understanding these conditions, specific steps can be taken to leverage internal strengths, minimize weaknesses, capitalize on existing opportunities, and address challenges that arise in CE development. With a comprehensive analytical approach, the efforts in CE development for agri-food waste management are expected to become more effective and positively impact environmental sustainability and sustainable economic growth. The IFAS EFAS strategy matrix is displayed in Figure 2 in detail.

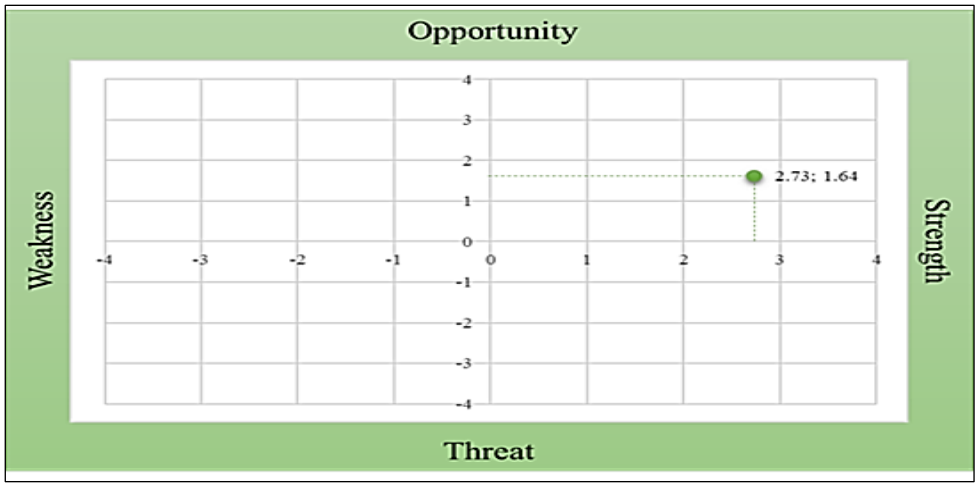

Figure 2: IFAS EFAS Strategy Matrix

The Grand Strategy Matrix presented in Figure 2 illustrates the strategic positioning framework used to determine appropriate strategies based on the intersection of internal capabilities and external conditions. This matrix comprises four quadrants that emerge from the evaluation of competitive position and market growth:

Quadrant I represents an excellent strategic position, where the households in Sanankerto Village can mostly support the main materials for village-owned enterprises. Therefore, village-owned enterprises can pursue aggressive market development, market penetration, product development, forward integration, backward integration, horizontal integration, and diversification strategies. This collaboration benefits Village-Owned Enterprises by leveraging its strong position to capitalise on market opportunities.

Quadrant II indicates strong market growth but weak competitive position. The household in Sanankerto Village supports the main materials considerately for village-owned Enterprises. However, the village-owned enterprises in this quadrant need to evaluate their current approach to the market seriously and consider strategies such as horizontal integration, market development, market penetration, or divestiture. The focus should be on improving competitive position through strategic realignment.

Quadrant III reflects that the household in Sanankerto Village has a small main materials support to village-owned enterprises. This circumstance makes village-owned enterprises compete in slow-growth industries with weak competitive positions. These village-owned enterprises must make drastic changes to avoid further decline, potentially implementing retrenchment strategies, diversification, or divestiture. Cost-reduction and asset-reduction strategies are often necessary.

Quadrant IV represents that the household in Sanankerto Village does not support enough materials for the village-owned enterprises. This condition leads the village-owned enterprises to a strong competitive position but slow industry growth. These organizations should pursue diversification into more promising growth areas while maintaining their current strengths. Viable strategies include concentric diversification, horizontal diversification, conglomerate diversification, and joint ventures.

This strategic analysis tool provides a systematic framework for village-owned enterprises to evaluate the availability of resources from the village household and their position and select appropriate strategic initiatives aligned with their competitive situation and market conditions.

Results

In this section, Table 1 shows that the average age of respondents is 41.35 years, with a maximum age of 61 and a minimum age of 20. Furthermore, the average income of respondents is Rp 2,457,188, with a maximum income of Rp 15,000,000 and a minimum income of Rp 300,000 per month. These figures indicate a significant income disparity in Sanankerto Village. This disparity is likely to impact decision-making when implementing the circular economy.

Table 1: Respondent Characteristics

Item	Total
Age	
Avg	41,35 y.o
Max	61 y.o
Min	20 y.o
Income	
Avg	Rp 2.457.188
Max	Rp 15.000.000
Min	Rp 300.000

Most of the household heads in Sanankerto Village have completed their education up to the Senior High School level, 55%, and 24% of the respondents have graduated from Elementary School. Furthermore, the distribution of respondents' gender shows that the majority are males, comprising 53% of the sample. The variations in the educational levels of the community members in Sanankerto Village are expected to impact their knowledge regarding environmental issues and the concept of the circular economy. For a more detailed breakdown of the respondents' educational levels and gender distribution, please refer to Figure 3 below.

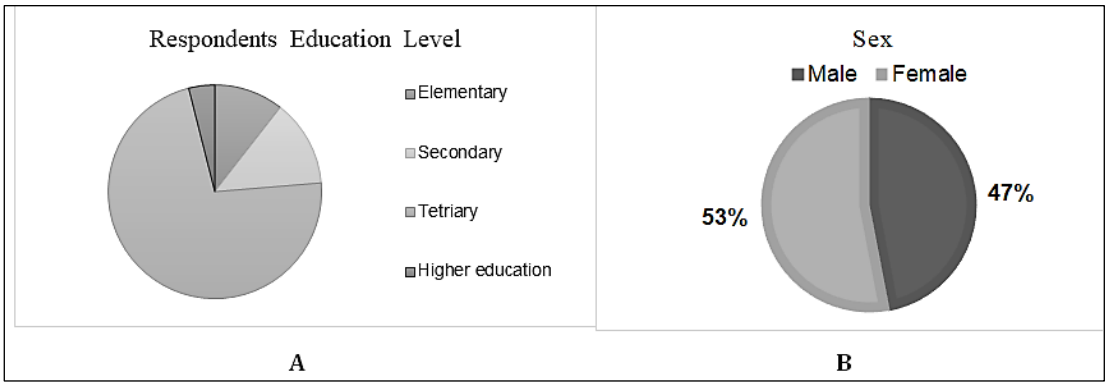

Figure 3: Respondent's Education Levels (A) and Respondent's Sex Ratios (B)

SWOT Analysis

Based on the assessment of the sustainability of the circular economy concept in maggot management, the researchers conducted a SWOT analysis to identify the factors that support maggot development (5) by comparing internal factors (Strengths - Weaknesses) with external factors (Opportunities - Threats) (30). Internal factors encompass the strengths and weaknesses in managing agri-food waste as the main source for maggot cultivation from the perspective of community readiness (31, 32). On the other hand, external factors involve the opportunities and challenges for comprehensive agri-food waste management at Kerto Rahardjo. The following is the SWOT analysis formulated by the researchers in Figure 4.

Depending on the SWOT matrix analysis, the researcher can formulate strategies to enhance the economic value of agri-food waste management as the primary source of maggot cultivation. The combination of SWOT components represents strategies that support the development of the potential for economic value enhancement in cultivation (5). It consists of Strengths-Opportunities (SO) strategies, Strengths-Threats (ST) strategies, Weakness-Opportunities (WO) strategies, and Weakness-Threats (WT) strategies, as presented in the following diagram:

Figure 4: SWOT Matrix Magot Cultivation in Kerto Rahardjo, Sanankerto Village

Table 2: SWOT Matrix Explanation Analysis

EFE/IFE	Strengths	Weaknesses
Opportunities	1. Establishment of Women empowerment group for waste management 2. Provision of starter pack facilities for maggot breeding by the government	1. Regular socialization is needed for waste management. 2. Assistance by the government through the formation of facilitators to mobilize residents. 3. Increasing the capacity of separate trash bins at residential points (ten houses for one separate trash bin) 4. Increasing the capacity of separate waste bins at the landfill site
Threats	1. Clustering of people who want to raise maggots. 2. The government provides additional facilities for raising pests for BSF (e.g., wallets)	1. Diversification of waste processing is not only for maggot feed but also for producing other commodities (e.g., compost, bio enzyme, BSF into fertilizer).

The following is an explanation of the SWOT matrix (33):

S-O Strategy: This strategy involves converting strengths into opportunities. It leverages the internal strengths of the local government to pursue external opportunities. If a region has significant weaknesses, the local government must address them to become strong. Conversely, when a region faces threats, the local government must strive to avoid them and concentrate on existing opportunities.

S-T Strategy: Through this strategy, the region must avoid or mitigate the impacts of external

threats. It does not imply that a resilient region will always encounter threats.

W-O Strategy: This strategy minimizes the local government's weaknesses by capitalizing on external opportunities.

W-T Strategy: This strategy is a defensive tactic that involves reducing internal weaknesses and avoiding threats to ensure sustainability.

The issues in the research will be analyzed using two stages, namely the SWOT method to design its development strategies (33). Further, the study will complement the IFAS and EFAS analysis methods. The final stage involves the SWOT Quadrant Positioning to determine the potential position for enhancing the economic value of agri-food waste management as the primary source for maggot cultivation in Kerto Rahardjo. Through these three analyses, it is expected that the research will be able to address the issues under investigation.

Internal Factor Analysis

Internal analysis is conducted to identify the strengths to leverage and weaknesses to anticipate (34). The IFAS matrix evaluates these factors. Determining internal strategic factors is performed before constructing the IFAS matrix. The results of the IFAS matrix provide insights into the potential position for enhancing the economic value of agri-food waste management as the main source for maggot cultivation in Kerto Rahardjo, as presented in Table 3.

Table 3: IFAS Analysis

Strength Factors	Weight	Rating	Total
The availability of sufficient waste for maggot farming.	0,2	4	0,8
The community possesses good knowledge of the types of waste.	0,08	4	0,32
The community has good knowledge of waste processing for maggot feed.	0,1	4	0,4
The community is willing to engage in maggot farming if supported by the government.	0,15	4	0,6
The role of women in household waste disposal tasks is highly dominant.	0,03	3	0,09
Strength Value	0,56		2,21
Weakness Factors	Weight	Rating	Total
The community exhibits a reluctance to engage in independent maggot farming.	0,13	1	0,13
Separate bins for wet and dry waste are absent at the Final Disposal Site (FDS).	0,08	2	0,16
Lack of waste educator personnel.	0,03	3	0,09
Limited participation from community organizations	0,05	3	0,15
Inadequate public awareness regarding waste segregation.	0,15	1	0,15
Weakness Value	0,44		0,68
Total IFAS			2,89
IFAS Difference (X)			1,53

The total weight value must be one based on the IFAS and EFAS analysis. Then, the researcher determines the ranking from one to four for each strength and weakness factor. The values one (very weak), two (not very weak), three (moderately weak), and four (very strong) are assigned. Thus, these rating values refer to the conditions of the researched subjects, which in this study are the communities of Sanankerto Village and Kerto Rahardjo. Subsequently, all scores are summed to obtain the total score for the evaluated subjects. If the score is below 1.5, it indicates that the internal state of the company or subject is weak, while a value above 2.5 indicates a strong internal position. The result of this study, with an IFAS score of 2.89, indicates that the internal position of Kerto Rahardjo for the success of maggot cultivation is strong.

External Factor Analysis

External analysis is conducted to identify potential opportunities that can be utilized and threats that need to be avoided (34). This analysis includes two external environmental factors: macro-environmental factors (political, economic, social,

and technological) and micro-environmental factors (business environment, distribution, infrastructure, human resources). The results of the external analysis are then evaluated to determine whether the current strategies have been responsive to existing opportunities and threats (28). For this purpose, the EFAS matrix is employed, as shown in Table 4.

Table 4: EFAS Result

Opportunities Factor	**Weight**	**Rating**	**Total**
Harvested rotten fruits/vegetables can increase the volume of wet waste for maggot feed.	0,15	4	0,6
Maggot cultivation business can enhance job opportunities.	0,1	3	0,3
Maggot cultivation business can empower women.	0,1	3	0,3
Sanankerto Village can serve as a model village for maggot cultivation areas.	0,1	3	0,3
Waste burning prohibition policy leads to waste segregation, where dry waste can be managed through 3R (Reduce, Reuse, Recycle) practices, while wet waste can be utilized for maggot feed.	0,15	4	0,6
Opportunities Value	0,6		2,1
Threads Factor	**Weight**	**Rating**	**Total**
Unaffordable land prices for most people make it challenging to expand maggot cultivation capacity through land extension.	0,1	1	0,1
Other regions can easily replicate the Maggot business idea.	0,2	1	0,2
Potential presence of pests that may disrupt production.	0,1	3	0,3
Threads Value	0,4		0,6
Total EFAS			2,7
EFAS difference (Y)			1,5

The EFAS calculation is done using the same method as the IFAS calculation. The findings of this research indicate that the EFAS score is 2.7, with an interpretation that the external position has significant potential to influence the community's conditions in Sanankerto Village, but this does not pose a threat to the ability of Kerto Rahardjo to capture the maggot cultivation potential. This is because the IFAS score is still higher than the EFAS score. After inputting the data into the IFAS) and EFAS matrices and assigning weights and ratings to each point, the next step undertaken by the researcher is to calculate the total scores obtained from both matrices. It is done to determine the positioning of a region or area based on the existing potentials. The intended positioning here refers to the positioning to ascertain the potential position for increasing the economic value of maggot cultivation. The following are the steps to determine the SWOT Quadrant Positioning. After discussing the IFAS and EFAS matrices, the actual position of a local government can be determined. From the IFAS matrix, the position of the X-axis can be identified using the following formula:

X = Total strength – Total weakness [1]

Meanwhile, for the EFAS matrix, the position of the Y-axis can be found with the following formula:

Y = Total opportunities – Total threats [2]

According to the IFAS and EFAS matrices, the positions of the X-axis and Y-axis can be determined, which in turn determines the SWOT quadrant position. It can be observed in Figure 5. In the figure, points X and Y are located in quadrant I, indicating that Kerto Rahardjo has strengths and opportunities to enhance the potential of maggot farming. The recommended strategy is Progressive, meaning that Kerto Rahardjo is in a prime and stable condition, allowing for continued expansion, growth, and maximum progress. These findings align with previous studies (5, 21, 30). With this progressive condition, the policy recommendation that the government of Sanankerto Village should prioritize is the SO strategy. Based on Table 2 on the above policy strategies, the SO strategy consists of forming women empowerment groups for waste processing (35-37) and enhancing stakeholder integration. The government plays an essential role (38-40). The government can support this by providing starter packs for maggot farming. The initial step is to involve women in empowering maggot cultivation, as 65% of women are involved in domestic tasks, waste disposal, and sorting. Furthermore, the government is expected to offer

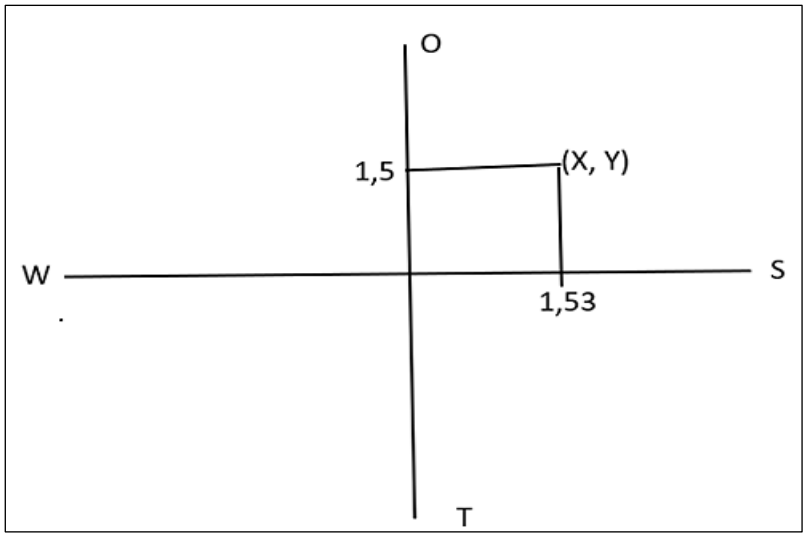

Figure 5: SWOT Positioning

starter pack facilities for maggot farming, as 73.5% of the community is willing to start independent maggot farming with government assistance.

Discussion

Based on the concept of Circular Economy (CE) that embraces an ideal vision, such as environmental effectiveness, economic system, and natural system combined positively into a single system that relies entirely on renewable energy and can recycle all materials (41), this concept becomes promising as it has attracted many business communities to participate in sustainable development efforts with a critical CE concept perspective. Sustainable development encompasses three dimensions: economic, environmental, and social. The main goal of CE is to establish a way to maintain material recycling and balance economic growth with environmental concerns (41). Moreover, implementing the circular economy in recycling industries can contribute significantly to Indonesia's GDP by 2030, amounting to US$14 billion (IDR 200 trillion) (42). The basic concept of CE involves developing recyclable products that can be used as production inputs again. Waste is separated into long-term and short-term parts, and a green energy system is utilized to reduce the consumption of non-renewable energy. In the first stage, this can be achieved through utilizing agri-food waste as a nutrient source for rearing maggots, thereby helping to reduce the amount of waste disposed of in landfills and its negative impact on the environment. Consequently, waste management is the first policy aligning with the SDGs to support CE at this stage. In this policy, the government must develop and promote sustainable and efficient organic waste management, incentivising businesses to use organic waste as input in maggot production. In the subsequent stages, namely maggot production, maggots are fed with the collected organic waste. Maggots exhibit rapid and efficient growth in converting organic waste into valuable biomass. The produced maggots can ultimately yield output suitable for various purposes (Figure 6).

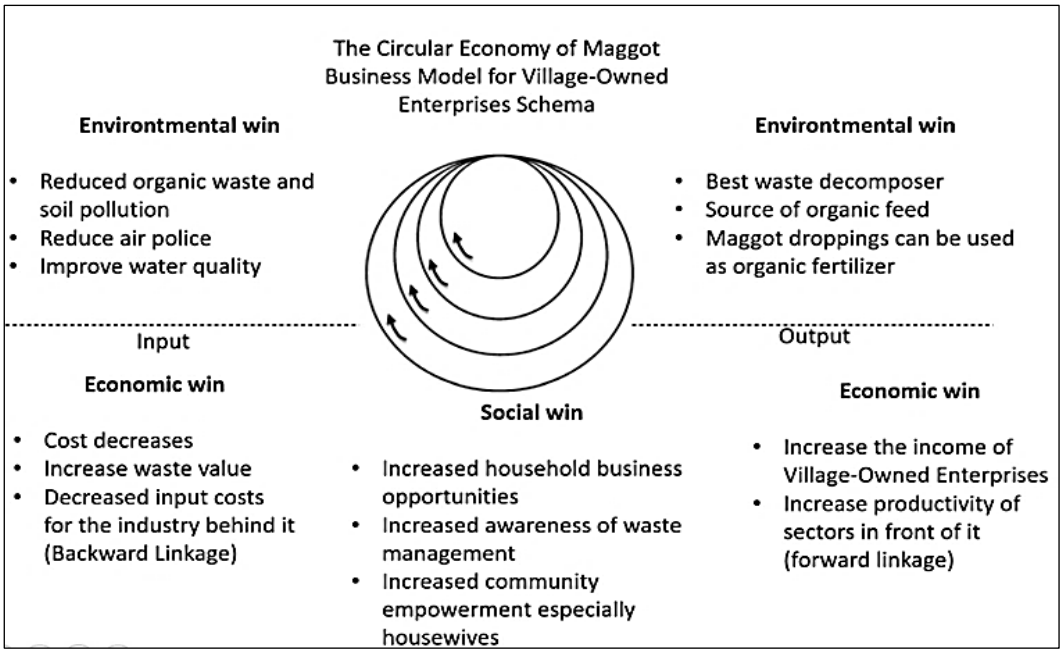

Figure 6: Circular Economy Business Scheme (Agri-food Waste Management as the Primary Source of Maggot Cultivation) in SME (18)

Figure 6 also explains the business model from organic waste utilization as input to produce maggot, which will benefit the environment by reducing organic waste and soil pollution, minimizing air pollution, and enhancing water quality. It is supported previous research (2), which indicates that CE is an appropriate waste management approach. This perception aligns with leading principles like the 3R (reduce, reuse, and recycle) for material recovery processes and reclassifying them into human-made technical materials that can be reclaimed through industrial recycling mechanisms and biological nutrients that can be reintegrated into the natural system. This statement is in line with previous researcher that CE represents an economic system with a closed-loop product life cycle, promoting concepts of reducing, reusing, and refurbishing materials in production, distribution, and consumption processes to achieve a sustainable economy, fostering environmental quality, and economic well-being, and fostering the creation of new business models with more responsible behaviour (42). The implementation of this circular economy initiative yields significant environmental advantages. Primarily, it facilitates substantial agri-food waste reduction through diversion from landfills, mitigating associated pollution including soil contamination and harmful emissions. This process embodies resource efficiency by transforming waste streams into valuable outputs like maggot-based animal feed and organic fertilizer. Consequently, reliance on conventional, resource-intensive agricultural inputs may decrease. Furthermore, the resulting organic fertilizer enhances soil fertility, promoting sustainable agricultural practices within the region and contributing to a closed-loop resource system aligned with CE principles. This approach offers a pathway to improved local environmental quality.

From a socio-economic perspective, the project offers considerable potential benefits. It establishes mechanisms for value creation by converting waste into marketable commodities, generating revenue streams for the Village-Owned Enterprise and creating local employment opportunities. This economic diversification can lead to improved livelihoods and potentially address existing income disparities. Socially, the initiative fosters community empowerment, particularly for women involved in waste management, alongside enhancing public awareness and practical skills related to sustainable practices. Successful implementation could position the village as a replicable model for sustainable development, further stimulating local pride and potential development pathways, while indirectly improving public health through reduced pollution. Waste management (biotic waste) can also reduce the demand for energy resources by using new and renewable energy sources such as biogas and fertilizers to support

soil fertility (16). Therefore, one of the policy measures that can be implemented is education and campaigns to educate the public about the benefits of this business model and the importance of utilizing organic waste.

Moreover, the government can implement regulations that encourage the processing of organic waste, such as agricultural or food waste, into value-added products, such as fertilizers or maggot feed. It will reduce the amount of waste disposed of in landfills. Not only does this benefit the environment, but it also has positive economic impacts, as it can lower costs incurred, increase the value of waste, and reduce input costs for downstream industries. Such measures can be facilitated through policy support and incentives, wherein the government provides fiscal support and incentives to promote businesses contributing to the circular economy, including maggot-based enterprises. These incentives may include tax deductions, grants, or other financial support. It is important to ensure that the legal instruments are well-prepared and act as a determinant factor in implementing a circular economy. Several studies have highlighted that the substance of laws and regulations is a critical factor and may lead to various challenges, such as legal uncertainty resulting in overlapping regulations across sectors, complexities in implementing governance procedures, and ultimately causing inefficiencies (43-45).Based on the illustration, the success of the CE has various environmental benefits, such as being an excellent waste decomposer, a source of organic feed, and utilizing maggot waste as organic fertilizer. Additionally, from an economic standpoint, CE can bring advantages by increasing the revenue of the Village-Owned Enterprise and enhancing the productivity of *Ketor* (agricultural production) in the area. The positive impact of CE also extends to the social aspects, as this business opportunity can improve household entrepreneurship and contribute to household welfare. Implementation of CE in Kerto Rahardjo, not only brings environmental and economic benefits but also social support from the community, especially the active involvement of women. In their daily lives, women play an important role in the collection, sorting, and management of household waste, which is the main ingredient in maggot cultivation. Through this participation, they are not only positioned as beneficiaries but appear as the driving force in the circular economy value chain. The various trainings, facilities, and mentoring they receive have helped build their self-confidence, improve their independent business capabilities, and strengthen their position in the community. More than that, women's involvement in CE activities is a real step towards creating gender equality in village development. CE-based activities open a fair space for women to be involved in decision-making and productive economic activities, marking a shift in roles from being confined to the domestic sphere to becoming active contributors to sustainable economic development. Collaboration within CE working groups also strengthens social relations and builds solidarity among residents, creating a spirit of togetherness in advancing the village. Beyond that, it fosters public awareness of waste management and empowers society, particularly women in households. Certain policies can be adopted and implemented to achieve the Sustainable Development Goals (SDGs), such as fostering partnerships between the public and private sectors. However, successfully implementing a circular economy within the community requires commitment from consumers and policymakers (16). As the primary stakeholder, the government can collaborate with the private sector to develop programs and projects that promote circular economy models, including the maggot business model. These collaborations may encompass joint research, community empowerment, and technological advancements. Moreover, to support market development and distribution networks, the government can facilitate market development for products derived from the Maggot business model, creating efficient distribution channels to ensure easy consumer access. Additionally, to encourage the sustainability of household businesses and maintain societal awareness, recognition and awards can be granted to those who sustainably implement the circular economy of the maggot business model and contribute to achieving the SDGs. The model that has been developed combines a circular economy approach with local community empowerment, particularly by involving women in the collection and management of waste. Therefore, their involvement in this scheme not only strengthens the social dimension of the circular economy but

also reflects a participatory approach that is contextual to the local community's social structure. The integration of this gender-based participatory model has proven effective in supporting sustainable small business development, as it fosters a sense of collective ownership and responsibility. In addition to improving the efficiency of waste collection and sorting, women's participation also amplifies the economic and social impact at the household level. This approach thus contributes not only to environmental sustainability but also to reinforcing the social pillar of circular economy implementation in rural areas. Furthermore, its success highlights the potential for replicating the model in other village contexts with similar characteristics, such as strong household roles held by women, active support from local governments support through training and funding, close proximity between residences, and strong community social bonds.

Conclusion

The circular economy can be seen as a transformative economic system that encompasses paradigm shifts in the way society socializes and interacts with nature to prevent resource depletion and scarcity, utilize renewable natural resources, and facilitate sustainable development through implementation at the micro level. The main focus of this study is to develop macroeconomic strategies to examine the sustainability of CE adaptation and strengthen agri-food waste management businesses carried out in Kerto Rahardjo. Kerto Rahardjo is one institution facing numerous challenges, the potential of managing agri-food waste as the primary source for maggot cultivation. SWOT, EFAS, and IFAS analyses were conducted to address the research objectives. An IFAS score of 2.89 indicates a robust internal position Kerto Rahardjo for successful maggot cultivation. Meanwhile, the findings of this research reveal an EFAS score of 2.7, suggesting that the external position significantly influences the conditions Kerto Rahardjo. However, this does not threaten Kerto Rahardjo's capacity to capitalize on the maggot cultivation potential, as the IFAS score remains higher than the EFAS score. Using SWOT quadrant analysis, points X and Y are positioned in quadrant I, signifying that Kerto Rahardjo possesses strengths and opportunities to enhance maggot farming potential further. The recommended strategy is Progressive, denoting that Kerto Rahardjo is in a favorable and stable state, enabling ongoing expansion, growth, and maximal advancement. Within this progressive context, the recommended policy for the Kerto Rahardjo to prioritize is the SO strategy.

Limitation

The findings of this study, centred in a single village enterprise in East Java, poses limited generalizability. Its reliance in qualitative SWOT, IFAS, EFAS analyses, derived from participatory methods over a three-month period. It provides strategic direction rather than quantitatively measured outcomes. Consequently, the analysis highlights potential benefits and necessary conditions for success, such as government support and community engagement. However, it does not evaluate the actual impact or financial viability post-implementation. Therefore, in the future research the empirical validation is needed.

Abbreviations

3R: Reduce, Reuse, Recycle, CE: Circular Economy, EFAS: External Factor Analysis Summary, GDP: Gross Domestic Product, IFAS: Internal Factor Analysis Summary, SDGs: Sustainable Development Goals, SMEs: Small Medium Enterprises, S-O: Strengths-Opportunities, S-T: Strengths-Threats, SWOT: Strengths, Weakness, Opportunities, Threats, UNDP: United Nations of Development Program, W-O: Weakness-Opportunities, W-T: Weaknesses-Threats.

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Author Contributions

Hadi Sumarsono: Conceptualization, study design, primarily responsible for data collection, field research at BumDes Kerto Rahardjo, Vika Annisa Qurrata: Assistance with study design, methodology, Ermita Yusida: analysis, interpretation of the data, Putra Hilmi Prayitno: supervision of field data collection, literature

review, Farida Rahmawati: interpretation of results, drafting of the initial manuscript, Febry Wijayanti: language correction, critical revision of the manuscript for important intellectual content, Jumadil Saputra: interpretation of results, final approval of the version to be published.

Conflict of Interest

The authors have carefully considered any actual or apparent conflicts of interest to declare.

Ethics Approval

This research has obtained ethical approval from the Ethic Committee of Universitas Negeri Malang.

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References

1. Kara S, Li W, Sadjadi N. Circular Economy. Procedia CIRP. 2022;105:2-6.
2. Ghisellini P, Cialani C, Ulgiati S. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. J Clean Prod. 2016;114:11-32.
3. Schöggl JP, Stumpf L, Baumgartner RJ. The narrative of sustainability and circular economy - A longitudinal review of two decades of research. Resour Conserv Recycl. 2020; 163: 105073.
4. Hannon E, Kuhlmann M. Developing Products for a Circular Economy. McKinsey & Company; 2016. https://www.mckinsey.com/business-functions/sustainability/our-insights/developing-products-for-a-circular-economy
5. Barragán- Fonseca KB, Muñoz- Ramírez AP, Mc Cune N, Pineda J, Dicke M, Cortés J. Fighting rural poverty in Colombia: circular agriculture by using insects as feed in aquaculture. Wageningen: Wageningen Livestock Research; 2022. Report No.: 1353. www.wageningenUR.nl/livestockresearch
6. Mebratu D. Sustainability and sustainable development: historical and conceptual review. Environ Impact Assess Rev. 1998;18(6):493-520.
7. Murray A, Skene K, Haynes K. The circular economy: an interdisciplinary exploration of the concept and application in a global context. J Bus Ethics. 2017;140:369-80.
8. Barreiro-Gen M, Lozano R. How circular is the circular economy? Analysing the implementation of circular economy in organisations. Bus Strategy Environ. 2020;29(8):3484-94.
9. Yong R. The circular economy in China. J Mater Cycles Waste Manag. 2007;9:121-9.
10. Yuan Z, Bi J, Moriguichi Y. The circular economy: A new development strategy in China. J Ind Ecol. 2006;10(1-2):4-8.
11. Veleva V, Bodkin G. Corporate-entrepreneur collaborations to advance a circular economy. J Clean Prod. 2018;188:20-37.
12. Howard MB, Webster K. Circular business advantage: what organisations need to know. Circulate;2018. https://www.researchgate.net/publication/328531132_Circular_business_advantage_what_organisations_need_to_know
13. Nurdiana J, Franco-Garcia ML, Heldeweg MA. How shall we start? The importance of general indices for circular cities in Indonesia. Sustainability. 2021;13(20):11168.
14. Waluyo, Kharisma DB. Circular economy and food waste problems in Indonesia: Lessons from the policies of leading Countries. Cogent Soc Sci. 2023;9(1):2202938.
15. Suhartini S, Rohma NA, Elviliana, Santoso I, Paul R, Listiningrum P, et al. Food waste to bioenergy: current status and role in future circular economies in Indonesia. Energy Ecol Environ. 2022;7(4):297-339.
16. Purwanti I. Konsep Dan Implementasi Ekonomi Sirkular Dalam Program Bank Sampah Studi Kasus: Keberlanjutan Bank Sampah Tanjung. AmaNu: Jurnal Manajemen Dan Ekonomi. 2021;4(1):89-98.
17. Rizos V, Behrens A, Van der Gaast W, Hofman E, Ioannou A, Kafyeke T, et al. Implementation of circular economy business models by small and medium-sized enterprises (SMEs): Barriers and enablers. Sustainability. 2016;8(11):1212.
18. Korhonen J, Honkasalo A, Seppälä J. Circular economy: the concept and its limitations. Ecol Econ. 2018;143:37-46.
19. Nattassha R, Handayati Y, Simatupang TM, Siallagan M. Understanding circular economy implementation in the agri-food supply chain: the case of an Indonesian organic fertiliser producer. Agric Food Secur. 2020;9:1-16.
20. UNDP. Modul Ajar 4: Memperkuat Implementasi Ekonomi Sirkular di Indonesia. 2022. https://www.undp.org/sites/g/files/zskgke326/files/2023-07/modul_4_ce.pdf
21. Prihartini E, Hendrarini H, Indah PN. Financial Analysis of Business Feasibility and Maggot Black Souldier Fly Cultivation Development Strategy. J Econ Finance Manag Stud. 2022;5(1):20-9.
22. Bongers A, Casas P. The circular economy and the optimal recycling rate: A macroeconomic approach. Ecol Econ. 2022; 199:107504.
23. Boonman H, Verstraten P, van der Weijde AH. Macroeconomic and environmental impacts of circular economy innovation policy. Sustain Prod Consum. 2023;35:216-28.
24. Ddiba D, Andersson K, Rosemarin A, Schulte-Herbrüggen H, Dickin S. The circular economy potential of urban organic waste streams in low-and middle-income countries. Environ Dev Sustain. 2022;24(1):1116-44.
25. Al Mashaqbeh S, Munive-Hernandez JE. Risk Analysis under a Circular Economy Context Using a Systems Thinking Approach. Sustainability. 2023;15(5):4141
26. Sinaga MLA, Madaningrum FR, Siagian RT, Samadikun BP, Sumiyati S. Study on waste bank capacity building plan and development strategies in Semarang City. In: *IOP* Conference Series: Earth and

Environmental Science. IOP Publishing; 2021:012082. https://doi.org/10.1088/1755-1315/896/1/012082
27. Srivastava PK, Kulshreshtha K, Mohanty CS, Pushpangadan P, Singh A. Stakeholder-based SWOT analysis for successful municipal solid waste management in Lucknow, India. Waste Manag. 2005;25(5):531-7.
28. Yuan H. A SWOT analysis of successful construction waste management. J Clean Prod. 2013;39:1-8.
29. Paes LAB, Bezerra BS, Deus RM, Jugend D, Battistelle RAG. Organic solid waste management in a circular economy perspective--A systematic review and SWOT analysis. J Clean Prod. 2019; 239:118086.
30. Yulian L, Yandri P. The Organizational Development Strategy of a Waste Bank at Bank Sampah Regensi by Using SWOT Analysis. Jurnal Mandiri: Ilmu Pengetahuan, Seni, dan Teknologi. 2022;6(2):59-74.
31. Suhelpi, Saragih L. Analisa Pemasaran Bank Sampah Dengan Pendekatan Analisis Swot Studi Kasus Pada Bank Sampah Dinas Lingkungan Hidup Kota Pematangsiantar. Manajemen: Jurnal Ekonomi. 2020;2(2):92-102.
32. Wahyuni E. Perencanaan Strategis Sistem Dan Teknologi Informasi Pada Bank Sampah Kota: Studi Kasus Bank Sampah Kota Prabumulih. *J* Pengembangan Sist Infdan Inform. 2020;1(1). https://doi.org/10.47747/jpsii.v1i1.64
33. Helms MM, Nixon J. Exploring SWOT analysis--where are we now? A review of academic research from the last decade. J Strategy Manag. 2010;3(3):215-51.
34. Bantacut T. Indonesian staple food adaptations for sustainability in continuously changing climates. J Environ Earth Sci. 2014;4(21):202-16.
35. Asteria D. Women's environmental literacy in managing waste for environmental sustainability of the city. Development. 2019;62(1):178-85.
36. Asteria D, Herdiansyah H. The role of women in managing waste banks and supporting waste management in local communities. Community Dev J. 2022;57(1):74-92.
37. Hadiningrat G. Women's role in food waste management in Indonesia (study case in Bandung). In: The 1st International Scientific Meeting on Public Health and Sports (ISMOPHS 2019). Atlantis Press; 2020:31-5.
38. Dagilienė L, Varaniūtė V, Bruneckienė J. Local governments' perspective on implementing the circular economy: A framework for future solutions. J Clean Prod. 2021;310:127340.
39. Mattera M, López-Portillo MDP, Gava L. Government's role in ensuring sustainable waste management: Valencia's case from the triple bottom line perspective. In: E3S Web of Conferences. EDP Sciences; 2020:06001.https://doi.org/10.1051/e3sconf/202016706001
40. Ten Wolde A. Briefing: Governments as drivers for a circular economy. In: Proceedings of the Institution of Civil Engineers-Waste and Resource Management. Thomas Telford Ltd; 2016:149-50. https://doi.org/10.1680/jwarm.16.00017
41. Winans K, Kendall A, Deng H. The history and current applications of the circular economy concept. Renew Sustain Energy Rev. 2017;68:825-33.
42. Kirchherr J, Reike D, Hekkert M. Conceptualizing the circular economy: An analysis of 114 definitions. Resour Conserv Recycl. 2017;127:221-32.
43. Kirchherr J, Piscicelli L, Bour R, Kostense-Smit E, Muller J, Huibrechtse-Truijens A, et al. Barriers to the circular economy: Evidence from the European Union (EU). Ecol Econ. 2018;150:264-72.
44. Mahpour A. Prioritizing barriers to adopt circular economy in construction and demolition waste management. Resour Conserv Recycl. 2018; 134: 216-27.
45. Smol M, Marcinek P, Koda E. Drivers and barriers for a circular economy (CE) implementation in Poland---A case study of raw materials recovery sector. Energies. 2021;14(8):2219.