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Article *in* Circular Economy and Sustainability · March 2024

DOI: 10.1007/s43615-024-00358-6

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ORIGINAL PAPER

Unleashing the Sustainable Transition of Circular Economy: A Case Study of SMEs Tapioca Industry in Lampung, Indonesia

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Received: 30 September 2023 / Accepted: 19 February 2024

Abstract
The circular economy paradigm has gained significant attention for its alignment with sustainability principles and its potential to decouple economic growth from resource depletion and environmental degradation. There is a lack of comprehensive assessment frameworks for circular economy implementation. Through a mixed-methods approach, including literature review, surveys, key informant interviews, and analysis of social, economic, and environmental benefits, this paper aims to Integrate a monitoring framework for implementing Circular Economy (CE) in Small and Medium-sized Enterprises (SMEs) within the tapioca industry. This study proposes a comprehensive framework called " RESOLVE-SF by integrating the Resolve model, which focuses on generating resolutions or solutions to problems, with an analysis of social, economic, and environmental benefits and SDGs achievement. However, the research highlights a social deficiency in terms of gender equality, revealing a gender wage gap and limited opportunities for women for particular job roles within the industry. This research provides valuable insights for policymakers, industry stakeholders, and researchers seeking to promote sustainable practices and achieve a more circular and resilient economy. These include advocating the transition to renewable energy sources, implementing efficient water management practices, addressing gender inequality and social inclusion, and aligning policy frameworks with the SDGs.

Keywords Circular Economy · SMEs · Tapioca Industry · And Sustainability

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Published online: 01 March 2024

Introduction

The concept of a circular economy (CE) has gained considerable attention in both scientific and professional communities due to its contribution to sustainable development [1–4]. A similar study acknowledged that circular economy and sustainability are interconnected [5]. The circular economy offers a promising approach to achieving sustainability through addressing the challenges of resource scarcity and environmental impact [6–8]. However, it is essential to differentiate between different types of circular economy approaches and evaluate their respective contributions to sustainability[6].

The promising system emerged as an alternative to the traditional production model. CE aims to decouple economic growth from resource depletion and environmental degradation [9]. The essence of the circular economy lies in its transformative Industrial principles aimed at regenerating resources [10], reducing waste, and more efficient use of resources [11–14], maximizing resource value like advocating the closing the loop [15–17], and extending product life [18–20]. Furthermore, this paradigm shifts toward changing the way products are manufactured and consumed [21], and engaging supply chain stakeholders for sustainable resource use [22, 23].

Additionally, digital technologies (DTs) facilitate upscaling of the CE by enabling the generation and handling of data and information necessary for circular business models and the intricate needs of circular supply chains[24]. DTs support CE practices for SMEs, initially for production efficiency, later facilitating a more circular transition [25]. Within the broader transformational concept of CE, researchers label CE as a catalyst [26],a driver [5], a new paradigm[2], and an Innovative business model [27] for sustainable development.

It is necessary to elaborate on the CE principles as a set of strategies) to underpin the transition to sustainable development through five main fields of action: Take, make, distribute, use, and recover [28]. The other authors introduce Environmental Strategies (Rs) to promote circularity as the "reduce, reuse, and recycle" (3Rs) [29]; or the Reduce, Reuse, Recycle and Recover (4Rs) [30] approach. Another study proposes 5R principles (Rethink, Reduce, Reuse, Repair, Recycle) for Circulatory strategies [17, 31, 32]. Additionally, the research presents a comprehensive set of objectives encompassing more nuanced R-typologies: Remanufacture, Refurbish, Repair, and Reuse, while also highlighting the importance of Refuse, Rethink, and Reduce as additional targets.[33]; Similarly, in the context of water management, the author develops nine strategies—Rethink, Avoid, Reduce, Replace, Reuse, Recycle, Cascade, Store, and Recover [34].

Understanding the concept of sustainability plays a crucial role in ensuring that the implementation of CE aligns with sustainability goals. Barbier uses both terms sustainable economic development and sustainable development inconsistently [35]. Later, the phrase SD gained popularity following the release of the Brundtland Commission Report by the World Commission on Environment and Development in 1987 [36]. Interestingly, the competing language of Sustainability versus Sustainable development are often so intertwined in many literatures and their general understanding within the framework of the Three Pillars [37]. However, varying viewpoints can create fragmented definitions, often prioritizing specific agendas over a comprehensive understanding [38].

This paper presents a comprehensive definition of sustainability as the harmonious integration of economic prosperity, social inclusivity, and environmental resilience, ensuring the well-being of present and future generations [2, 2, 17]. Moreover, this

paper highlights the close relationship between sustainability and sustainable development and emphasizes that varying viewpoints can create fragmented definitions, often prioritizing specific agendas over a comprehensive understanding [38].

However, for this research, the term of sustainability is used. Sustainability is generally described as a state of equilibrium or synergy among economic, environmental, and social aspects. Furthermore, the terms "Sustainability" and "Triple bottom line" (TBL) are frequently used interchangeably as well in many sources. The TBL concept is often referred to as the 3Ps (people, planet, and profits).

The TBL conception in Fig. 1, commonly represented by three intersecting circles with overall sustainability at the centre, has become a 'common view'[39–41] and intergenerational dimension[42]. The study uses a similar Venn diagram to describe the notion of sustainable economic development that appears to have been first presented by Barbier [38].

While the principles of CE have gained acknowledgment, their practical application in small and medium-sized enterprises (SMEs) within the tapioca industry has not been thoroughly investigated. One interesting aspect of CE that failed to address is providing evidence of the successful implementation of CE within the small-medium (SMEs) industry based on commodities particularly focusing on cassava. The involvement of SMEs in the transition towards a CE is still uncommon [43]. Cassava (Manihot esculenta) is one of the important agricultural products globally consumed as a staple food for 1 billion people [44]; as a raw material in the food industry, animal feed, bio-energy, and industries such as alcohol, citric acid, clothing, and chemicals [45]. Cassava production in Lampung predominantly is processed into tapioca flour [46]. The tapioca industry produces tapioca flour as the primary product. Also, it produces solid waste (skin, elot, and cassava fibre) and solid and liquid waste as a potential alternative energy source. For instance, to produce one ton of tapioca flour, approximately 16 cubic meters of water are needed, and a significant quantity of wastewater generated amounts to 17 cubic meters [47] which contributes to greenhouse gas emissions, and high organic pollutants [48].

To gain a comprehensive understanding of the practical applicability and effectiveness of circularity in SMEs within the tapioca industry, further research and empirical studies are needed. These studies can provide insights into the specific challenges and opportunities faced by SMEs in adopting CE practices, as well as the potential economic, environmental, and social impacts that can be achieved within this context.

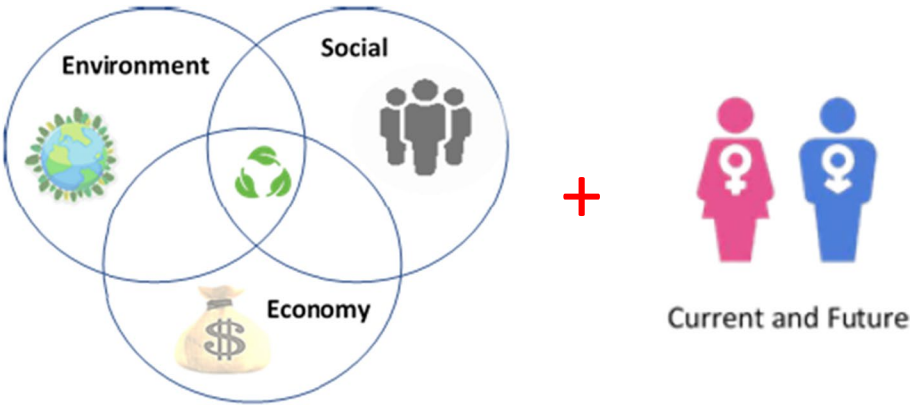

Fig. 1 TBL Diagram for sustainability Illustration, adapted from [37, 38]

Key challenges in the tapioca industry include water consumption, energy usage, waste generation, and the environmental impact of pesticide and fertilizer use. Grey water footprint issues have gained more attention over the past decade in the industry. The United Nations estimates that globally more than 80 percent of wastewater worldwide is released into the environment without any treatment [49]. However, wastewater can be an alternative water solution to the coming era of water scarcity [50–52]; a sustainable source of energy, nutrients, organic matter, and other useful by-products[53]. fertilizer (digestate) [54], biogas production and minimize slurry and waste [55, 56].

However, despite the growing interest in CE implementation within the tapioca industry, there is currently a lack of comprehensive assessment frameworks specifically tailored to small and medium-sized enterprises (SMEs) operating in this sector [2, 57].

The existing frameworks for circular strategies do not encompass a comprehensive view of both the present state and potential future innovations [58]. Consequently, there is a significant research gap regarding the practical applicability and effectiveness of CE initiatives in SMEs within the tapioca industry. Further research and empirical studies are essential to fill this gap, enabling a comprehensive understanding of circularity in this specific context and providing valuable insights for informed decision-making processes.

Therefore, this study aims to address the lack of comprehensive assessment frameworks for monitoring CE implementation in SMEs [13, 14, 27], against TBL with a specific focus on the tapioca industry. The findings of this research will provide industry-specific insights, recommendations, and contribute to an improvement in terms of greater environmental friendliness and an impact on responsibility consumption and production (Goal 12).

Incorporating a comprehensive assessment framework on CE implementation in SMEs in the tapioca industry, this paper, then, aims to address the following research questions: What challenges contribute to the limited adoption of the circular economy by SMEs in the tapioca industry? and what strategies can be offered to tackle those challenges from SDGs and responsible business perspectives.

The structure of this paper is as follows: It begins with an introduction, followed by the presentation of the research methodology in Section "Materials and Methods". The results are then presented in Section "Results", which is further divided into two subsections. In Section "Circular economy implementation in SMEs within the tapioca industry", the discussion takes place, where the outcomes are analyzed, and prospects are suggested to enhance the Sustainability of CE in the SMEs tapioca industry. Finally, the paper concludes by summarizing the findings and drawing overall conclusions in Section "Identification of Environmental, Economic, and Social Benefits".

Materials and Methods

The study employs a mixed-methods approach that involves both qualitative and quantitative approaches. It also consists of a comprehensive literature review, conducting interviews with key informants from various roles and positions. The key informants include the business owner of a large tapioca industry in Lampung Tengah Regency, the production manager responsible for wastewater management and converting biogas to electricity grid in Tulang Bawang Regency, the manager of the environmental office of Lampung Province, DTs Expert, workers, and local communities. The purpose of these interviews is to compare business processes and circular economy practices, particularly in the context of managing wastewater in the tapioca industry.

Two approaches were employed to select samples. Initially, a case study method was utilized to choose a particular SME in the tapioca industry that implements circular economy principles and provides convenient access to crucial information. This study method is used extensively among qualitative social studies [59, 60]. However, a case study provides conceptual insights [61] and; profound understanding of the phenomenon[60, 62, 63].

In the first phase, questionnaires were specifically focused on economic and environmental dimensions, while the social dimension was addressed through a separate worker and local communities' questionnaire. Subsequently, a purposive sampling of workers was conducted in the second phase. However, during the interviews, only 47 out of 50 workers were available for participation. This sample size is greater than minimum sample size requirement of 44 using Slovin's formula considering margin of error 0.05.

These survey findings were essential in exploring circular business models within the tapioca industry. Circular business models' classifications are presented by the ReSOLVE approach developed by the Ellen MacArthur foundation[64]. It lists six business actions that can help enterprises switch to CE, namely: regenerate, share optimize, loop, virtualize and exchange. [27, 65–67]; ReSOLVE framework as an analytical principle, exploring developable business models, and combining them into tapioca industry circular business model. This model was developed from Chyhjiun Jewelry's circular business model [68]. Combining the Resolve model adapted from [27, 64, 68] with the analysis of social, economic, environmental, and SDGs achievement could result in a comprehensive decision-making framework or model that considers multiple factors and their impacts. Such a model could be referred to as a "Sustainable and SDGs Achievement Framework " or "ReSOLVE-SF " for short. This business framework would incorporate the Resolve model's ability to generate resolutions or solutions to problems, while also considering the broader implications and benefits for society, the economy, and the environment and sustainable achievement.

The diagram in Fig. 2 illustrates the current state of embracing circular economy principles, encompassing the identification of its concepts with ReSOLVE model and the ongoing transition's impacts on both social economy and the environment, aligning with

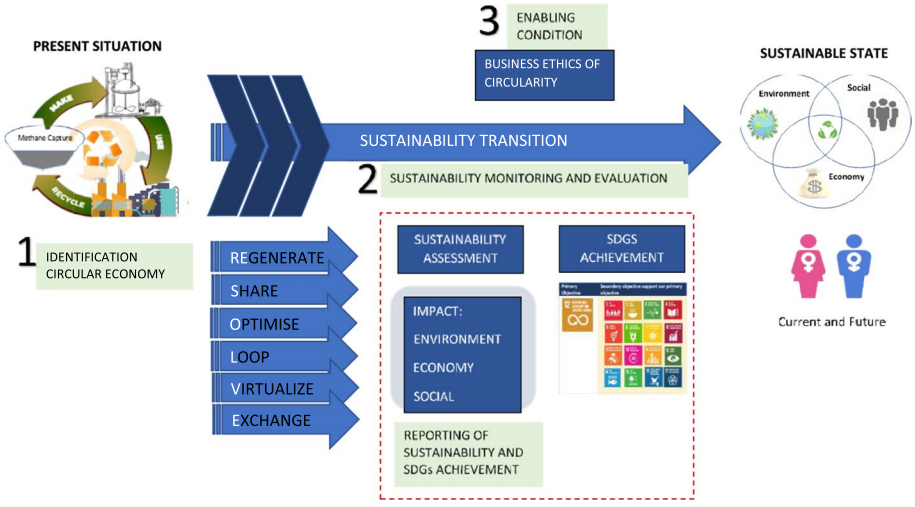

Fig. 2 Sustainable Business Model Framework of SMEs Tapioca Industry adapted from [23, 69]

Sustainable Development Goals (SDGs). It envisions a future vision where this transition leads to a balanced system that depicts the intersection between profit, people, and the planet, and intergenerational relations which are fundamental elements for achieving a sustainable state.

The Resolve-RF model identifies circular economy principles and takes these characteristics into a model of the tapioca industry. The benefit model focuses on assessing the environmental, economic, and social benefits associated with SDGs Achievement. The relationship between the characteristics and the corresponding benefits is considered and integrated into the overall analysis. In addition, it is crucial to incorporate CE ethics into the tapioca industry to drive sustainability[70]. An ethical circular economy strategy harnesses human and cultural interactions to drive circular economies and rebalance resource flows. This approach maximizes the circular economy concept, effectively striving for a sustainable and prosperous future for the world and its inhabitants [70].

By integrating CE ethics into the tapioca industry, stakeholders can ensure that their practices align with principles of sustainability, conservation, and responsible resource management. This not only benefits the environment but also contributes to the long-term viability and success of the industry. The current limitations of this model prevent it from fully capturing and quantifying the monitoring value, as it can only provide a general indication of the potential impacts and lacks precision. However, there is potential for future expansion and development to enhance its capabilities and transform it into a more precise tool for monitoring.

Results

This section presents the results of the implementation process of the business framework in our case study within the tapioca industry. The subsequent sections will delve into a detailed explanation of this implementation process, providing a comprehensive understanding of how the framework was applied and its specific outcomes within the context of the tapioca industry.

Circular economy implementation in SMEs within the tapioca industry

The application of the CE concept to waste and by-products of the tapioca flour production process can lead to sustainable development, through minimizing waste and providing economy, social and environmental benefits. Sustainability features enable not only the energy consumption of properties, but also the reporting of emissions, waste, and fuel consumption reliably as illustrated in Fig. 3.

The tapioca factory under observation had an actual production capacity of approximately 25 tons of cassava per day, resulting in 125 cubic meters of wastewater. To minimize the environmental impact and harness its potential value, the wastewater underwent treatment in a biogas reactor. This treatment process aimed to reduce the environmental load while simultaneously generating biogas which refer as creative use of wastewater. Using biogas obtained from wastewater offers several advantages, including the production of heat and electricity, as well as valuable by-products like nutrients and organic matter that contribute to the circular economy [71]. Moreover, burning biogas will prevent the release of 1.26 million tons of CO2 equivalent annually in Lampung province (as a case study), resulting in significant environmental benefits [72].

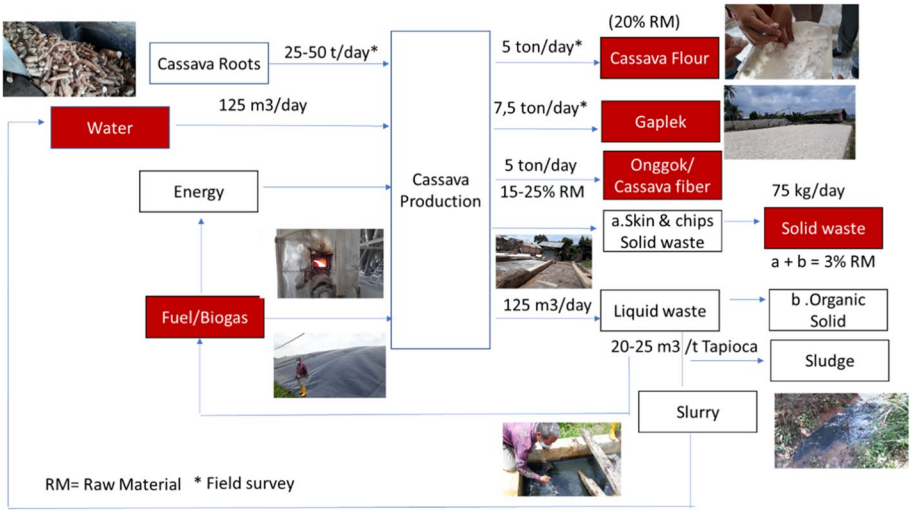

Fig. 3 Creative use of wastewater at Tapioca Industry in Lampung Tengah regency (a case study)

During our interview with a key informant, it was revealed that the biogas process implemented in wastewater management successfully reduced the chemical oxygen demand (COD)from around 15,000 mg/L to 200 mg/L, and increase degree of acidity or alkalinity to around 7. This demonstrates its effectiveness in treating the wastewater. This reduction is particularly significant when compared to the wastewater quality standard for tapioca wastewater in Indonesia, which is set at 300 mg/L[73].

However, based on our fieldwork and interview with a key informant in Tulang Bawang Regency, it is confirmed that the processing of 850 tons of cassava daily can indeed generate 2×1.5 MW of electricity for the national grid. The COD (Chemical Oxygen Demand) of tapioca, while lower compared to POME, can be further enhanced by using retention ponds and incorporating cassava pulp to increase COD. It's important to note that the investment cost for this initiative is substantial. the estimated approximately 3.53 kilowatts (kW) of electricity could be generated by a ton of cassava processed within the tapioca industry based on the given scenario involving larger-scale operations. For SMEs, the use of gensets can be a practical and cost-effective solution to minimize expenses associated with electricity generation.

The study findings indicate that the tapioca industry exhibits significant and purposeful attributes of a CE by effectively utilizing the wastewater. [54, 74]. Specifically, the wastewater was transformed into biogas, and the remaining waste materials, such as sludge and slurry, were utilized as fertilizer and reused water. The first stage in the processing of tapioca flour is peeling the skin of cassava. This process aims at removing the cassava skin and the rotten parts of the cassava. This process will produce a lot of solid waste from cassava peels.

The next step is the washing process. In our study, the peeled cassava undergoes a three-phase washing process with water to eliminate soil remnants and other impurities. This method involves a continuous flow of water and results in wastewater in large quantities. Wastewater from the pond the anaerobic digester used referred to recycled water as water input in the first phase washing process (only 10 percent of the total water intake uses recycled water). It is then continued with the shredded Process. Before grated, clean cassava is added

in a chopper machine to cut into smaller sizes (1–2 cm). Small pieces of cassava formed, then accommodated and inserted into a grated machine. This process aims to separate starch and cassava pulp (onggok). In this process, water is added to extract starch and drain the cassava fibre. This water slurry flows into a tub and the slurry was sieved. The starch liquid that has been extracted will go through the settling process into a tub, while the cassava fibre. is separated. The extraction process/dewatering will generally produce sediment that settles in the settling basin.

Subsequently, the sediment which is tapioca starch, undergoes a drying process. Drying is a process of evaporating water content to obtain dry tapioca flour. Biogas, generated in an anaerobic digester pond from the wastewater produced during tapioca flour production, is utilized to dry starch in a flash dryer. The heat from the combustion of biogas was transferred to the dryer with thermal oil and a heat exchange system and directly contact hot air with the material to be dried, and suspend the material to be dried (flour) in the airflow, and quickly removed water from the small particles which are easy to dehydrate and the powdery wet material. The dried tapioca is then packed with a size of 50 kg. Finally, the industry uses the rest of the liquid from the pond that would be used to irrigate the avocado and orange plantation. From the process, we derived a conclusion that the practice of CE is confirmed in the SMEs tapioca industry.

The implementation of circular economy business models in the tapioca industry in Table 1 describes a multifaceted commitment to sustainability, spanning environmental, economic, and social dimensions. By regenerating tapioca waste into biogas for renewable energy, the industry significantly contributes to reducing greenhouse gas emissions, aligning with the global goals of SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). This not only bears environmental benefits but also translates into economic gains by mitigating CO2 emissions and lowering energy costs.

Moreover, initiatives such as sharing repair expertise, utilizing by-products in other industries, and optimizing water resources demonstrate a holistic approach. These strategies not only enhance resource efficiency and reduce environmental impact (SDG 17: Partnerships for the Goals) but also generate additional income, fostering economic sustainability.

In parallel, efforts like treating wastewater for reuse address SDG 6 (Clean Water and Sanitation) while simultaneously lowering energy costs, contributing to economic efficiency. Overall, the tapioca industry's circular economy practices underscore a harmonious integration of environmental stewardship, economic prosperity, and social responsibility, aligning with a spectrum of Sustainable Development Goals.

In this research, it is important to acknowledge that the social impact cannot be solely viewed through the lens of circular principles in isolation, but rather it should be assessed holistically within the entire business context. However, the focus of this particular study is limited to analyzing the human rights aspect, specifically examining the wage gap. Also, it has a constraint in terms of the enabling conditions being examined. Specifically, the analysis is restricted to the realm of environmental ethics and should be assessed holistically within the entire business context.

Identification of Environmental, Economic, and Social Benefits

Environmental Benefits

The tapioca industry's adoption of anaerobic digestion technology and utilization of biogas as a heat source for drying tapioca and re-use of wastewater in the initial washing process of cassava offer environmental advantages.

Tabel 1 Resolve-RF Framework for Tapioca Industry case study

No	Circular Economy Business Model	Implementation in SMEs Tapioca Industry	Environmental Benefits	Economic Benefits	Social Benefits	SDGs Achievement		Enabler Condition (CE- ethics)
1	Regenerate[54]	Using tapioca waste for biogas production extracts and creating renewable energy and reducing environmental impact during waste disposal by providing an alternative heating source	Reduces greenhouse gas emissions and mitigates climate change	Each ton of CO2 emissions mitigated can be transformed into a value of $10 and lower energy cost	It adheres to the methodological framework outlined in the SETAC 2009 [75] and [76] but focuses on five specific social aspects: Access to Material, Fair Salary, Working Hours, Equal Opportunities/ Discrimination, and Social Benefits/ Social Security; In this industry, it is important to clarify that the research does not identify the presence of child labour and forced labour practices.-	SDG 7: Affordable and Clean Energy, SDG 13: Climate Action	SDG 12: Responsible production and consumption	Maximizing biogas for both heating and the generation of electricity for internal use
		Reuse sediment and digester liquid in agriculture, like irrigating avocado and orange plantations, to recover valuable resources from production	Reduces the need for synthetic fertilizers and promotes sustainable farming practices	Generates additional income from selling recovered resources		SDG 15: Life on Land		
2	Share	The tapioca industry shares repair expertise with fellow businesses, offering guidance and best practices for effective machinery maintenance. Additionally, tapioca by-products like cassava skin, elot, and onggok are used by other industries, like food or animal feed	Enhances resource efficiency and reduces environmental impact through collaborative efforts	Additional income for repairing and maintaining machinery of other tapioca businesses		SDG 17: Partnerships for the Goals		
3	Optimize; [13, 14]	Utilizing treated wastewater as a substitute for freshwater	Reduces water, energy consumption, and reliance on non-renewable energy sources	Lowers energy costs		SDG 6: Clean Water and Sanitation, SDG 7: Affordable and Clean Energy		The business owner's goal is to maximize the reuse of water obtained from methane capture
4	Loop	Using biogas, produced from tapioca waste through anaerobic digestion, as a source of renewable energy for heating in the tapioca flour production process	Reduces landfill waste and environmental pollution	Reduces raw material costs and waste disposal expenses				
5	Virtualize	The examined company doesn't use social media for interaction. Yet, embracing technology and innovation enables businesses to provide virtual options like digital platforms or online services, offering similar functions	Lower costs by enhancing efficiency in supply and distribution processes	-		SDGs 9: Industry, Innovation, and Infrastructure		During the interview, the DTs expert suggested utilizing a collaborative platform with blockchains
6	Exchange	Reusing wastewater can help maintain a sustainable water balance and alleviate the strain on local water sources		Reduce water cost		SDG 6: Clean Water and Sanitation		

One of the benefits is the reduction of methane emissions through anaerobic digestion. By capturing methane, a potent greenhouse gas, during the decomposition of organic waste, the industry effectively mitigates its CO2 equivalent emissions, playing a crucial role in combatting climate change[8, 77]. Additionally, the substitution of coal with biogas as a heat source in the drying process of tapioca showcases the industry's commitment to align itself with sustainable energy systems. This shift promotes a cleaner and more environmentally friendly energy future, acting for a more sustainable and resilient society.

Furthermore, reusing wastewater during the initial washing process of cassava is not only benefitting the environment but also providing an additional environmental advantage within the context of the tapioca industry case study. Approximately 10 percent of the wastewater from Anaerobic Digestion in the form of slurry from methane capture is recycled and utilized in the cassava initial washing phase. This practice contributes to water conservation by reducing the industry's overall water consumption. By incorporating recycled water, the tapioca industry optimizes resource efficiency and minimizes reliance on freshwater sources. Furthermore, reusing wastewater decreases the volume of discharged water, thereby mitigating potential environmental impacts associated with water discharge. Through this CE practice, the industry enhances its sustainable water management efforts, promotes efficient resource utilization, and contributes to improved water quality throughout the production process.

Economic Benefits

The tapioca industry's commitment to CE practices does not promote environmental sustainability per se but also brings about tangible economic advantages, including cost savings in energy and water, revenue generation opportunities, and the potential for carbon credit trading. By substituting coal with biogas, the industry achieves cost savings through reduced energy expenses. This transition to a more sustainable energy source not only contributes to the industry's profitability but also reduces carbon emissions. As defined by the Paris Agreement, each ton of CO2 emissions mitigated can be transformed into a value of $10, further enhancing the economic benefits of carbon action mitigation. Conversely, the government enforces a charge of $2.10 for each ton of CO2 equivalent.

Additionally, the optimization of water resources improves resource efficiency and contributes to overall cost reduction. Moreover, the adoption of sustainable practices aligns with the increasing demand for environmentally friendly products, enabling the industry to tap into new market segments and attract environmentally conscious consumers. Furthermore, the industry may become eligible for funding and grants provided by governments and organizations to support businesses that adopt sustainable practices, further enhancing its economic viability.

Lack of Social Initiative in the Circular Economy

While the CE has gained attention as a sustainable approach, it often overlooks the social dimensions. the limited consideration of social aspects within the CE framework can hinder the achievement of social benefits. It has been acknowledged that social factors receive insufficient attention in CE research[78]. In this research, several notable findings highlight significant social issues within the tapioca industry.

One of our significant findings related to social aspects is the existence of the gender wage gap. Our research revealed that job roles in the CE industry of tapioca are segregated

based on societal perceptions of gender capabilities. In the tapioca industry, women are often excluded from operating the drying machines, as these roles are considered more suitable for men. This gender-based job assignment leads to a significant wage disparity, particularly in lower-paid positions, as women have limited access to higher-paying roles (Bandeira et al., 2021).

Another notable finding in this research is that a significant majority of employees in the industry are earning incomes below the minimum regional wage. Additionally, it was observed that the industry lacks social security measures, specifically, it was observed that the business owners do not contribute to the Social Security Insurance agent/ BPJS, which provides social security coverage for workers in Indonesia. Despite this, the business owners express their commitment to covering any expenses related to work-related accidents or injuries.

Uncovering a crucial finding, this research highlights the tapioca industry's limited access to local materials, notably cassava. Merely 30 percent of the cassava utilized is locally sourced, with the majority acquired from different regencies to meet industry capacity requirements. This reliance on external sources prompts considerations about its impact on local farmers and the broader regional economy.

All the findings are in line with the CE has been criticized for its limited attention to the social dimension, focusing primarily on environmental benefits. This "social deficiency" can be compensated by integrating strategies that prioritize social considerations, but neglecting the interconnectedness of environmental and social issues undermines the CE's value [79]. Similarly, Murray et al. [80] highlight that the CE primarily focuses on environmental benefits, overlooking the social dimension. They argue that the CE does not give equal weight to social considerations compared to sustainability, which encompasses environmental, social, and economic aspects. Limited resources, including financial and human resources, can hinder SMEs from investing in social initiatives and generating positive social benefits. Additionally, their smaller customer bases and market reach limit their ability to create significant social impact. Cost constraints and the prioritization of immediate financial needs can further limit resources available for social programs [15].

By acknowledging the importance of social issues, we can enhance the overall sustainability and inclusivity of the CE, fostering a more just and equitable society. Incorporating a comprehensive understanding of social issues enables the CE to become a more inclusive and equitable proposition aligned with the principles of sustainability and social justice.

The Accelerating Role of SDG 12 in the transition towards sustainability

To attain the Sustainable Development Goals (SDGs), the adoption of circular economy practices is crucial. There are strong correlations between a CE implementation and SDGs[81, 82]. Moreover, studies have shown that CE practices can directly contribute to the attainment of various Sustainable Development Goals (SDGs) [83, 84]. Broadly speaking, CE practices are strongly linked to SDG 12 (responsible consumption and production), SDG 6 (clean water and sanitation), SDG 7 (clean and accessible energy), SDG 13 (climate change), and SDG 15 (life on earth) [84–87].

This research underscores the primary role of Sustainable Consumption and Production (SCP) in fostering CE principles. SCP is essential for a circular economy by meeting needs while minimizing resource use and waste [88]. Similarly, This aligns with the principles of sustainable production and consumption, promoting a CE approach where resources are conserved and utilized efficiently [89–91]. Achieving SCP will contribute significantly to the

achievement of almost all of the SDGs, directly or indirectly. The author illustrates SCP as a crosscutting enabler for the achievement of numerous SDGs [88].

Our research reveals significant contributions the SDG 12 aligning with several Sustainable Development Goals (SDGs). The reuse of water from biogas slurry primarily aligns with SDG 6 (Clean Water and Sanitation), by replacing coal with biogas, thereby supporting the targets of SDG 7. Additionally, by reusing water from biogas slurry, can contribute to SDGs by reducing water wastage and minimizing the demand for freshwater resources. Furthermore, this transition also relates to SDG 13, which emphasizes the urgent need for climate action. The burning of fossil fuels, such as coal, is a significant contributor to greenhouse gas emissions and exacerbates climate change. Lastly, by actively sharing its repair and maintenance expertise with other tapioca businesses, the tapioca industry contributes to the promotion of SDG 17: Partnerships for the Goals.

Additionally, collaboration between manufacturers and suppliers enhances sustainable practices, supporting SDG 12. Companies actively seek collaboration, often with suppliers, to gain access to green technology, materials, or knowledge within their network [92, 93]. Mina et al. highlight the importance of selecting circular suppliers for circular Supply Chains [94]. The interviews with key informants in the tapioca industry revealed a relationship between the industry and its supply chain. Specifically, the practice of providing credit to farmers was identified as a strategy to secure a consistent supply of cassava for the industry. This relationship may not directly pertain to Sustainable Consumption and Production (SCP) practices, but it is reflected in a parallel context in the nucleus-plasma model observed in the palm oil industry.

The nucleus-plasma model in the palm oil industry establishes collaboration between large plantation companies (nucleus) and smallholder farmers (plasma) [95]. While the nucleus provides resources and oversees processing, ensuring smallholders' access to markets, challenges such as power imbalances necessitate careful implementation. Government subsidies are recommended to address high-interest credit issues [96]. Sustainable practices in palm oil, despite revenue increases, may lead to a loss of net income for smallholders, emphasizing the need to improve economic performance for certified oil palm smallholders [97]. Addressing power imbalances in the nucleus-plasma model, the article on contract farming in Uganda offers a transformative solution for smallholders.

The article introduces a transformative perspective for smallholders [98]). Joining organic coffee smallholder contract farming programs often results in positive income effects, yet integration into value chains may expose smallholders to market volatility. Temporary support packages become crucial, aligning with business-led food security policies that require aid for higher transaction costs. In the context of cassava certification, support mechanisms for poor producers should encompass training, inputs, and credit, particularly emphasizing the cultivation of higher-value crops [99]. Overall, sustained industry-supplier and customer partnerships drive SDG 12. Moreover, understanding both the synergistic and trade-off relationships among the different goals is crucial for effective goal planning and implementation. It helps identify areas where collaborative efforts can lead to win–win outcomes, as well as areas where trade-offs need to be managed to minimize negative impacts and maximize progress toward the desired outcomes of all goals. offering opportunities for transformative and sustainable solutions in agricultural systems.

Empowering Circular Economy with CE Ethics Practices

Our sample industry continues to drive innovation in its CE business, focusing on several key areas. Firstly, the Company of the case study has committed to adopt the sustainability

and responsible business practices. When it comes to whitening tapioca flour, the Company has made a conscious decision to eliminate the use of chemicals. As a consequence of their dedication, the colour of the tapioca flour they produce is slightly brown instead of white. By ensuring that their products are environmentally friendly and pose no harm to consumers, aligns with the principles of minimizing harm to the environment and promoting ecological balance.

Secondly, in addition, to promote responsible production and consumption behaviour, currently, respondents use 10 percent of water reuse. By utilizing this captured liquid as a reusable water source within their operations, they reduce their reliance on freshwater while mitigating environmental impact and conserve this valuable resource. This commitment to water reuse aligns with ethical principles of resource efficiency, sustainability, and environmental responsibility.

Thirdly, the business owner has set a clear goal to transition entirely to local cassava within the next five years. by sourcing materials locally, they reduce transportation-related carbon emissions and support the local economy. our respondent is using 30 percent local cassava for their tapioca flour production. By exclusively sourcing local cassava, they aim to reduce the environmental impact associated with long-distance transportation and support local farmers. This strategic decision aligns with their overall commitment to sustainability and showcases their proactive approach to promoting a more sustainable and resilient supply chain.

Corporations should not only focus on understanding, believing, planning, and acquiring skills of Environmental Ethical Commitment (EEC), but also recognize the importance of identifying environmental strategies, comprehending the decision-making process, understanding the roles of organizational participants, and promoting the integration of humanity and ecology. These factors collectively contribute to advancing long-term ecological and organizational sustainable development The Company of the case study has a strong commitment to sustainability and responsible business practices aligns closely with ISO 14001[100]. By combining these various ethical perspectives, the business exemplifies a holistic approach to business ethics within the context of circularity. Their practices not only promote sustainable resource management but also prioritize employee welfare, community engagement, and environmental stewardship.

Discussion

The implementation of the CE in SMEs within the tapioca industry offers various benefits, including economic, social, and environmental advantages. By effectively utilizing wastewater through treatment in a biogas reactor, the tapioca industry demonstrates circularity by transforming wastewater into biogas. The industry also optimizes resource efficiency by recycling water from the anaerobic digester for the initial washing process, reducing water consumption and costs. Moreover, the adoption of CE practices, such as remanufacturing, value recovery, collaborative networks, resource optimization, waste minimization, and closing the loop, generates revenue, creates employment opportunities, enhances agricultural productivity, and reduces environmental impact.

However, it is important to acknowledge that there is a lack of attention to the social dimension within the CE framework. This deficiency becomes evident when considering the existence of the gender wage gap and the limited opportunities for women in certain job roles within the industry. Addressing this social issue requires promoting gender equality

and inclusivity in job opportunities, challenging stereotypes, and fostering a more equitable workforce. By integrating strategies that prioritize social considerations, the industry can enhance its overall sustainability and contribute to a more just and inclusive society.

However, discussing corporate social and environmental responsibility and sustainability, it is imperative to acknowledge the fundamental role of ethics. The concept of ethics cannot be disregarded or separated from these practices. Ethics provides tools that can help people seeking sustainability to adjudicate conflicts, set priorities, and seek consensus or compromise [101].

Implementing the principles of Circularity's Ethical Code in tapioca industry SMEs can have several positive impacts. Firstly, by promoting honesty, transparency, and fair competition, SMEs can establish trust among stakeholders, including suppliers, customers, and employees. This can lead to stronger business relationships and increased credibility within the industry. Ensuring the quality of offered products and services aligns with Circularity's code can help SMEs meet customer expectations and enhance customer satisfaction.

This study showed the importance of business ethics and social responsibility as for organizational growth and success. Specifically, they consider business ethics to lead to positive employee, customers and as well community relations[102]. Furthermore, they perceive better corporate image/reputation, greater customer loyalty; and a strong and healthier community as benefits that can inure to the benefit of corporations that are socially responsible [103]

Ethics of sustainability can drive SMEs to promote the use of natural resources and compliance with environmental regulations contributes to sustainability in the tapioca industry. SMEs can implement eco-friendly practices such as efficient resource management, waste reduction, and the use of renewable energy sources. This does not only reduce the environmental impact but the approach also enhances the company's reputation as an environmentally conscious business. Ethics can take precedence in the internal journey of a company as the foundation of essential moral values, leading to a subsequent dedication to sustainability. This commitment to current and future generations can manifest through specific actions focused on meeting the needs and expectations of key stakeholders, particularly in terms of social and environmental responsibility[104].

Identifying Research Gaps and Future Research Directions

While integrating strategies that prioritize social considerations can compensate for this "social deficiency," neglecting the interconnectedness between environmental and social issues diminishes the value of the CE. By addressing these social concerns, we can improve the overall sustainability and inclusivity of the CE, leading to a fairer and more equitable society. Additionally, the assessment of sustainability indicators and the evaluation of stakeholder engagement strategies, warrant further investigation. Therefore, it is crucial to encourage future research that evaluates the social benefit dimensions of the CE and business ethics. By filling this research gap, we can gain a comprehensive understanding of the CE impact on society, ensuring that sustainability initiatives are not only environmentally and economically sound but also socially just and ethically responsible.

Collaboration with industry associations, government bodies, and non-governmental organizations can also play a significant role in addressing the gender wage gap and promoting gender equality in the tapioca industry. These partnerships can provide support, resources, and guidance on implementing gender-sensitive policies and practices. Future research efforts could also focus on the development and evaluation of circular business

models specifically tailored for SMEs in the tapioca industry. Exploring the potential of emerging technologies, such as blockchain and the Internet of Things (IoT), in optimizing resource flows and enhancing traceability can further contribute to advancing circularity in the industry.

Additionally, it is important to internalize ethics of sustainability, ensuring that these principles become ingrained within the organization's culture, values, and day-to-day operations. This creates a solid foundation for long-term success while also contributing positively to society and the environment.

Implications for Practitioners and Policymakers

For business owners, evaluating the social benefits for the local community and workers is essential. They should assess the impact of their operations on SDGs, particularly SDG 6 and SDG 12, by considering water usage, waste management, and responsible consumption and production. Additionally, transitioning to biogas as an alternative to coal can positively contribute to SDGs 7 and 13, addressing affordable and clean energy and climate action. By integrating these considerations into their practices, businesses can enhance their reputation, attract environmentally conscious consumers, and improve community relations. Policymakers play a vital role in creating a supportive environment by developing policies and incentives that encourage businesses to adopt sustainable practices aligned with the SDGs, fostering collaboration for mutual benefits.

For policymakers, the analysis highlights the need for supportive regulatory frameworks and policies that promote circularity in the tapioca industry. Policymakers can utilize the research findings to develop targeted initiatives, financial incentives, and policy instruments that encourage SMEs to adopt CE practices. Collaboration between policymakers and industry stakeholders is essential for the effective implementation of these policies and for creating an enabling environment for circularity in the tapioca industry.

Conclusion

In conclusion, this paper has explored the application of CE practices in SMEs within the tapioca industry. The main findings of this study reveal the potential of CE strategies to drive sustainable development, minimize waste generation, and provide economic, social, and environmental benefits. By implementing waste minimization, resource optimization, value recovery, and closing the loop, the tapioca industry can enhance its sustainability performance and competitiveness.

To promote CE practices in SMEs within the tapioca industry, it is recommended to establish industry-wide platforms and knowledge-sharing networks to engage stakeholders involving employees, customers, suppliers, and local communities in your environmental initiatives. These platforms can facilitate collaboration, knowledge exchange, asymmetric information sharing, and best practices dissemination among stakeholders in the supply chain management network. Furthermore, policymakers need to develop supportive regulatory frameworks and financial mechanisms that encourage SMEs to adopt CE strategies. These measures can include tax incentives, grants, and subsidies for investments in circular infrastructure, research and development, and employee training.

Additionally, policy support and financial incentives are crucial for SMEs to overcome initial investment barriers and fully embrace circular practices [105] Mindset shift and

employee training should also be addressed to facilitate the transition to circular systems. Through collective efforts, we can create a more sustainable future, not only for the tapioca industry but also for other sectors facing similar challenges in adopting CE principles.

This comprehensive approach to sustainable practices exemplifies circular business ethics and responsibility that can serve as a model for other business owners. Through SMEs' actions, they inspire others to adopt similar strategies, fostering a more sustainable and ethical business landscape. By incorporating innovations in their CE practices, the company as shown in a case study contributes to safe products, local material use, and water reuse showcasing a holistic approach to business ethics for circularity. The Company encompasses ethical considerations related to sustainability, resource efficiency, and environmental responsibility, demonstrating its commitment to both business success and ethical leadership in the CE. The business places a strong emphasis on using local materials in their production processes.

Declarations

Competing Interest This study is supported by the ASEAN Centre for Sustainable Development Studies and Dialogue (ACSDSD), College of Management, Mahidol University, Thailand.

References

1. Sinha E (2022) Circular economy—A way forward to Sustainable Development: Identifying Conceptual Overlaps and Contingency Factors at the Microlevel. Sustain Dev 30:771–783. https://doi.org/10.1002/sd.2263
2. Geissdoerfer M, Savaget P, Bocken NMP, Hultink EJ (2017) The Circular Economy – A new sustainability paradigm? J Clean Prod 143:757–768. https://doi.org/10.1016/j.jclepro.2016.12.048
3. Korhonen J, Honkasalo A, Seppälä J (2018) Circular Economy: The Concept and its Limitations. Ecol Econ 143:37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041
4. Sauvé S, Bernard S, Sloan P (2016) Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environ Dev 17:48–56. https://doi.org/10.1016/j.envdev.2015.09.002
5. Barros MV, Salvador R, do Prado GF et al (2021) Circular economy as a driver to sustainable businesses. Clean Environ Syst 2:100006. https://doi.org/10.1016/j.cesys.2020.100006
6. Velenturf APM, Purnell P (2021) Principles for a sustainable circular economy. Sustain Prod Consum 27:1437–1457. https://doi.org/10.1016/j.spc.2021.02.018
7. Akinade OO, Oyedele LO (2019) Integrating construction supply chains within a circular economy: An ANFIS-based waste analytics system (A-WAS). J Clean Prod 229:863–873. https://doi.org/10.1016/j.jclepro.2019.04.232
8. Ellen Macarthur Foundation (2019) Completing the picture: How the circular economy tackles climate change. https://ellenmacarthurfoundation.org/completing-the-picture. Accessed 1 Oct 2021
9. Schulte A, Maga D, Thonemann N (2021) Combining life cycle assessment and circularity assessment to analyze environmental impacts of the medical remanufacturing of electrophysiology catheters. Sustain 13:1–23. https://doi.org/10.3390/su13020898
10. Merli R, Preziosi M, Acampora A (2017) How do scholars approach the circular economy? A systematic literature review https://doi.org/10.1016/j.jclepro.2017.12.112
11. Bassi F, Guidolin M (2021) Resource Efficiency and Circular Economy in European SMEs: Investigating the Role of Green Jobs and Skills https://doi.org/10.3390/su132112136
12. Moraga G, Huysveld S, De Meester S, Dewulf J (2022) Resource efficiency indicators to assess circular economy strategies: A case study on four materials in laptops. Resour Conserv Recycl 178 https://doi.org/10.1016/j.resconrec.2021.106099
13. Pieroni MPP, McAloone TC, Pigosso DCA (2019) Business model innovation for circular economy and sustainability: A review of approaches. J Clean Prod 215:198–216. https://doi.org/10.1016/j.jclepro.2019.01.036

14. Ferasso M, Beliaeva T, Kraus S et al (2020) Circular economy business models: The state of research and avenues ahead. Bus Strateg Environ 29:3006–3024. https://doi.org/10.1002/bse.2554
15. Bocken NMP, de Pauw I, Bakker C, van der Grinten B (2016) Product design and business model strategies for a circular economy. J Ind Prod Eng 33:308–320. https://doi.org/10.1080/21681015.2016.1172124
16. Babbitt CW, Gaustad G, Fisher A et al (2018) Closing the loop on circular economy research: From theory to practice and back again. Resour Conserv Recycl 135:1–2. https://doi.org/10.1016/j.resconrec.2018.04.012
17. Chang Y-T, Tserng HP, Chou C-M (2021) The Key Strategies to Implement Circular Economy in Building Projects-A Case Study of Taiwan. 13:754 https://doi.org/10.3390/su13020754
18. Mesa J, González-Quiroga A, Maury H (2020) Developing an indicator for material selection based on durability and environmental footprint: A Circular Economy perspective. Resour Conserv Recycl 160:104887. https://doi.org/10.1016/j.resconrec.2020.104887
19. Fontana A, Barni A, Leone D et al (2021) Circular Economy Strategies for Equipment Lifetime Extension: A Systematic Review. Sustainability 13:1117. https://doi.org/10.3390/su13031117
20. Rogers HA, Deutz P, Ramos TB (2021) Repairing the circular economy: Public perception and participant profile of the repair economy in Hull. UK Resour Conserv Recycl 168:105447. https://doi.org/10.1016/j.resconrec.2021.105447
21. Zerbino P (2022) How to manage the Circular Economy Rebound effect: A proposal for contingency-based guidelines. J Clean Prod 378:134584. https://doi.org/10.1016/j.jclepro.2022.134584
22. Kujala J, Heikkinen A, Blomberg A (2023) Stakeholder Engagement in a Sustainable Circular Economy. Springer International Publishing, Cham
23. Kirchherr J, Yang N-HN, Schulze-Spüntrup F et al (2023) Conceptualizing the Circular Economy (Revisited): An Analysis of 221 Definitions. Resour Conserv Recycl 194:107001. https://doi.org/10.1016/j.resconrec.2023.107001
24. Strée B, Witomski A, Stein N, et al (2020) Digital circular economy a cornerstone of a sustainable European industry transformation Digital circular economy as a cornerstone of a sustainable European industry transformation
25. Neri A, Negri M, Cagno E et al (2023) The role of digital technologies in supporting the implementation of circular economy practices by industrial small and medium enterprises. Bus Strateg Environ 32:4693–4718. https://doi.org/10.1002/bse.3388
26. Valverde J-M, Avilés-Palacios C (2021) Circular Economy as a Catalyst for Progress towards the Sustainable Development Goals: A Positive Relationship between Two Self-Sufficient Variables. Sustainability 13:12652. https://doi.org/10.3390/su132212652
27. Brendzel-Skowera K (2021) Circular Economy Business Models in the SME Sector. Sustainability 13:7059. https://doi.org/10.3390/su13137059
28. Prieto-Sandoval V, Ormazabal M, Jaca C, Viles E (2018) Key elements in assessing circular economy implementation in small and medium-sized enterprises. Bus Strateg Environ 27:1525–1534. https://doi.org/10.1002/bse.2210
29. Ioannidis A, Chalvatzis KJ, Leonidou LC, Feng Z (2021) Applying the reduce, reuse, and recycle principle in the hospitality sector: Its antecedents and performance implications. Bus Strateg Environ 30:3394–3410. https://doi.org/10.1002/bse.2809
30. Kalmykova Y, Sadagopan M, Rosado L (2018) Circular economy - From review of theories and practices to development of implementation tools. Resour Conserv Recycl 135:190–201. https://doi.org/10.1016/j.resconrec.2017.10.034
31. Tserng H-P, Chou C-M, Chang Y-T (2021) The Key Strategies to Implement Circular Economy in Building Projects-A Case Study of Taiwan https://doi.org/10.3390/su13020754
32. Khajuria A, Atienza VA, Chavanich S et al (2022) Accelerating circular economy solutions to achieve the 2030 agenda for sustainable development goals. Circ Econ 1:100001. https://doi.org/10.1016/j.cec.2022.100001
33. Morseletto P (2020) Targets for a circular economy. Resour Conserv Recycl 153:104553. https://doi.org/10.1016/j.resconrec.2019.104553
34. Morseletto P, Mooren CE, Munaretto S (2022) Circular Economy of Water: Definition, Strategies and Challenges. Circ Econ Sustain 2:1463–1477. https://doi.org/10.1007/s43615-022-00165-x
35. Mebratu D (1998) Sustainability and sustainable development: Historical and conceptual review. Environ Impact Assess Rev 18:493–520. https://doi.org/10.1016/S0195-9255(98)00019-5
36. Visser W, Brundtland GH (2013) Our Common Future ('The Brundtland Report'): World Commission on Environment and Development. In: The Top 50 Sustainability Books. Greenleaf Publishing Limited, pp 52–55

37. Purvis B, Mao Y, Robinson D (2019) Three pillars of sustainability: in search of conceptual origins. Sustain Sci 14:681–695. https://doi.org/10.1007/s11625-018-0627-5
38. Barbier EB (1987) The Concept of Sustainable Economic Development. Environ Conserv 14:101–110. https://doi.org/10.1017/S0376892900011449
39. Elkington J (1997) Cannibal with the forks: Line of 21st Century The Triple Bottom Business. Capstone Publishing Limited, United Kin
40. Giddings B, Hopwood B, O'Brien G (2002) Environment, economy and society: fitting them together into sustainable development. Sustain Dev 10:187–196. https://doi.org/10.1002/sd.199
41. Walker AM, Opferkuch K, Roos Lindgreen E et al (2022) What Is the Relation between Circular Economy and Sustainability? Answers from Frontrunner Companies Engaged with Circular Economy Practices. Circ Econ Sustain 2:731–758. https://doi.org/10.1007/s43615-021-00064-7
42. Stazyk EC, Moldavanova A, Frederickson HG (2016) Sustainability, Intergenerational Social Equity, and the Socially Responsible Organization. Adm Soc 48:655–682. https://doi.org/10.1177/0095399713519094
43. Garrido-Prada P, Lenihan H, Doran J et al (2021) Driving the circular economy through public environmental and energy R&D: Evidence from SMEs in the European Union. Ecol Econ 182:106884. https://doi.org/10.1016/j.ecolecon.2020.106884
44. Latif S, Müller J (2015) Potential of cassava leaves in human nutrition: A review. Trends Food Sci Technol 44:147–158. https://doi.org/10.1016/j.tifs.2015.04.006
45. Singvejsakul J, Chaovanapoonphol Y, Limnirankul B, et al (2021) Modeling the Price Volatility of Cassava Chips in Thailand: Evidence from Bayesian GARCH-X Estimates https://doi.org/10.3390/economies9030132
46. Center for Agricultural Data and Information System (2016) Summary result of cassava processing and distribution survey in Indonesia. Ministry of Agriculture, Jakarta
47. Situmorang A, Manik Y (2018) Initial sustainability assessment of tapioca starch production system in Lake Toba area. IOP Conf Ser Mater Sci Eng 337:012044. https://doi.org/10.1088/1757-899X/337/1/012044
48. Hasanudin U, Safira ND, Nurainy F et al (2023) Improving Biogas Production in Tapioca Industry by Using Onggok as Co-substrate. Int J Renew Energy Res 13:741–749. https://doi.org/10.20508/ijrer.v13i2.13814.g8748
49. The United Nation (2017) Wastewater: the untapped resource - UNESCO Digital Library. In: United Nations world water Dev. Rep. https://unesdoc.unesco.org/ark:/48223/pf0000247153. Accessed 8 Feb 2022
50. Pervez MN, Mishu MR, Stylios GK et al (2021) Sustainable Treatment of Food Industry Wastewater Using Membrane Technology: A Short Review. Water 13:3450. https://doi.org/10.3390/w13233450
51. Sauvé S, Lamontagne S, Dupras J, Stahel W (2021) Circular economy of water: Tackling quantity, quality and footprint of water. Environ Dev 39:100651. https://doi.org/10.1016/j.envdev.2021.100651
52. Hai FI, Yamamoto K, Jegatheesan JV (2018) Special Issue on Wastewater Treatment and Reuse Technologies https://doi.org/10.3390/app8050695
53. Qadir M, Drechsel P, Jiménez Cisneros B et al (2020) Global and regional potential of wastewater as a water, nutrient and energy source. Nat Resour Forum 44:40–51. https://doi.org/10.1111/1477-8947.12187
54. Lerdlattaporn R, Phalakornkule C, Trakulvichean S, Songkasiri W (2021) Implementing circular economy concept by converting cassava pulp and wastewater to biogas for sustainable production in starch industry. Sustain Environ Res 31 https://doi.org/10.1186/s42834-021-00093-9
55. Hasanudin U, Kustyawati ME, Iryani DA et al (2019) Estimation of energy and organic fertilizer generation from small scale tapioca industrial waste. IOP Conf Ser Earth Environ Sci 230:012084. https://doi.org/10.1088/1755-1315/230/1/012084
56. Van FY, Chin HH, Klemeš JJ et al (2020) Optimisation and process design tools for cleaner production. J Clean Prod 247:119181. https://doi.org/10.1016/j.jclepro.2019.119181
57. Walzberg J, Lonca G, Hanes RJ et al (2021) Do We Need a New Sustainability Assessment Method for the Circular Economy? A Critical Literature Review Front Sustain 1:12. https://doi.org/10.3389/frsus.2020.620047
58. Blomsma F, Pieroni M, Kravchenko M, et al (2019) Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. J Clean Prod 241 https://doi.org/10.1016/j.jclepro.2019.118271
59. Rashid Y, Rashid A, Warraich MA, et al (2019) Case Study Method: A Step-by-Step Guide for Business Researchers. Int J Qual Methods 18 https://doi.org/10.1177/1609406919862424
60. Crowe S, Cresswell K, Robertson A et al (2011) The case study approach. BMC Med Res Methodol 11:100. https://doi.org/10.1186/1471-2288-11-100

61. Takahashi ARW, Araujo L (2019) Case study research: opening up research opportunities. RAUSP Manag J 55:100–111. https://doi.org/10.1108/RAUSP-05-2019-0109
62. Burns W (2017) The Case for Case Studies in Confronting Environmental Issues. Case Stud Environ 1:1–4. https://doi.org/10.1525/cse.2017.sc.burns01
63. Hayden C (2022) Case Study Research Defined. Case Study Res. https://doi.org/10.5281/zenodo.7604301
64. Ellen MacArthur Foundation (2015) Growth within: a circular economy vision for a competitive Europe. https://www.ellenmacarthurfoundation.org. Accessed 27 Sep 2021
65. Smol M, Duda J, Czaplicka-Kotas A, Szołdrowska D (2020) Transformation towards Circular Economy (CE) in Municipal Waste Management System: Model Solutions for Poland. Sustainability 12:4561. https://doi.org/10.3390/su12114561
66. Tedesco M, Simioni FJ, Sehnem S et al (2022) Assessment of the circular economy in the Brazilian planted tree sector using the ReSOLVE framework. Sustain Prod Consum 31:397–406. https://doi.org/10.1016/j.spc.2022.03.005
67. Gonçalves MLMBB, Maximo GJ (2022) Circular Economy in the Food Chain: Production, Processing and Waste Management. Circ Econ Sustain 1–19. https://doi.org/10.1007/s43615-022-00243-0
68. Tu J-C, Chan H-C, Chen C-H (2020) Establishing Circular Model and Management Benefits of Enterprise from the Circular Economy Standpoint: A Case Study of Chyhjiun Jewelry in Taiwan. Sustainability 12:4146. https://doi.org/10.3390/su12104146
69. Sacco P, Vinante C, Borgianni Y, Orzes G (2021) Circular Economy at the Firm Level: A New Tool for Assessing Maturity and Circularity. Sustainability 13:5288. https://doi.org/10.3390/su13095288
70. Buch R, O'neill D, Lubenow C, et al (2017) A transdisciplinary approach to an ethical circular economy. https://sustainability-innovation.asu.edu/sustainabilitysolutions/wp-content/uploads/sites/15/2016/09/Ethical-Circular-Economy-Draft-ao060117-.pdf. Accessed 10 Jan 2023
71. Rao KKC, Otoo M, Drechsel P, Hanjra MA (2017) Resource recovery and reuse as an incentive for a more viable sanitation service chain. Water Altern 10:493–512
72. Hasanudin U, Haryanto A, Suroso E (2011) Mitigation of green house gases emission in cassava mill: Case study in Lampung, Indonesia. Paper presented at international conference and exhibition on sustainable energy and advanced material (ICE SEAM 2011), Solo, 3–4 October 2011
73. Menteri Lingkungan Hidup (2014) Permenlh No. 5 Tahun 2014 Tentang Baku Mutu Air Limbah (Minister of Environment Regulation Number 5 Year 2014 Regarding the Standard of Wastewater Quality). https://peraturan.go.id/id/permenlh-no-5-tahun-2014. Accessed 19 Jan 2024
74. Lansche J, Awiszus S, Latif S, Müller J (2020) Potential of biogas production from processing residues to reduce environmental impacts from cassava starch and crisp production-a case study from Malaysia. Appl Sci 10 https://doi.org/10.3390/APP10082975
75. UNEP (2009) Guidelines for social life cycle assessment of products. https://www.unep.org/resources/report/guidelines-social-life-cycle-assessment-products. Accessed 31 Jul 2022
76. UNEP (2020) Guidelines for social life cycle assessment of products and organizations. https://wedocs.unep.org/20.500.11822/34554. Accessed 03 Jun 2023
77. Yang M, Chen L, Wang J et al (2023) Circular economy strategies for combating climate change and other environmental issues. Environ Chem Lett 21:55–80. https://doi.org/10.1007/s10311-022-01499-6
78. Kirchherr J, Reike D, Hekkert M (2017) Conceptualizing the circular economy: An analysis of 114 definitions. Resour Conserv Recycl 127:221–232. https://doi.org/10.1016/j.resconrec.2017.09.005
79. Godelnik R (2021) Rethinking Corporate Sustainability in the Era of Climate Crisisp. Springer International Publishing, A Strategic Design Approach
80. Murray A, Skene K, Haynes K (2017) The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. J Bus Ethics 140:369–380. https://doi.org/10.1007/s10551-015-2693-2
81. Suárez-Eiroa B, Fernández E, Méndez-Martínez G, Soto-Oñate D (2019) Operational principles of circular economy for sustainable development: Linking theory and practice. J Clean Prod 214:952–961. https://doi.org/10.1016/j.jclepro.2018.12.271
82. Miguel Rodríguez-Antón J, Luis Rubio-Andrada, María, et al (2022) From the circular economy to the sustainable development goals in the European Union: an empirical comparison. 22:67–95 https://doi.org/10.1007/s10784-021-09553-4
83. Winans K, Kendall A, Deng H (2017) The history and current applications of the circular economy concept. Renew Sustain Energy Rev 68:825–833. https://doi.org/10.1016/j.rser.2016.09.123
84. Schroeder P, Anggraeni K, Weber U (2019) The Relevance of Circular Economy Practices to the Sustainable Development Goals. J Ind Ecol 23:77–95. https://doi.org/10.1111/jiec.12732

85. Durán-Romero G, López AM, Beliaeva T et al (2020) Bridging the gap between circular economy and climate change mitigation policies through eco-innovations and Quintuple Helix Model. Technol Forecast Soc Change 160:120246. https://doi.org/10.1016/j.techfore.2020.120246
86. Centobelli P, Cerchione R, Chiaroni D et al (2020) Designing business models in circular economy: A systematic literature review and research agenda. Bus Strateg Environ 29:1734–1749. https://doi.org/10.1002/bse.2466
87. Kristoffersen E, Mikalef P, Blomsma F, Li J (2021) Towards a business analytics capability for the circular economy. Technol Forecast Soc Chang 171:120957. https://doi.org/10.1016/j.techfore.2021.120957
88. UNEP (2016) Sustainable consumption and production indicators for the future SDGs. https://sdgs.un.org/publications/sustainable-consumption-and-production-indicators-future-sdgs-18025. Accessed 23 Jul 2021
89. Lyu H, Zhang J, Zhai Z et al (2020) Life cycle assessment for bioethanol production from whole plant cassava by integrated process. J Clean Prod 269:121902. https://doi.org/10.1016/j.jclepro.2020.121902
90. Asgari A, Asgari R (2021) Sustainable Production and Consumption How circular economy transforms business models in a transition towards circular ecosystem: the barriers and incentives. Sustain Prod Consum 28:566–579. https://doi.org/10.1016/j.spc.2021.06.020
91. Morales ME, Batlles-Delafuente A, Cortés-García FJ, Jesús Belmonte-Ureña L (2021) Theoretical Research on Circular Economy and Sustainability Trade-Offs and Synergies https://doi.org/10.3390/su132111636
92. Melander L (2018) Customer and Supplier Collaboration in Green Product Innovation: External and Internal Capabilities. Bus Strateg Environ 27:677–693. https://doi.org/10.1002/bse.2024
93. Chauhan C, Kaur P, Arrawatia R et al (2022) Supply chain collaboration and sustainable development goals (SDGs). Teamwork makes achieving SDGs dream work. J Bus Res 147:290–307. https://doi.org/10.1016/j.jbusres.2022.03.044
94. Mina H, Kannan D, Gholami-Zanjani SM, Biuki M (2021) Transition towards circular supplier selection in petrochemical industry: A hybrid approach to achieve sustainable development goals. J Clean Prod 286:125273. https://doi.org/10.1016/j.jclepro.2020.125273
95. Obidzinski K, Andriani R, Komarudin H, Andrianto A (2012) Environmental and Social Impacts of Oil Palm Plantations and their Implications for Biofuel Production in Indonesia. Ecol Soc 17:25. https://doi.org/10.5751/ES-04775-170125
96. Cahyadi ER, Waibel H (2013) Is Contract Farming in the Indonesian Oil Palm Industry Pro-poor? 30:62–76. https://doi.org/10.1355/ae30-ld
97. Hutabarat S, Slingerland M, Rietberg P, Dries D A Researcher L (2018) Costs and benefits of certification of independent oil palm smallholders in Indonesia International Food and Agribusiness Management Review 682. Int Food Agribus Manag Rev 21 https://doi.org/10.22434/IFAMR2016.0162
98. Bolwig S, Gibbon P, Jones S (2009) The Economics of Smallholder Organic Contract Farming in Tropical Africa. World Dev 37:1094–1104. https://doi.org/10.1016/j.worlddev.2008.09.012
99. Chamberlain W, Anseeuw W (2019) Inclusive businesses in agriculture: Defining the concept and its complex and evolving partnership structures in the field https://doi.org/10.1016/j.landusepol.2019.02.008
100. Whitelaw K (2004) ISO 14001 Environmental Systems Handbook, 2nd edn. Elsevier Ltd, Burlington
101. Kibert CJ, Thiele L, Peterson A, Monroe M (2019) The ethics of sustainability. http://rio20.net/en/documentos/the-ethics-of-sustainability. Accessed 01 Jul 2023
102. Diarra S, Tri E, Rudijanto D, et al (2021) The correlation between business ethics and customer satisfaction at PT. Indah Logistics Cargo Company. SEAJBEL 24:114–119
103. Adda G, Bosco Azigwe J, Awuni AR (2016) Business ethics and corporate social responsibility for business success and growth. EJBIR 4:26–42.
104. Torelli R (2021) Sustainability, responsibility and ethics: different concepts for a single path. https://doi.org/10.1108/SRJ-03-2020-0081
105. Zamfir A-M, Mocanu C, Grigorescu A (2017) Circular Economy and Decision Models among European SMEs. Sustainability 9:1507. https://doi.org/10.3390/su9091507