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Concept of Food Circular Economy in Technical and Vocational Education: A Comprehensive Review

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Abstract

The concept of a circular economy emphasizes the principle of reduce, reuse, and recycle which is closely related to the issue of food waste management. Through the practice of the concept of circular economy in the food system, issues related to Zero Hunger emphasized in the Sustainable Development Goals can be implemented optimally. Nevertheless, the exposure and understanding of the circular economy in the field of education, especially technical and vocational education, requires this matter to be examined in more depth. The objective of the study is to explore the integration of the circular economy concept in Technical and Vocational Education and Training (TVET). The methodology used is document analysis which is the collection of information from reports and articles from past studies. General and specific keywords were used in information searches in the Scopus, Web of Science (WoS), Education Resource Information Center (ERIC) and Dimensions databases. The concept of a circular economy can be effectively integrated into TVET education through sustainable practices, resource management, waste reduction and closed-loop production processes.

Keywords: Circular Economy, Food Waste, Technical and Vocational Education

Introduction

The Sustainable Development Goal (SDG) agenda sets the 2nd goal to end hunger and promote sustainable agriculture, while the 12th goal focuses on responsible consumption, energy efficiency and access to basic services, green jobs and a better quality of life for all

(Department of Statistics Malaysia, 2019). According to the Prime Minister's Office of Malaysia (2023) MADANI Malaysia which represents M (sustainability), A (modernity), D (creativity), A (respect), N (trust) and I (courtesy) promotes the use of sustainable resources and the use and responsible production. In addition, the New Industrial Master Plan 2030 in two of its four missions, namely "Advancing Economic Complexity" and "Promoting Net-zero Carbon Emissions" also supports the SDG agenda (Ibrahim, 2023). Realizing how important the agenda is, society needs to adopt the concept of a circular economy and it needs to start with the education sector.

Literature Review

Environmental education was first introduced in 1982 (Asis et al., 2021). Now environmental education is taught across the curriculum in formal and informal forms. The concept of a linear economy refers to an economic pattern based on resource extraction, production, consumption and waste disposal. In a linear economy, resources are extracted for the production of goods, then these goods are used, and finally discarded as waste after use (Crippa & Drąsutė, 2022). In contrast, the circular economy aims to reduce waste and maximize the reuse, recycling, and regeneration of resources to create a sustainable and efficient cycle (Schroeder et al., 2019). In this case, the 9R framework of the circular economy of adaptation from Potting et al (2017) can explain the principles of the circular economy in resource management (Figure 1).

Circular economy ↕ Linear ekonomi	Smarter product use	*R0 Refuse*
		R1 Rethink
		R2 Reduce
	Extend lifespan of the product and its parts	*R3 Reuse*
		R4 Repair
		R5 Refurbish
		R6 Remanufacture
		R7 Repurpose
	Useful application of materials	*R8 Recycle*
		R9 Recover

Figure 1. The 9R framework of cycle economy adapted from Potting et al., (2017)

Technical and Vocational Education (TVET) plays an important role in bridging environmental education and the circular economy where TVET offers training and skills development in important areas such as sustainable resource management, renewable energy technology, waste management and environmentally friendly production processes (Zubir et al., 2021). By applying these principles into the TVET program, individuals are equipped with the knowledge and skills needed to implement sustainable practices and foster innovation in various

industries (Limuna & Alwi, 2019). According to Hassan et al (2020) TVET encourages the development of an entrepreneurial and innovative mind by fostering the individual's ability to design sustainable products. Through this approach, TVET empowers teachers and students to be catalysts for sustainable change (Rocks & Lavender, 2018; Smith, 2018). In short, the important role of TVET lies in its alignment with environmental education and the circular economy. By providing training in sustainable practices, waste management, and fostering entrepreneurship, TVET equips individuals with the skills needed to embrace the principles of a circular economy (Ministry of Rural Development, 2019). This allows them to make a valuable contribution to economic development while reducing environmental impact (Abad-Segura et al., 2020; Bonoli et al., 2018). However, studies on the circular economy of food waste, especially in TVET education, are still lacking (Tamasiga et al., 2022). Poor understanding of the circular economy in the community in the education sector (Boluk et al., 2019; De Hemptinne et al., 2022; Shah & Rezai, 2023) and the absence of specific guidelines on food waste management (Bian et al., 2022; Reynolds et al., 2019) prompting this issue to be studied more deeply. Therefore, the objective of the study is to explore the integration of the circular economy concept in TVET education.

Methodology

The methodology used is document analysis, which is the collection of information from reports and articles from studies from 2018 to 2023. General and specific keywords are also used in information searches in the Scopus database, Web of Science (WoS), Education Resources Information Center (ERIC) and Dimensions as Table 1 below.

Table 1
Keyword of searching information

Database	Keyword
Scopus	TITLE-ABS-KEY (((*circular* OR *"zero waste"*) *economy*) AND *food* AND (*organization** OR *institution**))
WoS	ALL=(((circular OR "zero waste") economy) AND food AND (organization* OR institution*))
ERIC	Whenever necessary, use field code functions, phrase searches, and exact keywords from Scopus and WoS along with Boolean operators.
Dimensions	(((circular OR "zero waste") economy) AND food AND (organization OR institution))

Results & Discussion

What is a Food Circular Economy?

The European Union is promoting an alternative economic system designed for regeneration known as the circular economy. The circular economy is an industrial economy that reflects nature in actively optimizing the system (Schroeder et al., 2019). Climate change and global warming provide a clear signal that the linear economic model is no longer sustainable from a social, environmental and economic point of view (Suárez-Eiroa et al., 2019). According to

Johansen and Rönnbäck (2021); Shevchenko et al (2023); Yuan and Tang (2021) circular economy redefines the 3R system to 4R, 6R, 9R and even 10R (Rethink, Refuse, Reduce, Reuse, Recover, Repurpose, Repair, Refurbish, Remanufacture and Recycle), with these 10R principles can improve the economy and achieve sustainable environment (Kirchherr & Piscicelli, 2019). This shows that the circular economy is a necessity for the regeneration of resources that can ensure the survival of future generations Zucaro et al (2022) in line with the 2nd and 12th SDG goals (Nalathambi et al., 2023).

The circular economy can be implemented on almost all products found on this earth (Boyer et al., 2021; Di Maio et al., 2017). But the food circular economy faces different challenges because what needs to be considered is not only how and where food is produced but what happens to the final product (Amicarelli & Bux, 2021). The issue of food waste management in the education sector involves significant challenges. Educational institutions generate large amounts of food waste (Vishakar et al., 2022), which raises concerns about sustainability and environmental impact (Barik et al., 2018). According to Moqbel et al (2020) the lack of awareness and proper waste segregation practices among students and staff contributes to the problem (Moreira et al., 2018). In addition, the limited allocation of budgets and resources for waste management prevents the implementation of comprehensive solutions (CarmenNiño et al., 2023; Olukanni & Oresanya, 2018). Addressing this issue requires a multifaceted approach, including educational campaigns to raise awareness (Puertas et al., 2022), improving waste separation infrastructure (Nepal et al., 2023), collaboration with local authorities or organizations for efficient waste disposal (Budihardjo et al., 2023), and potentially integrating food waste reduction into the curriculum.

Food waste can be interpreted as the loss of edible food at different stages of the food chain, including harvesting, production, processing, distribution and consumption (Zborowski & Mikulec, 2022). According to Papargyropoulou et al., (2014) food waste consists of three types based on the type of waste: (1) unavoidable food waste; (2) avoidable food waste; and (3) possible avoidable food waste. Regardless of the definition, food waste still needs to be managed effectively. Food waste is a threat to the world because its production is increasing every year (Mannaa et al., 2024; Naik et al., 2023) . In reality, a third of the amount of food produced is wasted or lost every year, and at least 820 million people around the world do not have enough food (Martin-Rios et al., 2021).

Food waste not only contributes to the majority of domestic waste, but it also causes problems in food security for the world's population (Ramlan et al., 2023). In Malaysia, food waste is managed by the Solid Waste Management and Public Cleaning Corporation (PPSPPA) by collecting it together with other solid waste and dumping it in a landfill (Zainal & Abas, 2018). Restaurants manage waste by donating leftover food to individuals who come (Hajjdiab et al., 2018). Sometimes food waste is taken by restaurant workers and brought back as feed for farm animals (Ebrahim, 2023). Part of the food waste is made into compost (Tan et al., 2022). This kind of food waste management has not been able to solve the entire food waste problem in Malaysia because it uses a linear concept where resource regeneration does not occur. In general, inefficient food waste management causes greater food losses that can affect natural resources (Ismail, 2018).

In the field of education, the circular economy can be applied in learning in the classroom through certain subjects (Braz & de Mello, 2023; Subramanian & Suresh, 2022). The learning process for certain subjects does not run away from producing food waste either during or

after practical. According to Chong & Mapa, (2021) food waste is the most waste produced by secondary school students which is 62.6% (46.63kg), followed by plastic waste (18.5%), paper (10.2%), aluminum (4.2%) , boxes and cardboard (2.6%). Most of the food waste is thrown into the trash together with other solid waste. This shows that there is a lack of clear understanding of the circular economy in the community in the education sector and the absence of specific guidelines on food waste management in the education sector in Malaysia. A summary of the circular economy can be explained in Figure 2 below.

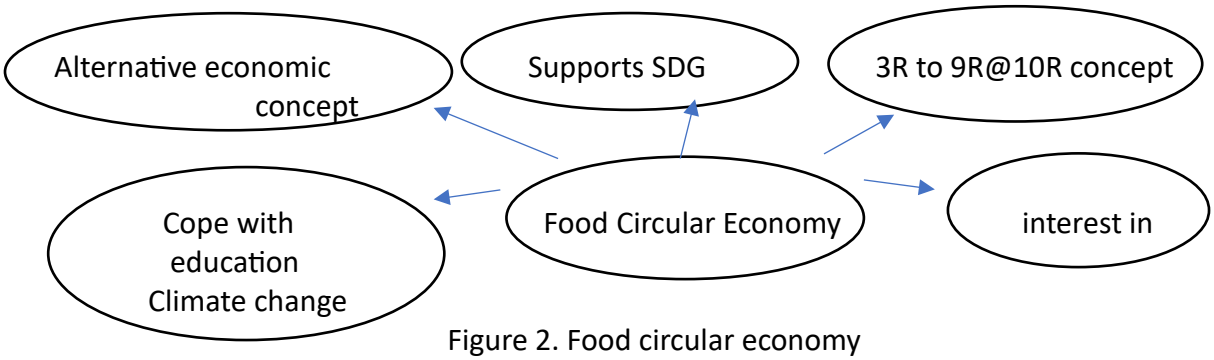

Figure 2. Food circular economy

Why Need a Circular Economy?

A poorly understood food system causes inefficiency in the use of resources and distribution of food. This problem of inefficiency causes the environment to be affected by the high rate of food waste across the food system (Krishnan et al., 2020). Unsustainable patterns of consumption and production are the main cause of worsening environmental problems (Rauf et al., 2023). According to (Ghosh, 2019) the impact of food on natural resources occurs during the food production phase where food loss occurs during the production process, which is the process of cultivation, care and storage. This also applies to the harvest of agricultural products due to the lack of food storage and transportation constraints (Abera et al., 2020; Jia et al., 2022; Karthikeyan et al., 2022; Xue et al., 2021). Such incidents show inefficiency in the use of resources and food distribution (Waiker et al., 2020). This often happens to people in developing countries because of the limited use of farming technology. This creates a situation of food security instability caused by food sources that are difficult to obtain.

From a social point of view, the practice of 3R (Reduce, Reuse, Recycle) has not sufficiently met the requirements to accommodate all production, distribution, and consumption activities in the waste composition system (Esposito et al., 2023; Liu & Nguyen, 2020; Michalec et al., 2018). In addition, there are no guidelines on the best practices of education that practice the circular economy. This is proven when there are still few educational institutions that provide special bins for food waste (Chong & Mapa, 2021). Food waste that has been separated from other solid waste can be made into compost (Alattar et al., 2020). Many people are still not aware that from an economic point of view, food waste is a school asset because the compost can be sold and bring money (Machado & Hettiarachchi, 2020). In addition to food waste that can be composted, other solid waste such as paper, drink cans and cardboard can be sold to private trucks that buy recyclables (Ballaran et al., 2019). Education that prioritizes academics still lacks a syllabus that mentions in detail about food waste management in schools (Grinberga-Zalite et al., 2022; Ko & Lu, 2022; Kowalewska & Kołłajtis-

Dołowy, 2018). Environmental education is taught at a glance and across the curriculum (Rahman, 2018). In short, a circular economy is needed to protect the environment, improve the economy, and improve social aspects as shown in Figure 3 below.

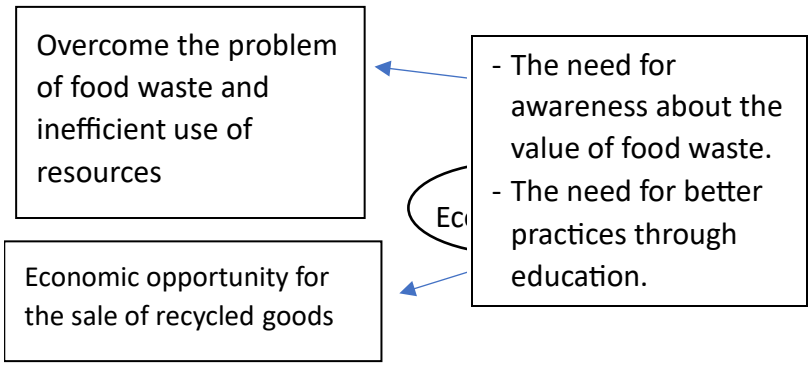

Figure 3. The need for a circular economy from an environmental, economic and social point of view.

How is the Circular Economy in TVET Education?

The concept of a circular economy can be effectively integrated into TVET education where TVET institutions can provide education in sustainable practices, resource management, waste reduction and closed-loop production processes. By integrating the principles of the circular economy into TVET, pupils can acquire the knowledge and skills needed to apply sustainable practices in various sectors such as manufacturing, construction, agriculture and renewable energy (Napathorn, 2021; Spencer, 2021). Pupils can learn about the efficient use of resources (Pavlova et al., 2020) and learn recycling and reuse of materials (Grinberga-Zalite et al., 2022). This helps them equip themselves for the transition towards a more resilient and sustainable economy.

Applications of the circular economy can be seen across various sectors in TVET. For example, in manufacturing, students can learn about implementing a closed loop system, where waste from one process becomes an input for another (Kopnina, 2019). In the field of agriculture, students can learn regenerative farming practices, organic waste management, and sustainable food production (Liu & Ramakrishna, 2020). In addition, TVET programs can address renewable energy technologies, waste management and environmentally friendly practices across industries (Anyigor-Ogah & Egba, 2018; Frantzeskaki, 2022; Handayani et al., 2020).

In the food service industry, especially in the Upper Secondary Vocational Program (PVMA) Food Preparation and Production course, the circular economy can be applied with specific strategies. First, adopt sustainable production methods such as efficient energy use and water conservation. Second, practice teaching techniques to minimize raw material waste during food processing. Third, encourage the reuse of packaging materials. Fourth, reuse byproducts to maximize the use of resources. Finally, instill a circular mindset to train students to innovate. By doing so, the PVMA Food Preparation and Production course can train students to lean

towards sustainable practices, reducing environmental impact while contributing positively to the food manufacturing industry. The circular economy in TVET education can be explained in Figure 4 below.

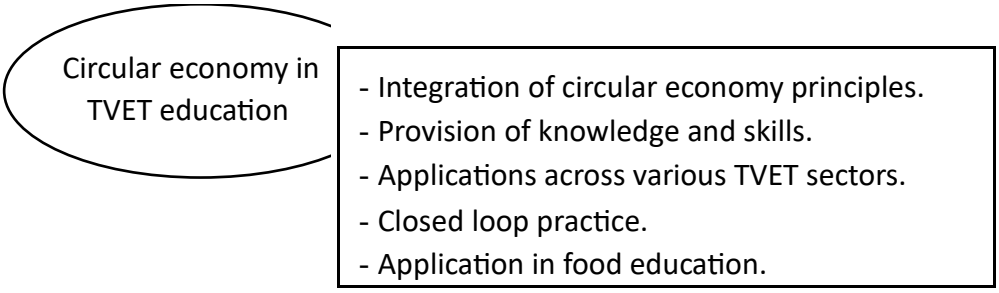

Figure 4. Circular economy in TVET education

Conclusion

In conclusion, this study describes the importance of integrating the concept of the circular economy into technical and vocational education and training (TVET) to address food waste management and align with the Sustainable Development Goals. The core principles of reduce, reuse and recycle have the potential to improve the quality of the food system and combat Zero Hunger concerns. This study has also successfully achieved its objective. However, a deeper study and integration of the concept of circular economy is important in TVET education. Through sustainable practices, resource management, waste reduction, and closed-loop production processes, circular economy ideas can be effectively integrated into TVET education. The concept paper presented serves as a catalyst for future research on the circular economy, particularly in food waste management in the TVET education sector. By fostering a comprehensive understanding and application of the circular economy, TVET can contribute to sustainable practices and better waste management, fostering a more environmentally conscious and responsible generation.

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