

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

Norzaharah Ab Hamid, Fathiyah Mohd Kamaruzaman,
Mohamad Sattar Rasul, Marlissa Omar, Mohamad Zuber Abd
Majid

Faculty of Education, Universiti Kebangsaan Malaysia, 43600 Bangi

Corresponding Author Email: fathiyah@ukm.edu.my

To Link this Article: <http://dx.doi.org/10.6007/IJARBSS/v13-i12/20169> DOI:10.6007/IJARBSS/v13-i12/20169

Published Date: 20 December 2023

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 & Draşutè, 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	<i>R0 Refuse</i>
		<i>R1 Rethink</i>
		<i>R2 Reduce</i>
	Extend lifespan of the product and its parts	<i>R3 Reuse</i>
		<i>R4 Repair</i>
		<i>R5 Refurbish</i>
		<i>R6 Remanufacture</i>
	Useful application of materials	<i>R7 Repurpose</i>
		<i>R8 Recycle</i>
<i>R9 Recover</i>		

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 (((<i>circular</i> OR " <i>zero waste</i> ") <i>economy</i>) AND <i>food</i> AND (<i>organization</i> * OR <i>institution</i> *))
WoS	ALL=(((<i>circular</i> OR " <i>zero waste</i> ") <i>economy</i>) AND <i>food</i> AND (<i>organization</i> * OR <i>institution</i> *))
ERIC	Whenever necessary, use field code functions, phrase searches, and exact keywords from Scopus and WoS along with Boolean operators.
Dimensions	(((<i>circular</i> OR " <i>zero waste</i> ") <i>economy</i>) AND <i>food</i> AND (<i>organization</i> OR <i>institution</i>))

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 (Carmen-Niño 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.

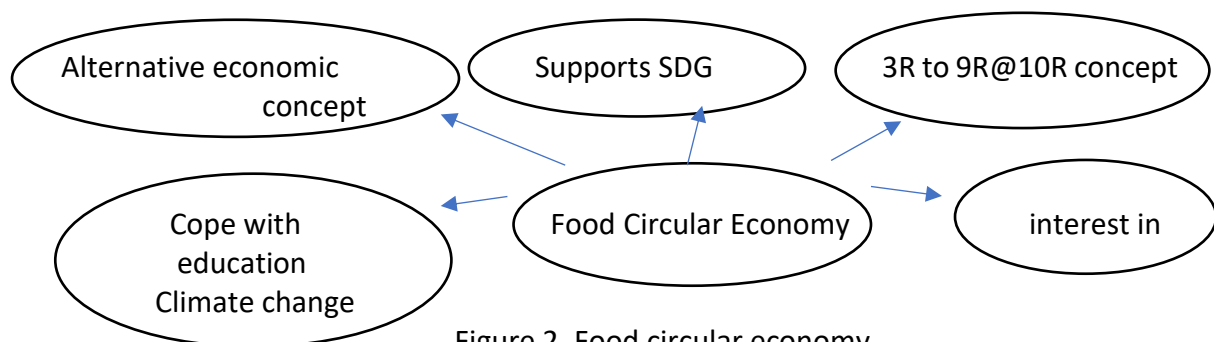


Figure 2. Food circular economy

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 & Kofajtis-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.

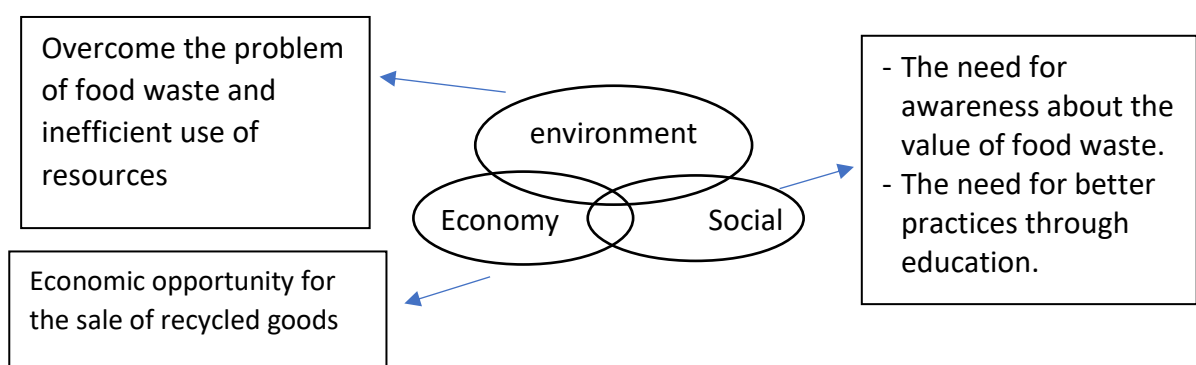


Figure 3. The need for a circular economy from an environmental, economic and social point of view.

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 by-products 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.

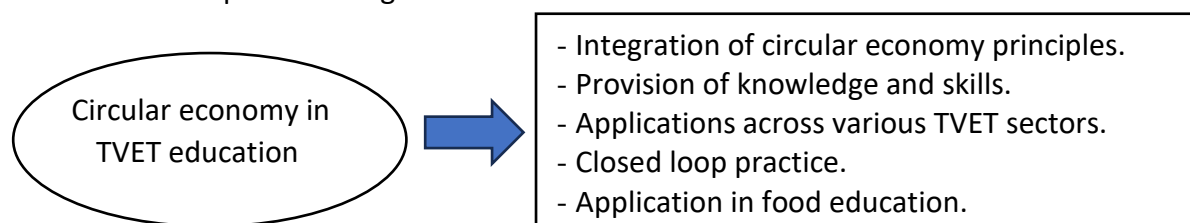


Figure 4. Circular economy in TVET education

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.

References

- Abad-Segura, E., de la Fuente, A. B., Gonzalez-Zamar, M. D., & Belmonte-Urena, L. J. (2020). Effects of circular economy policies on the environment and sustainable growth: Worldwide research. *Sustainability (Switzerland)*, 12(14), 1–27. <https://doi.org/10.3390/su12145792>
- Abera, G., Ibrahim, A. M., Forsido, S. F., & Kuyu, C. G. (2020). Assessment on post-harvest losses of tomato (*Lycopersicon esculentum* Mill.) in selected districts of East Shewa Zone of Ethiopia using a commodity system analysis methodology. *Heliyon*, 6(4). <https://doi.org/10.1016/j.heliyon.2020.e03749>
- Alattar, M. A., Delaney, J., Morse, J. L., & Nielsen-Pincus, M. (2020). Food waste knowledge, attitudes, and behavioral intentions among university students. *Journal of Agriculture, Food Systems, and Community Development*, 9(3), 109–124. <https://doi.org/10.5304/jafscd.2020.093.004>
- Amicarelli, V., & Bux, C. (2021). Food waste measurement toward a fair, healthy and environmental-friendly food system: a critical review. *British Food Journal*, 123(8), 2907–2935. <https://doi.org/10.1108/BFJ-07-2020-0658>
- Anwar Ibrahim. (2023). *New Industrial Master Plan 2030*. <https://www.pmo.gov.my/2023/09/speech-by-pm-anwar-for-the-launch-of-the-new-industrial-master-plan-2030-nimp-2030/>
- Anyigor-Ogah, A. C., & Egba, E. I. (2018). Enhancing waste management in technical and vocational jobs through information technology. *Chemical Engineering Transactions*, 63, 625–630. <https://doi.org/10.3303/CET1863105>
- Ballaran, P. M., Corpuz, C. B. A., Paras, L. A. R., Fabito, B. S., & Rivera, E. R. (2019). Perazuhan: A Mobile Application for Solid Waste Micro-Management Framework. *2019 IEEE Student Conference on Research and Development, SCOREd 2019*, 17–20. <https://doi.org/10.1109/SCORED.2019.8896301>
- Barik, S., Paul, K. K., & Priyadarshi, D. (2018). Utilization of kitchen food waste for biodiesel production. *IOP Conference Series: Earth and Environmental Science*, 167(1). <https://doi.org/10.1088/1755-1315/167/1/012036>
- Beddu Asis, A. H., Marinsah, S. A., & Ramlie, H. @ A. (2021). Tahap Kesedaran dan Pembudayaan Alam Sekitar dalam Kalangan Pelajar Sekolah Menengah di Kota Kinabalu, Sabah. *Jurnal Pusat Penataran Ilmu & Bahasa*, 3(2). <https://doi.org/https://doi.org/10.51200/manu.v3i2.3580>
- Bian, R., Shi, W., Luo, J., Li, W., Wang, Y., Joseph, S., Gould, H., Zheng, J., Zhang, X., Liu, X., Wang, Y., Liu, X., Shan, S., Li, L., & Pan, G. (2022). Copyrolysis of food waste and rice husk to biochar to create a sustainable resource for soil amendment: A pilot-scale case study in Jinhua, China. *Journal of Cleaner Production*, 347. <https://doi.org/10.1016/j.jclepro.2022.131269>
- Boluk, K. A., Cavaliere, C. T., & Higgins-Desbiolles, F. (2019). A critical framework for interrogating the United Nations Sustainable Development Goals 2030 Agenda in tourism. In *Journal of Sustainable Tourism* (Vol. 27, Issue 7, pp. 847–864). Routledge. <https://doi.org/10.1080/09669582.2019.1619748>
- Bonoli, A., Dolci, N., Foschi, E., Lalli, F., Prandstraller, D., & Zanni, S. (2018). End of service scenario for universities' informatic equipment: Recovery and repair as educational and

- research tool for circular economy and urban mining. *Detritus*, 4(December), 90–97. <https://doi.org/10.31025/2611-4135/2018.13747>
- Boyer, R. H. W., Hunka, A. D., Linder, M., Whalen, K. A., & Habibi, S. (2021). Product Labels for the Circular Economy: Are Customers Willing to Pay for Circular? *Sustainable Production and Consumption*, 27, 61–71. <https://doi.org/10.1016/j.spc.2020.10.010>
- Braz, A. C., & de Mello, A. M. (2023). Circular economy supply network transition phases management dynamics. *Business Strategy and Development*. <https://doi.org/10.1002/bsd2.237>
- Budiardjo, M. A., Sumiyati, S., Sawitri, D. R., Sari, A. M., & Julianggara, M. I. (2023). Recent progress and suggestions on waste management strategy in Kalisalak village, Batang regency. *IOP Conference Series: Earth and Environmental Science*, 1169(1). <https://doi.org/10.1088/1755-1315/1169/1/012009>
- Carmen-Nino, V. D., Herrera-Navarrete, R., Juárez-López, A. L., Sampedro-Rosas, M. L., & Reyes-Umana, M. (2023). Municipal Solid Waste Collection: Challenges, Strategies and Perspectives in the Optimization of a Municipal Route in a Southern Mexican Town. *Sustainability (Switzerland)*, 15(2). <https://doi.org/10.3390/su15021083>
- Chong, O. M., & Mapa, M. T. (2021). Komposisi sisa pepejal, program kitar semula dan pengetahuan pelajar terhadap amalan kitar semula di Sekolah Menengah Kebangsaan Bahang, Penampang, Sabah. *International Conference on Education, Social Sciences and Technology*, 87–95. <https://www.researchgate.net/publication/360774182>
- Crippa, C. M., & Draşutè, V. (2022, July). Circular Economy, Education for Sustainable Development and Green Skills: T(h)REE Elements for a Better Future. *The Future of Education*. https://conference.pixel-online.net/library_scheda.php?id_abs=5674
- De Hemptinne, J.-C., Kontogeorgis, G. M., Dohrn, R., Economou, I. G., Ten Kate, A., Kuitunen, S., Fele Zilnik, L., De Angelis, M. G., & Vesovic, V. (2022). A View on the Future of Applied Thermodynamics. *Industrial and Engineering Chemistry Research*, 61(39), 14664–14680. <https://doi.org/10.1021/acs.iecr.2c01906>
- Department of Statistics Malaysia. (2019). *SUSTAINABLE DEVELOPMENT GOALS (SDG) INDICATORS*.
- Di Maio, F., Rem, P. C., Balde, K., & Polder, M. (2017). Measuring resource efficiency and circular economy: A market value approach. *Resources, Conservation and Recycling*, 122, 163–171. <https://doi.org/10.1016/j.resconrec.2017.02.009>
- Ebrahim, A. (2023). Cafeteria Food Leftover as Potential Livestock Feed Resource in Ethiopia: A Review. *Asian Journal of Dairy and Food Research*, 42(1), 9–13. <https://doi.org/10.18805/ajdfr.DR-196>
- Esposito, B., Sica, D., Malandrino, O., & Supino, S. (2023). Social media on the route to circular economy transition from a dialogic perspective: evidence from the agri-food industry. *British Food Journal, ahead-of-print*(ahead-of-print). <https://doi.org/10.1108/BFJ-11-2022-0974>
- Frantzeskaki, N. (2022). Bringing Transition Management to Cities: Building Skills for Transformative Urban Governance. *Sustainability (Switzerland)*, 14(2). <https://doi.org/10.3390/su14020650>
- Grinberga-Zalite, G., Zvirbule, A., Hernik, J., & Popluga, D. (2022). DEVELOPING WASTE MANAGEMENT SKILLS FOR VOCATIONAL EDUCATIONAL INSTITUTIONS OF FOOD SECTOR. *22nd SGEM International Multidisciplinary Scientific GeoConference Proceedings 2022*, 22, 743–750. <https://doi.org/10.5593/sgem2022/5.1/s22.093>
- Hajjdiab, H., Anzer, A., Tabaza, H. A., & Ahmed, W. (2018). A food wastage reduction mobile application. *Proceedings - 2018 IEEE 6th International Conference on Future Internet of*

- Things and Cloud Workshops, W-FiCloud 2018*, 152–157. <https://doi.org/10.1109/W-FiCloud.2018.00030>
- Handayani, M. N., Ali, M., Wahyudin, D., & Mukhidin, M. (2020). Student's green skills in agricultural vocational school. *IOP Conference Series: Materials Science and Engineering*, 830(4). <https://doi.org/10.1088/1757-899X/830/4/042083>
- Hassan, S. C., Hassan, N. C., Daud, S. M., & Karim, A. A. (2020). *Tahap Kesiediaan Keusahawanan Pelajar di Institusi Pendidikan Teknikal dan Latihan Vokasional (TVET) di Hulu Langat (Student Level of Entrepreneurship Readiness at Technical Education and Vocational Training Institution (TVET) in Hulu Langat)* (Vol. 2, Issue 3). <http://myjms.moe.gov.my/index.php/jdpd>
- Ismail, N. S. (2018). Isu Perundangan Dalam Sekuriti Makanan - Analisis Dari Perspektif Tasawur Islam. *Jurnal Islam Dan Masyarakat Kontemporari*, 19. <https://www.researchgate.net/publication/339302089>
- Jia, L., Zhang, J., & Qiao, G. (2022). Scale and Environmental Impacts of Food Loss and Waste in China—A Material Flow Analysis. *International Journal of Environmental Research and Public Health*, 20(1), 460. <https://doi.org/10.3390/ijerph20010460>
- Johansen, K., & Rönnbäck, A. Ö. (2021). Small Automation Technology Solution Providers: Facilitators for Sustainable Manufacturing. *Procedia CIRP*, 104, 677–682. <https://doi.org/10.1016/j.procir.2021.11.114>
- Karthikeyan, R., Thangavel, P., Raghunath, R. T., Muthu Priyan, K. A., & Praveen Balaji, M. (2022). Performance analysis of greenhouse solar dryer using evacuated tubes. *Materials Today: Proceedings*, 66, 1509–1513. <https://doi.org/10.1016/j.matpr.2022.06.447>
- Kirchherr, J., & Piscicelli, L. (2019). Towards an Education for the Circular Economy (ECE): Five Teaching Principles and a Case Study. *Resources, Conservation and Recycling*, 150. <https://doi.org/10.1016/j.resconrec.2019.104406>
- Ko, W.-H., & Lu, M.-Y. (2022). Do professional courses prepare hospitality students for efficient surplus food management? A self-evaluation of professional competence in food waste prevention. *International Journal of Sustainability in Higher Education*, 23(6), 1315–1331. <https://doi.org/10.1108/IJSHE-07-2021-0308>
- Kopnina, H. (2019). Green-washing or best case practices? Using circular economy and Cradle to Cradle case studies in business education. *Journal of Cleaner Production*, 219, 613–621. <https://doi.org/10.1016/j.jclepro.2019.02.005>
- Kowalewska, M. T., & Kołtajis-Dołowy, A. (2018). Food, nutrient, and energy waste among school students. *British Food Journal*, 120(8), 1807–1831. <https://doi.org/10.1108/BFJ-11-2017-0611>
- Krishnan, R., Agarwal, R., Bajada, C., & Arshinder, K. (2020). Redesigning a food supply chain for environmental sustainability – An analysis of resource use and recovery. *Journal of Cleaner Production*, 242. <https://doi.org/10.1016/j.jclepro.2019.118374>
- Nalathambi, K. D., Satirin, K., Salleh, M., Hajar, S., Noh, M., Solaiman, H. S., & Jayaraman, R. (2023). Effort of Politeknik Malaysia as TVET institute in Attaining Sustainable Development Goals (SDGs) Through Twelfth Malaysia Plan. In *Borneo Engineering & Advanced Multidisciplinary International Journal (BEAM)* (Vol. 2, Issue 1). <https://beam.pmu.edu.my>
- Limuna, B., & Alwi, A. (2019). Pendekatan analisis SmartPLS dalam pembentukan model kemahiran hijau (KH). *Jurnal Penyelidikan Teknokrat II*, XXI. <https://myjms.mohe.gov.my/index.php/jpt/article/view/8408>

- Liu, C., & Nguyen, T. T. (2020). Evaluation of household food waste generation in hanoi and policy implications towards SDGs target 12.3. *Sustainability (Switzerland)*, 12(16). <https://doi.org/10.3390/su12166565>
- Liu, L., & Ramakrishna, S. (2020). An Introduction to Circular Economy. In *An Introduction to Circular Economy*. Springer Singapore. <https://doi.org/10.1007/978-981-15-8510-4>
- Machado, C. R., & Hettiarachchi, H. (2020). Composting as a Municipal Solid Waste Management Strategy: Lessons Learned from Cajicá, Colombia. In *Organic Waste Composting through Nexus Thinking: Practices, Policies, and Trends* (pp. 17–38). Springer International Publishing. https://doi.org/10.1007/978-3-030-36283-6_2
- Mannaa, M., Mansour, A., Park, I., Lee, D.-W., & Seo, Y.-S. (2024). Insect-based agri-food waste valorization: Agricultural applications and roles of insect gut microbiota. *Environmental Science and Ecotechnology*, 17. <https://doi.org/10.1016/j.ese.2023.100287>
- Martin-Rios, C., Hofmann, A., & Mackenzie, N. (2021). Sustainability-oriented innovations in food waste management technology. *Sustainability (Switzerland)*, 13(1), 1–12. <https://doi.org/10.3390/su13010210>
- Michalec, A., Fodor, M., Hayes, E., & Longhurst, J. (2018). Co-designing food waste services in the catering sector. *British Food Journal*, 120(12), 2762–2777. <https://doi.org/10.1108/BFJ-04-2018-0226>
- Ministry of Rural Development. (2019). *LUAR BANDAR SEJAHTERA*.
- Mohd Saiful Anuar Zainal, & Zakaria Abas. (2018). Adoption of circular economy for a sustainable solid waste management system in Malaysia. *Malaysian Management Journal*, 22, 35–51. <http://hdl.handle.net/11159/4481>
- Moqbel, S., Abu-Zurayk, R., Bozeya, A., Alsisan, R., & Al Bawab, A. (2020). Assessment of sustainable recycling at The University of Jordan. *International Journal of Sustainability in Higher Education*, 21(6), 1111–1129. <https://doi.org/10.1108/IJSHE-11-2019-0334>
- Moreira, A. M. M., GÃ¼nther, W. M. R., & Ribeiro, H. (2018). School of Public Health, University of Sao Pauloâ€™Marching Towards Socioeconomic and Environmental Sustainability. In *World Sustainability Series* (pp. 701–713). Springer. https://doi.org/10.1007/978-3-319-76885-4_47
- Naik, B., Kumar, V., Rizwanuddin, S., Chauhan, M., Gupta, A. K., Rustagi, S., Kumar, V., & Gupta, S. (2023). Agro-industrial waste: a cost-effective and eco-friendly substrate to produce amylase. *Food Production, Processing and Nutrition*, 5(1). <https://doi.org/10.1186/s43014-023-00143-2>
- Napathorn, C. (2021). The development of green skills across firms in the institutional context of Thailand. *Asia-Pacific Journal of Business Administration*. <https://doi.org/10.1108/APJBA-10-2020-0370>
- Nepal, M., Karki Nepal, A., Khadayat, M. S., Rai, R. K., Shyamsundar, P., & Somanathan, E. (2023). Low-Cost Strategies to Improve Municipal Solid Waste Management in Developing Countries: Experimental Evidence from Nepal. *Environmental and Resource Economics*, 84(3), 729–752. <https://doi.org/10.1007/s10640-021-00640-3>
- Olukanni, D. O., & Oresanya, O. O. (2018). Progression in waste management processes in Lagos State, Nigeria. *International Journal of Engineering Research in Africa*, 35, 11–23. <https://doi.org/10.4028/www.scientific.net/JERA.35.11>
- Papargyropoulou, E., Lozano, R., K. Steinberger, J., Wright, N., & Ujang, Z. Bin. (2014). The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production*, 76, 106–115. <https://doi.org/10.1016/j.jclepro.2014.04.020>

- Pavlova, A., Sergienko, O., Wang, Z., Heikinheimo, L., & Obuka, V. (2020). Creating aligned studies in resource efficiency and circular economy in the baltic sea region. *International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM, 2020-August(5.2)*, 685–692. <https://doi.org/10.5593/sgem2020/5.2/s22.084>
- Potting, J., Hekkert, M., Ernst Worrel, & Aldert Hanemaaijer. (2017). *CIRCULAR ECONOMY: MEASURING INNOVATION IN THE PRODUCT CHAIN*. <https://www.researchgate.net/publication/319314335>
- Pricilla Tan, Mapa, M. T. Bin, & Maulana, N. B. (2022). Pengurusan Sisa Makanan oleh Pengusaha Restoran: Kajian Kes di Kota Kinabalu, Sabah. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, 7(6), e001540. <https://doi.org/10.47405/mjssh.v7i6.1540>
- Prime Minister's Office of Malaysia. (2023, September 23). *Malaysia Madani*. INTIPATI KENYATAAN NEGARA SEWAKTU PERHIMPUNAN AGUNG PBB KE-78 – MALAYSIA MADANI 10/10.
- Puertas, R., Carracedo, P., & Marti, L. (2022). Environmental policies for the treatment of waste generated by COVID-19: Text mining review. *Waste Management and Research*, 40(10), 1480–1493. <https://doi.org/10.1177/0734242X221084073>
- Rahman, H. A. (2018). *Usaha dan Cabaran Dalam Mengaplikasikan Pendidikan Alam Sekitar Dalam Sistem Persekolahan di Malaysia (Efforts and Challenges in the Application of Environmental Education in Malay)*. <https://www.researchgate.net/publication/325486020>
- Ramlan, A. S., Mohamad Dzain, I. Z., & Hassan, R. (2023). The Application of Data Science on Food Waste Problem: A Preliminary Work. *International Journal on Perceptive and Cognitive Computing (IJPCC)*, 9(1). <https://doi.org/10.31436/ijpcc.v9i1.352>
- Rauf, A. R., Inanka, A. P., Anwar, A., & Dewi, F. (2023). *Smart Technology Adoption in Food Supply Chain to Tackle Climate Change: Practice in Small-Holder Farmers and SME* (pp. 317–324). https://doi.org/https://doi.org/10.2991/978-94-6463-144-9_31
- Reynolds, C., Goucher, L., Quested, T., Bromley, S., Gillick, S., Wells, V. K., Evans, D., Koh, L., Carlsson Kanyama, A., Katzeff, C., Svenfelt, Å., & Jackson, P. (2019). Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions. *Food Policy*, 83, 7–27. <https://doi.org/10.1016/j.foodpol.2019.01.009>
- Rocks, E., & Lavender, P. (2018). Exploring transformative journeys through a higher education programme in a further education college. *Education and Training*, 60(6), 584–595. <https://doi.org/10.1108/ET-02-2018-0047>
- Sadhan Kumar Ghosh. (2019). Circular economy: Global perspective (Malaysia). In *Circular Economy: Global Perspective*. Springer Singapore. <https://doi.org/10.1007/978-981-15-1052-6>
- Schroeder, P., Anggraeni, K., & Weber, U. (2019). The Relevance of Circular Economy Practices to the Sustainable Development Goals. *Journal of Industrial Ecology*, 23(1), 77–95. <https://doi.org/10.1111/jiec.12732>
- Shah, M. U., & Rezai, R. (2023). Public-sector participation in the circular economy: A stakeholder relationship analysis of economic and social factors of the recycling system. *Journal of Cleaner Production*, 400. <https://doi.org/10.1016/j.jclepro.2023.136700>
- Shevchenko, T., Saidani, M., Ranjbari, M., Kronenberg, J., Danko, Y., & Laitala, K. (2023). Consumer behavior in the circular economy: Developing a product-centric framework. *Journal of Cleaner Production*, 384. <https://doi.org/10.1016/j.jclepro.2022.135568>

- Smith, P. H. (2018). The paradox of higher vocational education: the teaching assistant game, the pursuit of capital and the self. *Educational Review*, 70(2), 188–207. <https://doi.org/10.1080/00131911.2017.1294148>
- Spencer, R. V. (2021). Improvement of Human and Environmental Health Through Waste Management in Antigua and Barbuda. In *Fostering Transformative Change for Sustainability in the Context of Socio-Ecological Production Landscapes and Seascapes (SEPLS)* (pp. 215–228). Springer Singapore. https://doi.org/10.1007/978-981-33-6761-6_12
- Suarez-Eiroa, B., Fernandez, E., Mendez-Martinez, G., & Soto-Onate, D. (2019). Operational principles of circular economy for sustainable development: Linking theory and practice. In *Journal of Cleaner Production* (Vol. 214, pp. 952–961). Elsevier Ltd. <https://doi.org/10.1016/j.jclepro.2018.12.271>
- Subramanian, N., & Suresh, M. (2022). The contribution of organizational learning and green human resource management practices to the circular economy: a relational analysis – Part I. *Learning Organization*, 29(5), 428–442. <https://doi.org/10.1108/TLO-12-2021-0143>
- Tamasiga, P., Miri, T., Onyeaka, H., & Hart, A. (2022). Food Waste and Circular Economy: Challenges and Opportunities. In *Sustainability (Switzerland)* (Vol. 14, Issue 16). MDPI. <https://doi.org/10.3390/su14169896>
- Varna Vishakar, V., Kumar, S., & Kumar, A. (2022). Design and analysis of biogas plant for the institutional campus. *Materials Today: Proceedings*, 69, 1498–1500. <https://doi.org/10.1016/j.matpr.2022.10.164>
- Waiker, V., Ambad, R., Joshi, A., & Khandal, V. (2020). An observance of household food remains compartment. *International Journal of Current Research and Review*, 12(18), 173–179. <https://doi.org/10.31782/IJCRR.2020.121826>
- Xue, L., Liu, X., Lu, S., Cheng, G., Hu, Y., Liu, J., Dou, Z., Cheng, S., & Liu, G. (2021). China's food loss and waste embodies increasing environmental impacts. *Nature Food*, 2(7), 519–528. <https://doi.org/10.1038/s43016-021-00317-6>
- Yuan, Q. H., & Tang, L. Y. (2021). The Principles in Green Design. *E3S Web of Conferences*, 259. <https://doi.org/10.1051/e3sconf/202125902002>
- Zborowski, M., & Mikulec, A. (2022). Dietary Catering: The Perfect Solution for Rational Food Management in Households. *Sustainability (Switzerland)*, 14(15). <https://doi.org/10.3390/su14159174>
- Zucaro, A., Maselli, G., & Ulgiati, S. (2022). Insights in Urban Resource Management: A Comprehensive Understanding of Unexplored Patterns. *Frontiers in Sustainable Cities*, 3. <https://doi.org/10.3389/frsc.2021.807735>
- Zubir, Z. M. M., Lai, S. C., Zaime, F. A., Lee, F. M., Ibrahim, B., & Ismail, A. (2021). Dimension of Green Skills: Perspectives from the Industry Experts. *JOURNAL OF TECHNICAL EDUCATION AND TRAINING*, 13(1), 159–166. <https://doi.org/10.30880/jtet>