

CIRCULAR E FOOD SUPPLY CHAIN FOR ACHIEVING ZERO FOOD WASTE GOALS: INSIGHTS FROM SRI LANKAN HOTEL INDUSTRY

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Abstract: As one of the largest food consuming industries in the world, the hotel industry makes a significant contribution to the global food waste generation. There is a significant impact for the sustainability in terms of food waste from the hotels. One of the major types of food waste generated in the hotel sector can be identified as “plate waste” which consists of edible foods, but not eaten by the guests. Similarly, in Sri Lanka, food waste can be identified as a growing problem due to rapid urbanization, and changes in lifestyles. The concept of circular economy has obtained world attention in reducing waste, hence adopting CE into food supply chain can be identified as an ideal way to achieve zero food waste goals of hotel industry. Since, a few studies have been specifically focused on investigating the application of CE concept in food supply chain in hotel industry, this research aimed to investigate the existing CE practices, and challenges faced when adopting CE into food supply chain of hotel industry in Sri Lanka. as the suitable research strategy, exploratory case study strategy was adopted in this research by investigating three selected hotels in Sri Lanka. Content analysis was used as a suitable data analysis technique. As derived through analysis, various insights from Sri Lanka hotel industry were derived and finally, a framework for CE transition of food supply chain for achieving zero food waste was developed. The developed framework provides important insights for CE transition in hotel industry to accelerate the existing waste management practices towards circularity. Hence, this research would be a key milestone for future research of transforming hotel industry towards circularity.

Keywords: *Circular Economy, Food Supply Chain, Zero Waste, Hotel Industry, Sri Lanka*

1. Introduction

Worldwide, food waste can be identified as a key issue that threatens food security and sustainability. Food waste is generated by the materials intended for the consumption of humans that are discharged, lost, degraded, or contaminated (Reitemeier et al., 2021). The hotel sector is a main sector which generates a high amount of food waste. Therefore, it is important to sustainably manage food waste among the business operations of the hotel sector to reduce food waste (Kasavan et al., 2017). Many strategies such as source reduction, donation and redistribution, waste recycling, waste treatment and recovery of energy are being used to manage food waste in a sustainable manner. The target 12.3 of UN’s Sustainable Development Goals refers to minimizing the per capita global food waste on retail and consumer levels by half and reducing food losses happening through the production and supply chains by 2030. However, the threat of food waste is still available at a considerable level. Similarly, in Sri Lanka, food waste can be identified as a growing problem with the ongoing changes of food systems, rapid urbanization, and changes in lifestyles (Reitemeier et al., 2021). The hotel industry contributes greatly to the generation of food waste since the hotels generate a high amount of food waste compared to the other types of waste (Sandaruwani & Gnanapala, 2016). The Circular Economy (CE) concept has obtained world attention in eliminating waste by transforming industries from linear to circularity (Camilleri, 2021). Accordingly, CE can be adopted into the supply chain to achieve circularity and to reduce waste. Hence, many research studies have been conducted on adopting CE into the supply chain of various industries in achieving various benefits. For example, Nattassha et al. (2020) have studied about the CE implementation in the agri-food supply chain. Another study has been conducted by Akinade and Oyedele (2019) on integrating construction supply chains within a circular economy by an Adaptive Neuro-Fuzzy Inference System (ANFIS)- based waste analytics system. Moreover, Agarwal et al. (2023) have studied about the obstacles for implementing CE in context of supply chain in rubber industry.

This research aims to investigate the application of circular economy (CE) practices within the food supply chain of Sri Lanka’s hotel industry, addressing the growing issue of food waste driven by rapid urbanization and lifestyle changes. However, a few studies have been specifically focused on investigating the application of CE concept in food supply chain in hotel industry. Tamasiga et al. (2022) have studied about challenges and opportunities relating to food waste and CE in food supply chain in hotel industry. Hence, it is evident in the previous literature that the consideration given up on the application of CE concept in food supply chain for achieving zero food waste in hotel industry is limited. To fill up the above research gap, this research seeks to answer the following research questions (RQs).

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RQ1: What are the existing CE practices of hotel industry in Sri Lanka?

RQ2: What are the barriers to adopting CE into the food supply chain of hotel industry?

RQ3: What are the strategies for CE transition in food supply chain for zero food waste of hotel industry in Sri Lanka?

2. Literature Review

2.1. FOOD WASTE GENERATION IN HOTEL INDUSTRY

According to Yu & Nagurney (2013), food supply chain can be defined as a dynamic and integrated system process which involve food brands, primary producers, processors, regulators as well as other resources tied up in different processes and governance. Food supply chains which can be identified as complex global networks for creating pathways for the food products from the farms to final consumers, (Yu & Nagurney, 2013), are different from other product supply chains, since there are a continuous and significant changes in the quality of food products throughout the entire process within the food supply chain (Dabbene et al., 2014). Food supply chain in hotel sector consists of different stages such as harvesting (production), procurement, transportation, storage, food preparation, food service, and waste management (Derqui et al., 2016).

Table 1 shows the different stages of the hotel food supply chain and the drivers for food waste generation within the stages of food supply chain.

Table 1: Food waste drivers in different stages in hotel food supply chain

Stage	Description	Food waste drivers
Harvesting (production)	This stage involves with the cultivation and harvesting of raw ingredients that need for food preparation.	Overproduction or surplus crops Crop damages during harvesting
Procurement	It is the process of acquiring necessary ingredients and products for the hotel.	Errors in the demand planning Overordering of perishable items Inadequate quality
Transportation	It involves the movement of raw ingredients and food products for the hotel.	Bruising while transporting Poor transport infrastructure Spoiling with delays
Storage	It is a process of storing and preserving of food items before food preparation while maintaining the quality of the products.	Damages form pests and insects Spoilage due to improper storage Expiring perishable items Natural drying out of food
Food preparation	It involves the cooking process which transform of raw ingredients into finished foods.	Process loss Inadequate quality Excess amount of preparation
Food service	It includes the presentation and delivery of meals to guests.	Oversizing of food portion Buffet overproduction Uneaten foods (plate waste)
Waste management	It includes handling and disposing of food waste which was generated throughout different stages of the supply chain.	Improper separation waste Lack of recycling programs

Source- Parfitt et al. (2010) and Derqui et al. (2016)

It is helpful to systematically manage the food products to eliminate the toxicity volume of waste as an alternative solution for the food waste problem (Seberini, 2020). In order to achieve zero food waste, the operation process of the organization can be changed by implementing Circular Economy (CE) concept which has been obtained world attention in eliminating waste by transforming business processes from traditional linear approach to circularity (Camilleri, 2021).

2.2 CIRCULAR ECONOMY FOR ACHIEVING ZERO FOOD WASTE GOALS IN HOTEL INDUSTRY

CE plays a vital role in achieving zero waste goals by transforming traditional linear model into a more sustainable circular model (Elisha, 2020). With the time, the concept of CE has been evolved with new concepts and it is still evolving (De Melo et al., 2022). After the 3R strategies, CE has been upgraded with 5R framework which consist of five strategies as Rethink, Reduce, Reuse, Repair and Recycle, since 3R has been insufficient in representing various loops for emphasizing CE (Ping Tserng et al., 2021). However, the latest concept of CE exists with ten “R” principles from R0 to R9, with the aim of reducing the consumption of natural resource and materials as well as reducing the waste generation (De Melo et al., 2022). Those principles are “Refuse, Rethink, Reduce, Re-use, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover” (Potting et al., 2017).

Zero waste concept can be identified as one of the recent concepts of the CE, with the aim of regenerating the waste in nature within the closed loops. The concept of CE can be adopted into the food supply chain to achieve zero food waste goals with an advanced closed-loop system (Camilleri, 2021). Leising et al. (2018) have been defined the circular supply chain in

their study as collaboration of supply chain and CE as a connecting network in the supply chain, by managing data transparency, material flows and exchanges, responsibilities, predictability and sharing benefits. Nowadays, it modifies supply chain with a closed-loop system where products and materials are designed with new ideas with aim of reusing, refurbishing, remanufacturing, and recycling (Elisha, 2020). The application of CE requires proper collaboration between every stage of the supply chain in order to create closed-loop system and share information (Sudusinghe & Seuring, 2022). Table 2 illustrates both applications of CE principles into different stages of food supply chain in hotel and the interactions among CE and food supply chain to achieve zero food waste goals.

Table 2: Applications and interactions of CE into food supply chain

Supply chain stages	CE applications	Interactions
Harvesting (production)	Reducing unnecessary production	Regenerative farming practices Using by-products
	Using advanced techniques for harvesting with less damages	
	Using of compost from wasted foods	
	Using recovered energy from the food waste (biogas)	
Procurement	Minimizing excess inventory	Inventory management and demand planning Smart menu planning
	Demanding planning with historical data analysis	
	Returning damage food items back to supplier	
Transportation	Reducing transportation time to enhance freshness	Frequent deliveries with small orders
	Using proper packaging to reduce damages for foods	
	Returning damage food items back to supplier	
Storage	Minimising overstock with proper inventory management practices	Inventory management Food preservation
	Following first-in first-out strategy and a proper labelling system	
Food preparation	Portion control to reduce overproduction	Energy-efficient cooking Connectivity with other departments
	Reducing resource utilisation	
Food service	Avoiding overproduction of buffet	Portion control Customer satisfaction Collaboration culture among waiters and guests
	Educating staff and guests for avoiding plate waste	
	Offering half portions and children’s menu	
Waste management	Conducting waste audits and analyse waste patterns	Food waste recycling Energy recovery
	Composting food waste	
	Recovering energy from the food waste (biogas)	

Sources: Derqui et al. (2016), Baratsas et al. (2021), Fassio et al. (2022), and Gonçalves & Maximo (2023)

According to Table 2, a number of interactions between CE and food supply chain can be identified with the application of CE into food supply chain in hotel sector. Refuse, Rethink, Recycle and Recover can be recognized as the most commonly applicable CE principles. However, these principles need to be applied to the food supply chain with different strategies, which regarded to relevant stage. Specially, composting of food waste and recovering of energy from food waste can be described as common strategies which is applicable for all the stages in food supply chain.

3. The selected case study: Hotel industry in Sri Lanka

Similar to the global context, food waste generation has become a growing problem in Sri Lanka due to the population growth, rapid urbanization, changes of food systems, and changes in lifestyles of humans (Reitemeier et al., 2021). Contribution of the hotel sector towards the food waste generation is a critical problem related to sustainability, with the high amount of food waste production from the hotels (Sandaruwani & Gnanapala, 2016) and with the limited landfilling capacity in Sri Lanka as an island (Kasavan et al., 2017). In order to reduce food waste generation, Sri Lanka is following different strategies. Additionally, several acts, ordinances and organizational level policies have been established to govern the waste management practices by addressing waste collection, waste recycling, waste disposal, waste reduction and waste prevention methods, such as solid waste management guidelines, National Environmental Act No. 47 of 1980 of Sri Lanka, which are not specific to food waste management (Aloysius & Ananda, 2023). The concept of CE has been used as an important technique for waste management in Sri Lanka for several years (Aloysius & Ananda, 2023). Then it helps to be easier to manage the food waste with an advanced closed-loop business process while reducing energy and resource utilization (Velenturf & Purnell, 2021). Even though Sri Lanka is following CE concept for waste management, the problems relating to food waste generation in the hotel sector are still exist (Peiris & Dayarathne, 2023). Hence, there is necessity of investigating on applicability of CE transition in food supply chain for achieving zero food waste in hotel industry.

4. Research Methodology

The existing CE practices, and barriers to adopt of hotel industry in Sri Lanka were studied by adopting exploratory case study strategy under qualitative research phenomenon. There are three main research approaches as qualitative approach, quantitative approach, and mixed approach (Pluye et al., 2009). According to Pluye et al. (2009), the qualitative approach considers on interpreting with an idealistic or humanistic perspective, while qualitative approach requires comprehensive and in-depth information on the study. The mixed approach is a method that integrates both quantitative and qualitative approaches. As stated by Yin (2011), exploratory case study is an effective method to obtain deep understanding of phenomenon or topic which involves conducting a detailed investigation of a specific case to explore and generate new insights. Accordingly, 03 five star rated hotel buildings were selected and studied representing a sample of the hotel industry in Sri Lanka. Direct observations and semi-structured interviews were conducted with the selected professionals from each case, namely, facility managers, food, and beverage managers, to name a few. Altogether, 09 semi-structured interviews were conducted consisting of 03 interviews from each case.

The details of the interviewees are presented in Table 3.

Table 3: Profile of the interviewees

Case	Interviewee	Years of Experience
Case A	Sustainability executive	06
	Kitchen stewarding manager	10
	Executive chef	28
Case B	Chief engineer	30
	Purchasing officer	28
	Assistant engineer	05
Case C	Maintenance engineer	15
	Purchasing officer	10
	Sustainability executive	06

The collected data were analysed by using content analysis technique. Content analysis is a widely used approach for analysing qualitative data, making it the most prevalent technique in the field. (Wahyuni, 2012). As expressed by Guthrie et al. (2004), content analysis is a data gathering method that involves systematically categorizing quantitative information into predetermined categories.

5. Analysis and Findings

Through the investigation of selected hotel buildings in Sri Lanka, the existing CE strategies were recognized under supply chain stages: harvesting (production), procurement, transportation, storage, food preparation, food service, and waste management. Table 4 summarizes the existing CE practices of hotel industry in Sri Lanka.

As the majority of experts pointed out, using home grown food items from roof gardens and in-house vegetation areas which promote local harvesting and pest control are considered highly during harvesting stage to avoid food waste in hotel buildings. Initiating an environmental and sustainability purchasing policy within the organization was identified as a key strategy for reducing food waste. Further, having an appropriate quality assessment and control of food items was also recognized by several professionals that was also highlighted in previous literature. providing appropriate packaging, use of local suppliers are other existing CE strategies adopted in hotel buildings in Sri Lanka. Avoid overproduction of buffet,

offering half portions and children’s menu and educating staff and guests for avoiding plate waste are also identified as existing CE practices of hotel buildings as stated by many professionals. By analysing the previous literature as well as existing CE practices adopted to reduce food waste of hotel industry in Sri Lanka, a framework for CE transition of food supply chain for zero food waste was developed as shown in Figure 1.

Table 4: Existing CE practices of hotel industry in Sri Lanka

Supply chain stages	Existing CE practices	Case A			Case B			Case C		
		A1	A2	A3	B1	B2	B3	C1	C2	C3
Harvesting	Using crop rotating strategy for changing the farming patterns of vegetables and fruits	x								
	Growing seasonal food items							x		
	Using pest control strategies to reduce the pest damages to plants.	x			x			x		
	Applying tree coverings to cover the plants to minimize the impact of sea breeze.	x	x			x			x	x
	Using home grown food items from roof gardens and in-house vegetation areas which promote local harvesting	x	x	x			x		x	x
Procurement	Following an Environmental and sustainability purchasing policy	x	x					x		x
	Selecting suppliers who can provide quality products.	x				x			x	
	Quality assessment and control of food items when purchasing	x							x	
Transportation	Selecting local and nearby suppliers to reduce transportation time and avoid damages during transportation of food items.	x			x	x				
	Using appropriate food packaging					x			x	x
Storage	Adopting proper inventory management practices	x	x							
	Purchasing food from nearby suppliers to maintain freshness	x			x	x		x	x	
Food preparation	Avoiding overproduction of buffet		x	x				x		
	Offering half portions and children’s menu									
Food service	Educating staff and guests for avoiding plate waste			x	x	x				
Waste management	In-house composting facility for food and other bio-degradable waste	x								x
	Providing food waste for piggery farms rather landfilling			x						
	In-house bio-gas plant using food waste			x	x					

The developed framework can be applied as a basis to transit the hotel industry in any similar context towards circularity to achieve zero food waste by adopting the proposed practices in food supply chain. The framework provides important insights for CE transition in the hotel industry specifically for achieving zero food waste goals. The CE strategies proposed under each stage of the food supply chain give a firm basis to accelerate the existing waste management practices towards circularity. Further, this research can be used as a basis for initiating institutional level policies and procedure to adopt the concept of CE within the food supply chain of the hotel industry. The CE concept can be implemented by adopting into the different stages in the hotel operations. It can be adopted into the food supply chain of the hotels, as one of the good places that can be implemented to ensure food security and to improve sustainability of supply chain (Sharma et al., 2019). However, various challenges hinder the adoption of the CE concept in the hotel industry.

6. Discussion

As derived through analysis, unavailability of adequate strategies, knowledge and innovative solutions can be recognized as a major disadvantage for adopting CE for the hotel industry in Sri Lanka. In addition to that, lack of awareness of the internal stakeholders such as managers and employees as well as the external stakeholders such as suppliers and customers can be another great barrier to successfully applying CE into the hotel sector. Moreover, behavioural factors and attitudes of the

customers may lead to increase the food waste generation in the hotel sector, as a drawback for adopting CE into the Sri Lankan hotel industry. Existing literature also proves that many national and organizational barriers could impede the CE transition in the hotel industry. Table 5 summarizes the organizational and national level barriers faced by hotel industry in Sri Lanka when transforming the industry towards circularity to reduce food waste.

Table 5: Challenges for CE transition of hotel industry in Sri Lanka

Barriers	
Institutional level	Lack of expertise knowledge
	High initial cost of investment
	Lack of awareness and leadership of the internal stakeholders
	Behavioural factors and attitudes of the employees and guests
	Issues related to space availability
	Unavailability of proper institutional guidelines for CE
	Unavailability of sustainability policies in hotels
National level	Unavailability of national level policy to manage food waste
	Unavailability of national level policy for CE
	Unavailability of incentives by the government for adopting CE
	Unavailability of modern technology provisions

Figure 1 presents the proposed framework developed from insights gathered through literature findings and semi-structured interviews. This framework illustrates strategies for reducing food waste by applying circular economy principles, showing how these principles can be effectively integrated to minimize waste within the hotel sector.

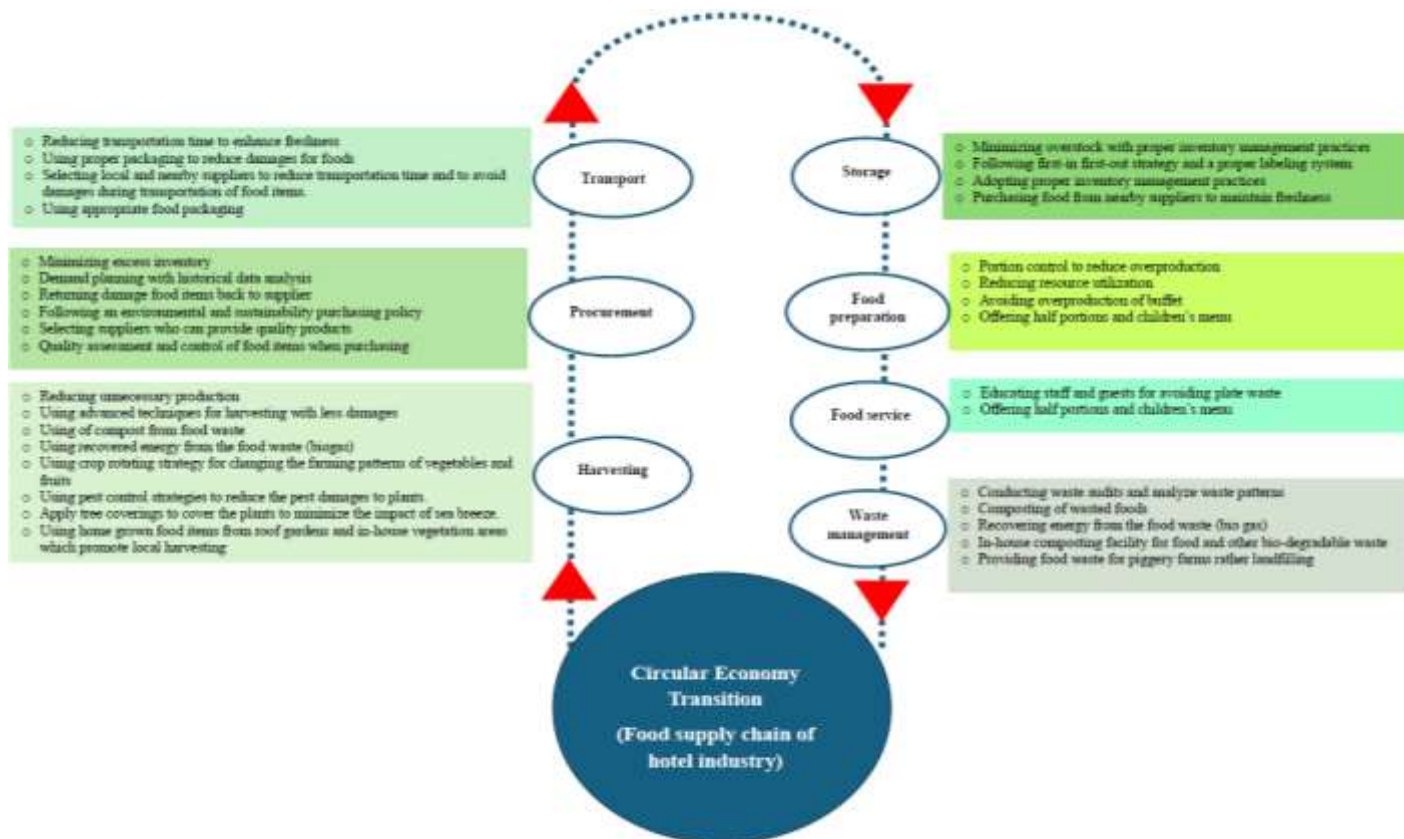


Figure 1: Proposed framework

According to the study of Gedam et al. (2021), the barriers for adopting CE have been categorized into several sub-categories as economic, technology & information, supply chain related, institutional, organizational, social, and environmental. High initial cost of investment can be identified as a major economic barrier for adopting CE, since transitioning towards CE could requires high initial investments for new infrastructures, processes, and technologies for the activities such as recycling, remanufacturing, and refurbishment (Su et al., 2013). Lack of technology, techniques and innovation can be recognized as a technology and information related barrier for adopting CE for an organization. The

presence of new technologies and innovative solutions is a prerequisite for the adoption of CE, and as it is interconnected with the financial capabilities of the organization, lack of technology, and innovation is a barrier for adopting CE (Ghisellini et al., 2016). When it comes to the closed-loop supply chain with the application of CE, it can be complex with the involvement of many stakeholders at various stages (Principato et al., 2019). Therefore, the lack of supply chain design and optimization can be identified as a barrier for CE adaptation (Gedam et al., 2021). In addition to that, coordinating all the stakeholders among supply chain in CE approach can be challenging for the organization (Ghisellini et al., 2016). Further, lack of awareness, collaboration and leadership can be identified as an organizational barrier for adopting to CE practices (Gedam et al., 2021). In the process of transition towards CE, the awareness and collaboration of the internal stakeholders as well as proper leadership is an essential factor (Su et al., 2013). Therefore, proper training programs should be conducted to improve the awareness and skills, otherwise it redirects to another barrier due to lack of training and skills (Gedam et al., 2021). When considering about social barriers for adopting to CE, lack of awareness of external stakeholders such as consumers and suppliers can be recognized, since the involvement of consumers and suppliers is an essential factor to transition towards CE from linear economy (Sharma et al., 2019).

7. Conclusions and a way forward

As one of the largest food consumers in the world, the contribution of hotels towards food waste generation is considerably high, since 50% of the food waste from total solid waste is generated by the hotel sector. In the hotels, food waste is generated by both intentional actions and unintentional losses. When it comes to the food supply chain in the hotel industry, it consists of different stages such as harvesting (production), procurement, transportation, storage, food preparation, food service, and waste management. Food supply chain creates a pathway to food products. On the other hand, it contributes to generating food waste throughout the process. Starting with harvesting, each of the stage in food supply chain contributes to the food waste generation in hotel sector. The concept of CE which has been obtained world attention in eliminating waste by transforming business processes from traditional linear approach to circularity, can be integrated with the hotel food supply chain, with the aim of achieving zero food waste goals. With the application of CE concept, a wide range of interactions between CE and food supply chain can be recognized such as innovative design process, raw material and energy optimization, waste reduction and extended producer responsibility.

CE transition of hotel industry can be considered through the enhancement of food supply chain. Several benefits can be achieved by applying CE in different stages in the supply chain. Primarily, application of CE encourages to upgrade the business processes by reducing waste generation in every stage of the supply chain. Hence, various CE strategies and interactions between CE and food supply chain were derived through the literature. The investigation was mainly focused on the selected case study of hotel industry in Sri Lanka in order to identify current CE or related food waste management practices, barriers to adopt CE and possible strategies for CE transition. Even though, the concept itself was not recognized in hotel industry, many CE practices were recognized through the investigation, such as reducing excessive crop production, using advanced techniques for harvesting with less damages, reducing transportation time, to name a few. Combining the insights from both literature and case studies, a framework for adopting CE into the food supply chain of hotel industry was then developed. The developed framework provides significant insights for CE transition in the hotel industry to accelerate the existing waste management practices towards circularity.

However, several organizational level barriers were recognized, which could hinder the CE transition in the hotel industry, such as lack of expertise, high initial cost, lack of awareness, employee behaviour and attitudes of guests. Nevertheless, unavailability of national policy for CE transition of hotel industry for achieving zero food waste, unavailability of government incentives for organizations and lack of modern technology provisions were identified as national level barriers to adopt CE. The research findings suggest that it is essential to have a national level mechanism for CE transition. Further, establishing organizational level guidelines will also be important for successfully adopting the CE concept in the hotel industry to achieve zero food waste goals. The next stage of this research will be focusing on proposing the provisions and improvements for a national policy of CE. This research highlights how circular economy (CE) principles can help the hotel industry reduce food waste, providing a framework with actionable strategies like efficient inventory management and waste-to-resource initiatives. By adopting CE practices, hotels can lower costs, improve their sustainability image, and meet increasing environmental expectations from consumers. The study also suggests policy support for waste reduction and lays a foundation for future research, emphasizing the need for training and awareness among hotel staff to foster a sustainability-focused culture.

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