Applying the Multilayer Zero-Waste Concept through Design Thinking in the Food and Beverage Industry: A Case Study of Rummi Kopi Lan Tresna

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ABSTRACT

Indonesia is one of the largest contributors to global food waste, creating significant environmental, economic, and social challenges. The high volume of organic and packaging waste generated by the Food and industry Beverage (F&B) threatens sustainability and highlights the urgent need for innovative and effective waste management strategies. This study explores the application of a multilayer zero-waste concept using a Design Thinking approach within the F&B industry, focusing on reducing both food and packaging waste while enhancing operational efficiency and promoting sustainable business practices. A qualitative research method was employed, conducted at Rummi Kopi Lan Tresna in Bogor, West Java, Indonesia, using data collected through direct observation and interviews with kitchen staff, baristas, and management. The research applied the five stages of Design Thinking-Empathize, Define, Ideate, Prototype, and Test-to identify key waste management challenges and develop tailored, practical solutions. The findings reveal that approximately 30% of served food remained uneaten, primarily due to oversized portions and limited customer awareness, while waste separation practices were minimal, resulting in organic and non-organic waste being mixed. The structured application of Design Thinking enabled the establishment of a comprehensive waste management system focused on preventive measures, process improvements, and post-use handling, significantly reducing waste and improving resource efficiency. This study concludes that integrating zero-waste principles with Thinking not only optimizes Design resource use but also fosters sustainable operations and increases stakeholder engagement within the F&B sector. The offers research original insights bv synthesizing zero-waste strategies with Design Thinking in a real-world F&B context, providing actionable and scalable solutions for practitioners, policymakers, and businesses aiming to implement environmentally responsible and economically viable waste management practices.

Keywords: Zero waste, Design Thinking, food waste, circular economy, F&B industry

INTRODUCTION

Indonesia is recognized as one of the world's largest contributors to food waste. According to The Economist Intelligence Unit (2021), Indonesia ranks second globally after Saudi Arabia in terms of per capita food waste, averaging 300 kilograms of food waste per person per year. This

waste originates from various stages of the supply chain, including production, distribution, and consumption. At the household level, data from the Central Bureau of Statistics (BPS, 2022) indicate that the average household food waste generation reaches 77 kilograms per capita annually.

Moreover, data from the Ministry of Environment and Forestry (KLHK, 2022) show that food waste accounts for 41.07% of the total waste in Indonesia, amounting to approximately 20.93 million tons per year, making it the highest in Southeast Asia. This high volume reflects a major challenge in managing food waste, highlighting the need for sustainable solutions to mitigate environmental impacts and enhance supply chain efficiency within the Food and Beverage (F&B) industry.

In addition to food waste, the beverage sector also produces significant packaging waste. Data from KLHK (2021) reveal that plastic waste comprises 15.57% of Indonesia's total waste, amounting to around 9.8 million tons per year. Meanwhile, the plastic recycling rate remains low at approximately 10%. This contributes serious situation to environmental issues, such as marine pollution and the spread of microplastics, posing threats to ecosystems and human health.

The impacts of food and beverage waste are wide-ranging, encompassing economic, social, and environmental dimensions. Economically, food waste in Indonesia is estimated to cause losses ranging from IDR 213 trillion to IDR 551 trillion per year, demonstrating significant inefficiencies in Environmentally, resource utilization. poorly managed food waste contributes approximately 7.29% of Indonesia's total greenhouse gas emissions.

Socially, food waste highlights the disparity between food availability and access. In 2023, it was estimated that over 23 million Indonesians were unable to meet their basic food needs. Additionally, unmanaged beverage packaging waste has heavily polluted rivers and oceans. Indonesia is among the largest contributors of marine plastic waste, with an estimated 0.48 to 1.29 million metric tons entering the oceans annually as of 2015.

Sustainability and the circular economy have become global priorities, with various initiatives and policies being adopted worldwide. In Indonesia, the government has demonstrated its commitment to waste reduction through numerous policies and targets. The application of the zero-waste concept in the food and beverage industry aligns with these goals and supports national efforts to reduce waste.

Although numerous studies have explored zero-waste practices and Design Thinking independently, research integrating these two concepts specifically within the context of the Indonesian F&B industry remains limited. This study seeks to bridge this gap by examining how the multilayer zero-waste concept can be effectively applied using Design Thinking methodologies to address waste management challenges in the Food & Beverage sector.

MATERIALS & METHODS

This study was conducted at Rummi Kopi Lan Tresna, a Food and Beverage (F&B) business located in Sentul, Bogor Regency, West Java, Indonesia. The research site was selected purposively, based on specific criteria that support the study's objectives. In qualitative research, purposive sampling is used to ensure that the site possesses characteristics aligned with the phenomenon being studied and can provide rich, in-depth data (Creswell & Creswell, 2014).

Rummi Kopi Lan Tresna was selected despite because. the incomplete implementation of management waste practices, there were initial efforts towards waste reduction strategies, making it a relevant case study for offering zero-waste and circular economy solutions in the F&B industry. Early steps, such as the utilization of food scraps and growing awareness of waste separation, had been observed. although systematically not yet

implemented. Facing waste management challenges, Rummi Kopi Lan Tresna provided an experimental ground for applying Design Thinking methods to develop innovative, replicable solutions for the F&B sector.

In qualitative research, direct interaction with research subjects is essential for obtaining accurate, contextual data (Miles & Huberman, 1994). Rummi Kopi Lan Tresna offered an ideal environment for comprehensive operational observations, covering the kitchen, bar, and customer service areas, allowing researchers to gain a deep understanding of consumption patterns and food waste management. Therefore, the site's selection was consistent with qualitative research strategies emphasizing exploration understand deep to the implementation of zero-waste concepts in the F&B industry (Patton, 2002).

This study utilized Design Thinking as the primary framework for analyzing and developing innovative waste management solutions within the F&B industry. Design Thinking is a problem-solving approach that combines analytical and creative processes, enabling individuals to experiment, prototype, and redesign solutions based on iterative feedback (Razzouk & Shute, 2012). The approach emphasizes the exploration of innovative solutions grounded in user empathy, offering flexibility to tailor solutions to real-world needs. In this study, Design Thinking enabled a systematic, datadriven evaluation of consumption patterns, kitchen operations, and waste management practices at Rummi Kopi Lan Tresna.

Moreover, the approach emphasizes collaborative innovation, involving multiple stakeholders such as kitchen staff, baristas, restaurant management, and customers in the solution development process. This collaborative principle aligns with the concept of participatory design, which asserts that stakeholders directly involved in a system should actively participate in designing solutions to ensure practical, context-appropriate outcomes (Brown. 2009). Thus, the use of Design Thinking in this study aimed not only to create a more efficient waste management system but also to ensure that solutions are sustainable and accepted by the operational team at Rummi Kopi Lan Tresna.

The method also provided flexibility in challenges responding to encountered during implementation. In the F&B industry, waste management often faces issues such as mismatches between raw material planning and actual demand (Tavill, 2020), as well as barriers like low consumer awareness and logistical constraints in waste segregation (Costello, 2019). By adopting Design Thinking, this study integrated the principles of "Slow the Loop," "Narrow the Loop," and "Close the Loop" from the circular economy framework to address such challenges (Bocken et al., 2017). Therefore, the application of Design Thinking in this research aimed to identify core problems at each operational stage, develop alternative solutions based on the "Reduce - Optimize - Recycle" concept, and iterate solutions for maximum effectiveness.

The study followed the five key stages of Design Thinking developed by Stanford d.school (Sakama et al., 2018):

Empathize: Understanding user perspectives and identifying major waste management problems.

Define: Structuring and analyzing issues to formulate actionable solutions.

Ideate: Generating and exploring innovative ideas for waste reduction strategies.

Prototype: Implementing solutions in initial models for effectiveness testing.

Test: Evaluating prototype effectiveness based on feedback, performing iterations, and refining solutions.

Primary data were collected through direct observation and interviews with management and operational staff at Rummi Kopi Lan Tresna, including the Head Chef, kitchen staff, Head Barista, junior baristas, Head Front-of-House, and floor captains. The purpose was to understand challenges and practices related to food and beverage waste management. Additionally, secondary

data were obtained through a literature review, encompassing scholarly articles, journals, books, and other relevant sources on zero waste, circular economy, and Design Thinking applications in the F&B industry.

This study also employed a hypothesis to guide the formulation and analysis of the research problem. According to Sugiyono (2016), a hypothesis is a temporary answer to a research problem, subject to validation through data analysis and findings. The hypotheses formulated in this study were: H0 (Null Hypothesis):

H0 (Null Hypothesis):

The application of Design Thinking methods in food and beverage waste management at Rummi Kopi Lan Tresna does not succeed in creating a more efficient system for waste reduction and operational sustainability.

H1 (Alternative Hypothesis):

The application of Design Thinking methods in food and beverage waste management at Rummi Kopi Lan Tresna succeeds in creating a more efficient system for waste reduction and operational sustainability.

The research framework was based on the Design Thinking process, comprising the following five stages:

Empathize: Conducting observations and interviews with the Head Chef, kitchen staff, Head Barista, junior baristas, Head Front-of-House, and floor captains to understand waste management systems in the kitchen, bar, and customer service areas, as well as observing customer interactions with food and beverages to identify consumption patterns and potential wastage. Define: Identifying core problems based on observation and interview results. categorized into three main stages-Pre-Process. Process, and Post-Processfocusing on challenges in raw material efficiency, serving practices, and waste segregation systems.

Ideate: Conducting brainstorming sessions with the operational team to explore

references and strategies for optimizing food and beverage waste management based on the circular economy framework.

Prototype: Testing developed concepts through small-scale implementation, providing recommendations, and adjusting strategies to ensure operational fit at Rummi Kopi Lan Tresna.

Test: Analyzing the implementation results and evaluating the effectiveness of the solutions based on staff feedback and observed changes in waste management practices, to ensure that the adopted solutions improve sustainability and operational efficiency.

RESULT & DISCUSSION

Empathize

The Empathize phase in Design Thinking aims to deeply understand existing problems before designing appropriate solutions. In this study, the empathizing process was conducted through observations and interviews with the kitchen, bar, and service staff at Rummi Kopi Lan Tresna, a restaurant offering traditional Indonesian cuisine located in Bukit Sentul, Cijayanti, Bogor Regency, West Java, Indonesia. Observations were made by monitoring employee work patterns in handling food ingredients and waste, while interviews explored daily experiences and challenges encountered in the waste management system.

Findings from the observations and interviews revealed that waste segregation was still suboptimal, with organic and nonorganic waste frequently mixed. complicating recycling processes. In the kitchen, approximately 30% of vegetable parts were unused and discarded without further utilization. Moreover, chicken and beef offals often spoiled due to inefficient stock rotation. From the customer side, about 30% of main dishes, particularly snacks like fried bananas and cassava, were often left uneaten, indicating a need to adjust portion sizes to minimize leftovers.

In the bar area, coffee grounds were disposed of without reuse, despite their

potential to be processed into fertilizer or cosmetic products like facial scrubs. Additionally, plastic and glass waste management was unstructured, leading to an accumulation of unmanaged waste. Staff awareness regarding zero-waste practices remained low, and no systematic internal efforts were in place to reduce and manage waste efficiently.

The understanding of problems is illustrated in the Empathy Map presented in Table 1.

Table 1. Empathy Map	
Say/Do	Thinks
"We don't have a clear waste separation system,	"We want to manage waste better, but don't know where
so all waste is often mixed."	to start."
"There are a lot of coffee grounds every day, but	"If there were a simple way to reuse waste like coffee
we don't utilize them."	grounds, we would try it."
"Many customers don't finish their food,	"If there were policies supporting waste reduction, we
especially snacks."	would be willing to follow them."
"We are confused about how to manage waste in	"There should be strategies to reduce customer food
an environmentally friendly way."	leftovers."
Disposing of all types of waste together without	
separation.	
Ignoring food leftovers without initiatives to	
minimize food waste.	
Lack of recycling or waste processing habits in	
the kitchen and bar.	
Feel	See
Confusion about starting zero-waste initiatives.	No clearly separated waste bins, causing organic and
Interest if simple solutions are available.	non-organic waste to be mixed.
Concern about the environmental impact of	A significant amount of uneaten customer food,
generated waste.	especially snacks.
	Daily disposal of coffee grounds without further
	utilization.
	Accumulation of unmanaged plastic, glass, and paper
	waste.

Define

In the Design Thinking context, the Define stage aims to formulate a user-centered problem statement to direct solution development effectively (Doorley et al., 2018). Based on the findings from the Empathize stage, the main waste management problem at Rummi Kopi Lan Tresna can be framed as follows:

"How might Rummi Kopi Lan Tresna optimize organic and non-organic waste management through separation systems, reuse strategies, and educational initiatives for staff and customers to achieve greater sustainability and efficiency?"

To guide solution development during the Ideate phase, several "How Might We" (HMW) questions were formulated (Kolko, 2015), including:

- 1. How might Rummi Kopi Lan Tresna reduce customer food leftovers without compromising the dining experience?
- 2. How might the restaurant reuse organic waste such as coffee grounds and food scraps more effectively?
- 3. How might a simple and effective waste separation system be implemented across all staff?
- 4. How might customer awareness of waste management be increased?
- 5. How might partnerships with recycling communities or waste banks be established to enhance non-organic waste recycling?

This problem framing ensures that solutions in the Ideate phase are specific, actionable, and aligned with improving structured, sustainable, and impactful waste management at Rummi Kopi Lan Tresna.

Ideate

1. Prevention Stage (Preventive)

The prevention stage focuses on initial strategies to minimize food waste generation within the Food and Beverage (F&B) industry. Key initiatives at this stage include resource planning, menu and portion design, internal awareness building, and customer education.

inventory First. management and procurement planning play a critical role in minimizing food waste. Adjusting raw material purchases based on historical demand data helps avoid overstocking, which can lead to spoilage (Ashraf et al., 2020). Selecting suppliers who provide fresh, high-quality raw materials is equally important in minimizing early spoilage. The application of the First In, First Out (FIFO) system ensures that older inventory is used before newer stock, reducing the risk of expiration (Bartelmeß & Godemann, 2020). Written Standard Operating Procedures (SOPs) for monitoring sensitive ingredients, such as meat and vegetables, are necessary to guarantee optimal storage conditions.

Second, menu and portion design can significantly contribute to reducing food waste. Offering flexible portion sizes—for example, child-sized or half portions based on customer segmentation can reduce unfinished meals. Utilizing multifunctional ingredients across multiple menu items also increases operational flexibility and minimizes wastage.

Third, raising internal awareness and providing staff training are crucial. Staff must understand the importance of waste management to improve operational efficiency (Zhang et al., 2020). Clear SOPs on waste separation at early stages, distinguishing between organic and nonorganic waste, must be implemented.

Finally, collaborating with external parties such as waste banks, composting centers, or maggot farms supports broader waste management efforts. Collaborations, like utilizing organic waste for maggot farming (Morone et al., 2019), help reduce waste sent to landfills and create additional environmental and economic value. Governmental support in the form of educational programs and recycling facilities is also vital.

By implementing these preventive measures, F&B businesses can significantly minimize food waste from the outset, align operations with circular economy principles, and build environmental awareness internally and externally (Korhonen et al., 2018).

2. Process Stage

During the operational stage, strategies to reduce spontaneous food and beverage waste generation must be applied proactively, focusing on direct interactions between staff and customers.

Effective communication between staff and customers is crucial to minimizing order errors that result in food waste. Research shows that communication highlighting the social benefits of food waste reduction can enhance customer trust and engagement (Xu & Jeong, 2024).

One implemented strategy was reconfirming customer orders—particularly regarding special preferences like spiciness levels, modifications, ingredient and portion sizes—before processing. This approach minimizes mismatches between customer expectations and served products, one of the major causes of restaurant food waste. Proactive staff interventions in advising over-ordering customers against have proven effective in reducing food waste (Yu et al., 2020).

Additionally, when customers fail to finish their meals, staff members actively offer takeaway options to ensure that food still fit for consumption is not wasted. This practice aligns with studies showing that encouraging food takeaway significantly reduces waste (Yoon, 2015).

Internal communication among kitchen and bar staff was also improved to ensure orders are prepared exactly as requested, with verification steps introduced prior to serving to minimize production errors.

3. Post-Process Stage (Waste Management)

Post-consumption waste management focuses on systematically processing organic and non-organic waste based on circular economy principles.

Organic waste management should prioritize composting, maggot farming, and by-products. upcycling of Properly separating and processing kitchen scraps, fruit peels, coffee grounds, and food leftovers can generate compost that enriches soil fertility (Lazcano & Domínguez, 2019; Zaman, 2020). Maggot farming using food waste—especially protein-rich scraps offers an eco-friendly method to produce high-value animal feed while reducing waste volume by up to 80% (Hassan et al., 2020).

Upcycling coffee grounds into products such as fertilizer or skincare items, like natural scrubs, adds further economic and environmental value (Lehmann & Joseph, 2019). Moreover, leftover bones and offals can be reused to create broths and stocks, ingredient utilization maximizing and minimizing waste-a best practice commonly adopted in sustainable restaurant operations (Zaman, 2020).

For non-organic waste, an effective waste separation system is essential. Providing color-coded bins for plastics, glass, paper, and metals simplifies recycling efforts (Ghisellini et al., 2016). Collaborating with waste banks and recycling companies ensures that separated materials are properly processed. Reducing single-use plastics by adopting refillable systems—such as reusable straws and glass bottles-also contributes to environmental sustainability while enhancing the restaurant's ecoconscious brand image (Geissdoerfer et al., 2017).

Finally, practices such as returning reusable glass bottles to suppliers and sending cardboard waste to recycling industries support closed-loop material cycles, aligning with the principles of a circular economy (Ellen MacArthur Foundation, 2015).

Prototype

To develop innovative solutions based on the Design Thinking approach and apply circular economy principles within Rummi Kopi Lan Tresna's operations, a structured Standard Operating Procedure (SOP) was designed. This SOP ensures that every employee understands and implements effective waste management practices, aiming to reduce environmental impacts and improve operational efficiency. The SOP covers guidelines for waste separation, reuse, and recycling of both organic and non-organic waste.

Standard Operating Procedure (SOP) for Waste Management at Rummi Kopi Lan Tresna

1. Objective

This SOP aims to regulate the waste management system at Rummi Kopi Lan Tresna to enhance efficiency, reduce environmental impacts, and embed sustainability principles into restaurant operations.

2. Scope

This SOP applies to all waste management activities, encompassing pre-waste handling, operational waste handling, and post-waste evaluation, involving all employees including kitchen staff, baristas, service personnel, and cleaning teams.

- 3. Definitions
- Organic Waste: Decomposable materials such as food scraps, fruit peels, and coffee grounds.
- Non-Organic Waste: Plastics, glass, paper, and metals requiring special recycling processes.
- Compost: Organic fertilizer produced from decomposed organic waste.
- Maggot: Larvae of the Black Soldier Fly (BSF) used for converting organic waste into animal feed.
- 4. Waste Management Procedures
- a. Pre-Waste Management (*Reduce & Awareness*)
- 1) Initial Waste Separation
- i. All operational areas must be equipped with color-coded waste bins:

- Green: Organic waste (food scraps, coffee grounds, fruit peels)
- Blue: Paper and cardboard
- Yellow: Plastic (packaging, straws, plastic bottles)
- Red: Glass and metal
- ii. Employees must dispose of waste according to the appropriate category.
- 2) Training and Education
- i. Employees receive regular training sessions on waste separation and environmental sustainability practices.
- Customers are educated through posters and digital media about the waste management initiatives at Rummi Kopi Lan Tresna.
- 3) Food Waste Prevention
- i. Adjusting portion sizes to minimize food waste.
- ii. Offering smaller portion options to customers.
- iii. Optimizing the use of ingredients to maximize raw material efficiency.
- b. Operational Waste Management (Reuse & Recycling)
- 1) Organic Waste Processing
- i. Composting:
- Organic waste (vegetables, fruit peels, coffee grounds) is collected in composting containers.
- Materials are mixed with dry additives such as sawdust or dry leaves.
- Compost is aerated every three days to maintain moisture balance.
- Mature compost is ready after 4–6 weeks and can be used for agricultural purposes.
- ii. Maggot Cultivation:
- High-protein food scraps (offals, greasy leftovers) are collected in designated containers.
- These scraps are fed to Black Soldier Fly larvae (BSF) for biomass conversion into animal feed.
- Cultivation areas must be kept clean to prevent odors.
- 2) Non-Organic Waste Processing
- i. Plastic and Paper:

- Paper and cardboard are stored for recycling or sent to waste banks.
- Plastics are collected and handed over to recycling agents.
- ii. Glass and Metal:
- Glass bottles are collected for return to suppliers or recycling.
- Metals and cans are gathered and sold to scrap collectors.
- c. Post-Waste Management (Monitoring & Evaluation)
- 1) Monitoring and Evaluation
- Cleaning teams are responsible for daily checks on waste separation compliance.
- Monthly audits evaluate the effectiveness of waste management practices.
- Quarterly reports are prepared to track waste reduction progress and recycling achievements.
- 2) Incentives and Recognition
- Employees consistently adhering to waste management practices may receive incentives or awards.
- Customers who bring reusable containers or consistently finish their meals may be offered special discounts.

Managerial Implications

Rummi Kopi Lan Tresna must continue to enhance innovation in waste management to establish a more sustainable and efficient operational system. The optimization of waste segregation and reutilization—such as processing coffee grounds into fertilizer or cosmetic products—can significantly strengthen the brand image of Rummi Kopi Lan Tresna as an environmentally conscious restaurant.

Reducing food waste through strategies such as portion adjustments and customer education initiatives can contribute to efforts broader sustainability while minimizing the negative environmental impacts of restaurant operations. Moreover, proactive waste management aligns with expectations evolving customer for businesses that prioritize environmental stewardship.

The implementation of an effective waste management system requires not only a deep understanding of operational challenges but also experience in exploring circular economy concepts. Creativity plays a critical role in identifying innovative waste management solutions, such as utilizing food scraps for maggot cultivation or establishing recycling programs for nonorganic waste streams.

Sustained innovation in waste management practices offers dual benefits: it supports environmental conservation and simultaneously enhances the competitive advantage of Rummi Kopi Lan Tresna. By embedding sustainability principles into day-to-day operations, the restaurant can differentiate itself in an increasingly ecoconscious market, foster customer loyalty, and ensure long-term business resilience.

CONCLUSION

This study highlights the challenges of waste management at Rummi Kopi Lan Tresna, a restaurant serving traditional Indonesian cuisine located in Bogor, West Java. Through the application of the Design methodology, Thinking the research identified several key issues: suboptimal waste segregation, underutilization of organic waste such as coffee grounds and food leftovers, and the absence of a structured system for managing non-organic waste. Furthermore, approximately 30% of customer-ordered food was found to remain uneaten, indicating a need for improved portion control strategies. Employee awareness of zero-waste concepts remained customer education low. and on had sustainability practices not been systematically implemented.

The Empathize stage of the Design Thinking process revealed the need for a clearer, more efficient waste management system. The Define stage framed the primary research question: How might Rummi Kopi Lan Tresna optimize organic and non-organic waste management through segregation, reuse, and education to achieve greater sustainability and operational efficiency?

n the Ideate phase, solutions were proposed dimensions: three pre-waste across generation (prevention strategies such as portion adjustments and inventory control), during operations (real-time waste reduction practices including customer communication and order confirmation), and post-waste generation (recycling and upcycling initiatives). These strategies aimed to reduce environmental impact, enhance operational efficiency, and position the restaurant as a sustainability-oriented business.

Through the structured application of Design Thinking principles, Rummi Kopi Lan Tresna can significantly minimize waste generation, strengthen brand image, and contribute meaningfully to the circular economy movement within the Food and Beverage sector.

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