Science is love, love requeries honesty

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From Plate to Planet: A Circular Economy Restaurant Model for Sustainable Tourism Through Resource Efficiency

Jussac Maulana MASJHOER [1]

Abstract

This study explores how restaurants can adopt circular economy principles to mitigate environmental challenges, such as resource overuse and food waste generation, and contribute to sustainable tourism. The research conducted a life cycle assessment using the Resource Efficient and Cleaner Production (RECP) framework to identify and implement cost-effective, immediate actions in restaurants. The study found that RECP options like recording the weight of raw materials, measuring food waste, and segregating waste can significantly reduce food waste. Additionally, forming a team to control RECP implementation, improving staff knowledge of Occupational Health and Safety, and conducting regular inspections of electronic equipment is cost-effective and can be implemented immediately. Low-cost options include setting up organic waste processing and installing fire extinguishers. This research needs to be followed up with quantitative research that measures whether these practices can reduce waste generation and energy efficiency and have implications for saving restaurant operating costs. In addition, there is a need to adapt the RECP assessment to other restaurants so that the practices implemented can be generalized.

Keywords: Environmental Impact Assessment, Food Waste, Restaurants, Sustainable Development, Tourism
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1. INTRODUCTION

Restaurants have an essential role in supporting the development of tourism destinations. Herrero et al. (2022) argue that restaurants are a sub-system in a complex tourism sector besides accommodation, transport, and recreational activities. Restaurants in tourist destinations function as places to eat and can act as attractive tourist attractions. According to Pérez Gálvez et al. (2017), local gastronomy plays a direct role as a tourist attraction, as tourists are encouraged to experience new foods. Loyalty and destination selection by tourists are positively influenced by local images and restaurants (Hernandez-Rojas et al., 2021; Pérez Gálvez et al., 2017). On the other hand, the experience that travelers have had at an ethnic restaurant influences their desire to consume local food in their home country (Aybek & Özdemir, 2022). In this context, the restaurant also functions as a showcase that introduces the uniqueness of the culinary culture and presents a distinctive dining experience. Tourism destination managers can use the prestige of high-quality local food and restaurants serving distinctive local cuisine to maintain tourist loyalty (Hernandez-Rojas et al., 2021; Nakayama & Wan, 2019). Restaurants contribute positively to creating an image of food of origin that fuels tourism growth in a destination. However, despite their positive contributions, restaurants face significant environmental challenges regarding resource utilization and food waste.

Like other tourism industries, restaurant operations consume energy and resources to produce products and cater to travelers. According to the Environmental Protection Agency (2015), restaurants are a huge energy drain, using about five to seven times more energy than other

[1] Assist. Prof., Jussac Maulana Masjhoer, Sekolah Tinggi Pariwisata Ambarrukmo Yogyakarta, jussacmaulana@stipram.ac.id, ORCID ID: 0000-0001-7042-2098.

commercial buildings. Food and beverage services in hotels consume more than 50% of energy (Santiago, 2021). Furthermore, the high energy expenditure per diner is due to food waste and energy-intensive services (Juvan et al., 2017; Kasavan et al., 2022; Knezevic Cvelbar et al., 2021). Energy is directly used by restaurants for food preparation and cooking, food storage, heating, air conditioning, and ventilation systems (Milindi et al., 2022). In addition to energy wastage, restaurants generate food waste. According to a report by the United Nations Environment Programme (2024), 60% of food waste comes from households, 12% from retail, and 28% is generated by the food service sector, which includes restaurants. This food waste contributes to the wastage of natural resources, including agricultural land, energy, and water, and generates significant greenhouse gas emissions when the waste decomposes in landfills (Gössling et al., 2012; Lang et al., 2020). Therefore, resource optimization in restaurants is a crucial issue that needs serious attention to achieve sustainable tourism and realize SDG 12.3.

The tourism industry in Sleman Regency, Special Region of Yogyakarta, has experienced rapid growth in recent years. This can be seen from the more than 8 million tourists in 2023, the largest among other districts/cities in Yogyakarta (BPS Provinsi D.I. Yogyakarta, 2024). The main driving factor for the high number of visits is the variety of tourist attractions in Sleman, which include natural beauty such as Mount Merapi, the richness of Javanese culture, and easy accessibility through Yogyakarta International Airport (YIA). The increase in tourists drives the demand for food and beverages, triggering the emergence of many new restaurants. In 2023, 1,629 restaurants offered traditional to international dishes in Sleman (BPS Kabupaten Sleman, 2024). The diverse quality and quantity of these restaurants attract more tourists and serve as a means of learning about Yogyakarta's culture. However, restaurants also have the potential to cause environmental impacts through the waste of energy, resources, and food waste (Lang et al., 2020; Lévesque et al., 2023; Lévesque et al., 2024; Milindi et al., 2022; Tonini et al., 2018). Strippoli et al. (2024) stated that circular economy (CE) research in the tourism sector could trigger the development and implementation of solutions and raise awareness among tourism stakeholders of the importance of CE in reducing the damaging excesses of tourism. Therefore, this article explores how restaurants can adopt circular economy principles to optimize resources and support sustainable tourism. Best-practice efforts in implementing circularity in restaurants will be collated through a life cycle assessment which will be further compared with RECP options and green practices in restaurants. Thus, it is expected to provide insights and recommendations for restaurant owners, tourist destination managers, and policymakers to adopt a more sustainable approach to restaurant operations. The study's theoretical implication is to provide an understanding of the application of the circular economy concept in the restaurant industry, which is an important part of the tourism sector. In addition, this research also has practical implications for restaurant managers because the results can be used as a guide in developing environmentally friendly practices tailored to their restaurants' needs.

2. CONCEPTUAL FRAMEWORK

2.1. Tourism Circular Economy

The circular economy (CE) is a mechanism that considers resource use, waste generation, and energy leakage to be minimized by inhibiting and narrowing material and energy cycles (Geissdoerfer et al., 2017). Homrich et al. (2018) argue that CE is an economically beneficial approach to respond to resource scarcity and waste generation due to traditional open systems. Circularity can be achieved by applying reject, rethink, reduce, reuse, repair, renew, remanufacture, recycle, and recover (Potting et al., 2017). CE is an economic model that uses raw materials to create a positive relationship between economic growth and resource sustainability (Bittner et al., 2024). Circular economy

research has been widely implemented in the tourism industry and yielded valuable insights. In the tourism industry, applying a circular economy is expected to improve efficiency in the production process and reduce waste pollution and CO_2 emissions released by hotels and restaurants (Bittner et al., 2024). Research by Goh et al. (2025) revealed that the circular economy concept can reduce greenhouse gas emissions through composting restaurant food waste. Furthermore, circular economy in wine tourism can generate profits due to efficient use of resources and reduce waste and energy costs (Mora et al., 2025). Circular Economy (CE) has been considered an alternative solution to reduce the environmental impact of the tourism industry by reducing environmental, social, and economic burdens in an integrated, holistic approach (Strippoli et al., 2024). The biggest challenge to CE implementation in Indonesia is the lack of infrastructure support, weak government role, and lack of CE knowledge (Bittner et al., 2024). Although the concept of CE has advantages, there are barriers for industries to implement it, such as cultural, market, regulatory, and technological reasons (Kirchherr et al., 2017).

2.2. Restaurant Productivity through LCA

Restaurant productivity can be measured by how healthy resources are managed to achieve the products and services provided to guests. The more products and services achieved with fewer resources, the higher the productivity (Tsybka & Romanova, 2016). A potential solution to achieve restaurant productivity is using a circular economy approach through life cycle assessment (LCA). Applying circularity principles in restaurant operations can reduce food waste, optimize resource use, and create added value (Farrukh et al., 2023; Herrero et al., 2022; Lévesque et al., 2024). Research has been conducted using restaurant LCA methods to assess sustainability and impacts. Herrero et al. (2022) suggested that life cycle assessment is a tool to measure the environmental impact of a product, process, or service over its life cycle. This assessment has provided information on ecological impacts in restaurants from food production, raw material supply, food storage and preparation, and waste treatment (Baldwin et al., 2011; Mistretta et al., 2019; Švec et al., 2023; Tonini et al., 2018). This method provides a consistent analytical framework and environmental data support for decision-making for sustainable solutions (Herrero et al., 2022; Lévesque et al., 2023). Farrukh et al. (2023) argue that best practices in resource and energy efficiency in the tourism sector must be emphasized to bring ecological and economic benefits. In addition to reducing environmental impacts, optimizing energy and resources can automatically reduce costs and thus provide financial benefits for restaurants (Milindi et al., 2022). In addition, restaurants will have a unique value and enhance a positive image in the eyes of consumers who are increasingly concerned about environmental issues.

2.3. Restaurant's Green Practices

Studies on the impact of restaurant operations on the environment have become a hot topic in recent years (Filimonau et al., 2023; Lévesque et al., 2023; Milindi et al., 2022). Madanaguli et al. (2022) revealed that environmental unsustainability in the restaurant industry stems from food waste and inefficient use of energy and water. However, along with the development of environmentally friendly tourism, restaurants, as part of the tourism industry, also implement environmentally friendly operations (Chiang & Sheu, 2020). Implementing environmentally friendly practices in restaurants can strengthen competitive advantage by developing a green identity (Bonfanti et al., 2025). As understood by restaurant associations and chains, green practices refer to efforts to balance environmental, economic, and social aspects (Kim & Hall, 2020). Namkung & Jang (2014) explain that restaurant green practices include water efficiency, waste reduction and recycling, sustainable furniture and building materials, sustainable food, and reducing energy, waste, chemicals, and

pollution. Eco-friendly measures that can be adopted as best practices in addressing different categories of resource wastage are presented in the following table:

Table 1. Green measures for resource efficiency

Component	Green Measures	References
Food waste	Pre-ordering, reducing menu variety, local sourcing, using technology, alternative protein sources, local and seasonal ingredients, smart recipes, employee education, waste management, oil reuse, biodiesel from cooking oil, biodiesel from composting food waste, donation, portion control, off-site disposal, recycling, and composting.	(Filimonau et al., 2020; Hatjiathanassiadou et al., 2019; Mu et al., 2019; Tan et al., 2019; Trafialek et al., 2020)
Electricity	Environmentally friendly energy sources, employee education, efficient lighting and equipment	(Lee et al., 2020; Tan et al., 2019; Trafialek et al., 2020)
Water	Regular water audits, employee awareness education, menu reconfiguration, regular plumbing maintenance, appropriate water dispensers	(Hatjiathanassiadou et al., 2019; Lee et al., 2020; Tan et al., 2019)

Source: Adapted from (Madanaguli et al., 2022)

3. METHOD

3.1. Study Location

This research was conducted on one of the leading restaurants in Sleman District, Yogyakarta, Indonesia, called TR Restaurant (TRR). This restaurant concept is natural by the typical atmosphere of Mount Merapi. It has a unique and traditional gazebo or pavilion equipped with plants that grow with the lush. The shady and relaxed atmosphere, like a "small forest," is the strength of this restaurant. TR restaurant was established in 2000 and still exists because of its uniqueness. Some interesting and exciting special menu items at TRR are a typical menu of freshwater fish. Gourami, catfish, tilapia, and wader have become the mainstay menu of this restaurant. The choice of TR Restaurant as a research site is grounded in several key factors. Firstly, the resources used by this restaurant are consistent with its atmosphere and demonstrate a commitment to environmental sustainability. Furthermore, TR Restaurant enjoys a steady stream of customers, which heightens the potential for food waste and elevated resource consumption.

3.2. Resource Efficient and Cleaner Production (RECP)

The "Resource Efficient and Cleaner Production" (RECP) assessment is used as a tool to understand the overall life cycle of energy, material, and water consumption, as well as waste production, emissions, and effluents (Tsybka & Romanova, 2016). RECP analyses the inputs of resources, water, and energy that go into the production process at the restaurant to produce outputs of gaseous emissions, liquid waste, and solid waste (see Figure 1). Modifications were made in the RECP assessment to conduct qualitative assessments without quantitative measurements only (Dzulkifli & Masjhoer, 2020). The RECP best practices were qualitatively compiled based on direct observation, interviews, and documentation.

The whole RECP assessment goes through three stages:

Getting Started is concerned with securing the commitment and engagement of the restaurant's management and staff. The critical task in this phase is to engage the management and staff. Research approval was obtained by offering the benefits and green image that the restaurant will receive from the RECP assessment. We promise that there will be no cost burden or disruption during the research. The cooperation commitment is made with the restaurant owner, who doubles as the manager. This is so that the implementation of the RECP assessment can be carried out freely. In addition,

researchers can confirm the evaluation results to people who are responsible and understand their work.

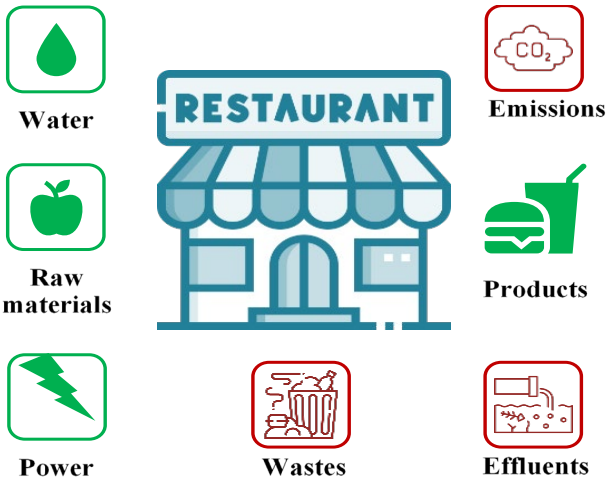

Figure 1. RECP concept
Source: Adapted from Tsybka & Romanova (2016)

Assessing Operations & Practices undertaken to map, review, and, where possible, benchmark operational performance and identify and select priority areas and actions for RECP implementation. Critical tasks in this phase are mapping activities and flows, inspecting operations, practices, and performance benchmarks, and establishing priorities and actions. The operations assessment was conducted in each main activity area by interviewing authorized staff, conducting direct observation, and documenting the situation. The information extracted includes resource and energy use, production activities, and downstream waste. Researchers will look for potential resource leakage from all activities in the restaurant. Interview data were transcribed into text and observational and documentary data were grouped before analysis. The data was then compared with RECP best practices suitable for the restaurant.

Developing Solutions aims to compile catalogs (or lists) of feasible RECP solutions for each of the established RECP priority areas through the further generation and customization of RECP options and to assess their technical and environmental. The essential tasks in this phase are developing RECP options. All potential leaks and wastage of resources found in the restaurant are solved in accordance with RECP practices. RECP involves the application of eight practices, ranging from low or even no-cost solutions to high investment, as follows in Table 2. Each identified leak may apply more than one RECP option. The options may be immediate, low-cost, or require substantial investment.

Table 2. RECP practices

No.	Code	Detail
1	GH	Good Housekeeping: suitable measures should be taken to avert leaks and spills and ensure the implementation of proper, standardized operation and maintenance procedures and practices.
2	IS	Input Substitution: substituting hazardous or non-renewable materials and energy sources with less dangerous or renewable alternatives or materials with a longer lifespan is crucial for reducing the environmental impact of industrial processes.
3	BPC	Better Process Control: The alteration of operational methods, device commands, and documentation of processes for improved efficiency and reduced waste and pollution generation is necessary.
4	EM	Equipment Modification: Modifying the production equipment to increase efficiency and reduce waste and emission generation.
5	TC	Technology Change: the goal is to minimize waste and emissions during production by optimizing the technology, processing sequence, and synthesis pathway.

6	OSR	Onsite Reuse & Recycling: reuse of the wasted materials in the same process or for another helpful application within the enterprise
7	UBP	Useful By-Product: the transformation of previously discarded wastes into materials that can be reused or recycled for another application outside the company
8	PM	Product Modification: modifying product characteristics to minimize the product's environmental impacts during or after its use (disposal) or reduce its production's environmental impacts.

Source: Adapted from Tsybka & Romanova (2016)

4. FINDINGS

4.1. Restaurant Main Activity Area

RECP assessment methodology provides a structured approach to identifying, evaluating, implementing, and sustaining RECP in restaurants, thereby seeding and engraining virtuous cycles of continuous improvement. From the walkthrough and data collection, it can be identified that the TR restaurant consists of three main activities, each reflecting its function/process, using energy, resources, and materials in operation, and producing waste. The TRR's main activity area is described in Figure 2.

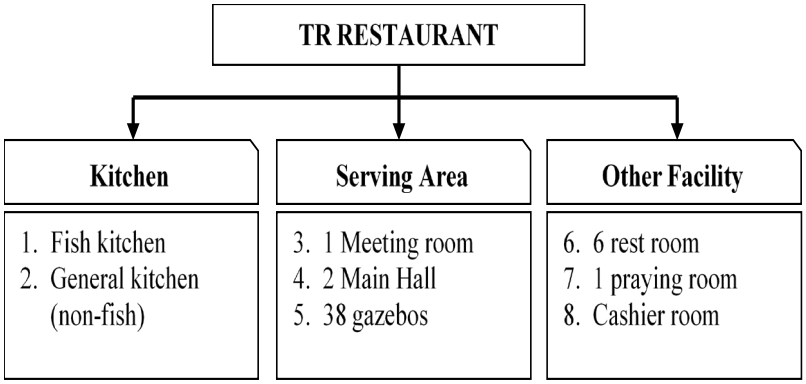

Figure 2. Main activity area in TR Restaurant
Source: Own elaboration

The kitchen is the center of most activity and consumes the most resources and energy in TR restaurants. It contains cooking equipment and a series of production processes ranging from preparation, cooking, and serving to cleaning cutlery. Direct energy in the kitchen consists of electrical energy used for food preparation and cooking. Other direct energy use involves kitchen heating, ventilation, and air conditioning (HVAC) systems. It also includes the energy spent on packaging, shipping, storing, and reheating cooked food (Milindi et al., 2022). The serving area is the location for guests to enjoy the food that has been ordered. The serving area comprises several gazebos, main halls, and meeting rooms with electrical equipment such as lights and fans. Other facilities include toilets, prayer rooms, and a cashier's room with lights and cashier equipment. Other facilities are not used very often, such as prayer rooms, which are only used by some guests who want to perform their worship, and this also applies to toilets.

4.2. Production Process

The production process (Fig. 3) in TRR begins with purchasing foodstuff materials from the local market and suppliers. The foodstuff then goes into the preparation stage, which includes cleaning, cutting as needed on the menu, and preparing spices. The production process begins when guests start making menu reservations. The drinks and food section will work according to the order. The fish kitchen will process the fish-based menu by grilling and frying. Menus like vegetables, soups, and non-fish cooked in the general kitchen. Each dish is collected in a prep table for the presentation process to the guest. The average waiting time for guests who order is twenty minutes. The last

process is cleaning the cutlery in the laundry room. Here is the food and beverage production process at TR Restaurant:

a. The guest orders the food menu, and then the order is forwarded to the cashier to be recorded.
b. The menu list is then forwarded to the drinks and food section.
c. Drinks that have been made directly delivered to guests by the waiters
d. The food menu first goes to the checker section, which distributes it to fish and non-fish kitchens while preparing garnishes and structuring each menu.
e. The completed menu then returns to the checker section to be organized and garnished
f. The checker collects Each dish on the preparation table for the presentation process to the guest.
g. Cuisine that has been collected and arranged, delivered by the waiters
h. Desk cleaning is done after the guests have finished eating

The materials used in the production process in TRR are food ingredients such as fish, vegetables, fruits, spices, cooking oil, and so on—chemicals in the form of cleaning soap and floor cleaner. In production, electricity is needed to cook rice using a rice cooker, make fruit juice using a blender, operate a refrigerator to store food, turn on a fan while grilling fish, and turn on water pumps and lights. TRR uses large amounts of water resources, starting from the preparation stage, where the foodstuff is washed. Water is also used in the cooking process. The process of cleaning the cutlery uses water and soap. In addition to electricity and water, TRR uses gas and charcoal in production, and gasoline is used to power the generator. The production flow at TR restaurant can be seen in Figure 3.

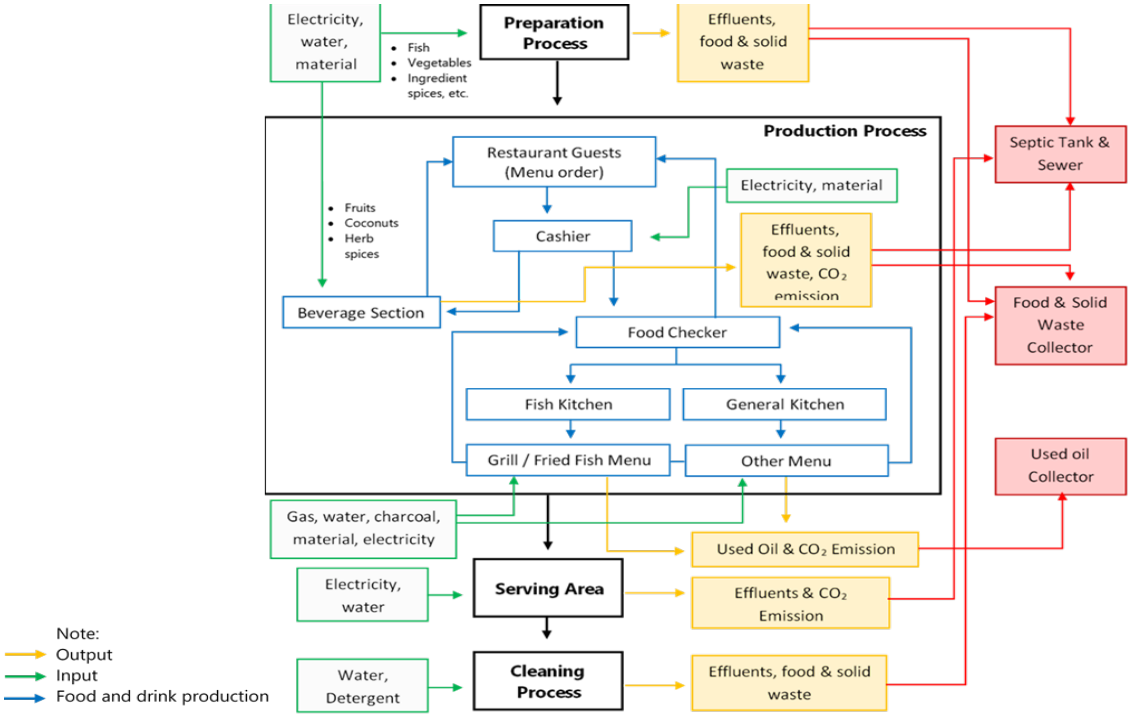

Figure 3. The production process in TR restaurant
Source: Own elaboration

4.3. Inspect operation

TRR implemented home-based management in running the restaurant and has not implemented a professional restaurant management system. TRR has 32 employees divided into seven parts: servers, cashiers, drinks, checkers, fish kitchens, and general kitchens. The number will increase when the holiday season arrives. All staff clean the restaurant once a month. Water supply to meet the restaurant's needs is obtained from groundwater using two pumps and stored in two 500-litre reservoirs. Here are the observation and inspection results performed on three main activity areas on TRR.

4.3.1. Kitchen

The kitchen is divided into two parts: the fish kitchen, done by male staff, and the general kitchen (non-fish), which women do. Based on the observation, the fish kitchen is not tidy and clean, unlike the general kitchen. The smoke makes walls and roofs dark; rainwater can enter the kitchen due to the leaking roof. In the fish kitchen, there are oil spills in the area of the frying stove. The oil spill is congested and black. However, every morning cleaned, the oil crust was left. Water is used to clean fish and other food items. Dirty water flows into the septic tank hole and seeps into the soil. The tap is visible but not closed tightly at some point, so water drips out (see Figure 4). Oil and water spills on the floor of the kitchen area have the potential to cause workplace accidents. A common injury in restaurants is slipping on wet or oily floors, which occurs because workers are in a hurry and are not careful (Nabeel & Alamgir, 2018). Restaurants can be dangerous workplaces as staff work in hot areas for long periods and on slippery floors, potentially causing injuries (Lippert et al., 2020). Injured staff certainly impact the restaurant's production performance and overall economic losses. From an environmental perspective, dripping and wasting water is considered a waste of resources. Water is a vital resource in restaurants as the water footprint is directly determined by the water used in the kitchen for pre-cooking and cooking processes (Milindi et al., 2022).

Materials used in the kitchen are foodstuffs such as fish, chicken, vegetables, and so forth. The rest of the fish clearance is in the form of innards in a bucket with a total weight of 5 kg. The remaining raw materials and food scraps from guests are put in plastic bags. Every night, organic waste is taken by a third party to make animals food from it. The rest of the cooking oil is put in the oil drum, and every week, a third party will buy the residual oil. Although some waste is separated, this good practice is not implemented thoroughly. Mixed waste can be found in the bins around the restaurant and the kitchen. Mixed waste will complicate waste management downstream. According to Pirani & Arafat (2016), food waste starts from preparation, production, and leftovers from guests. During preparation, unavoidable food waste includes fruit peels, vegetable pieces, and damaged food raw materials (Abdelaal et al., 2019). Food waste also occurs because consumers do not consume food. It is often difficult for restaurants to determine the appropriate portion in each menu, causing food waste.

Fish dishes are made with gas and charcoal. Two tubes are installed through a pipeline that distributes gas to each stove in the kitchen. During operation, the three stoves in the fish kitchen are left burning with little flame; this keeps the oil warm, and when an order comes in, the chef takes less time to get the appropriate heat temperature—combustion of gas and charcoal results in gaseous emissions that impact air quality and human health. The direct carbon footprint was determined based on the cooking smoke emitted in the kitchen during cooking activities (Milindi et al., 2022). There are concentrations of ethane, hexane, NO_2, N_2O, SO_2, NH_3, and HCl during charcoal grilling (Alves et al., 2022), and the highest emissions occur during the first 15 to 20 minutes after ignition (Jelonek et al., 2020). Although charcoal is considered environmentally unfriendly due to its gaseous emissions and

particulate matter, the technique affects the flavor of the dishes and has become a signature of restaurants. Charcoal has been a source of energy and part of most cultures worldwide for centuries (Alves et al., 2022; Jelonek et al., 2020).

Some staff in the fish kitchen do not use adequate security equipment, such as shoes, aprons, and hair protectors, during work; this is different from the soup kitchen. No fire extinguishers were found in the kitchen, and no health, safety, or job security appeals procedures were available. Work situations in kitchens can pose a risk of accidents with the amount of equipment involved. Restaurant staff performs all the activities of preparing and cooking food, cutting vegetables, transporting food, washing cutlery, and assisting with support activities such as cleaning, stocking, and provisioning. Matias et al. (2013) and Pandy et al. (2010) argue that the kitchen has potential physical, biological, chemical, ergonomic, and psychosocial risks because they involve long working hours. Common hazards in restaurants are burns, cuts, lacerations, and punctures (Lippert et al., 2020; Pandy et al., 2010). Employers generally consider OHS risks to be caused by "bad employees" and their "work attitudes," such as incorrect work practices, lack of knowledge, and negligence that contribute to accidents, incidents, and injuries (Pandy et al., 2010). Nevertheless, restaurants need to pay attention to OSH in their production process. OHS should be seen as a means of sustainability, expansion, and social responsibility (Matias et al., 2013).

Figure 4. (a) Oil spill in the fish kitchen; (b) Cleaning process in the kitchen; (c) Food and solid waste from the production process; (d) The stove is left burning in a small flame
Source: Own elaboration

4.3.2. Serving Area

Based on general observations, the serving area is kept neat and clean. The environment section cleans the serving area every morning before TRR opens. All the lamps in the serving area use LED lights. However, some lights have burned out, and a few empty slots exist. Each gazebo and the main hall have hand-washing stations equipped with dispensers filled with hand-washing soap. Guests can use the soap, and liquid waste flows through small ditches. The serving area is surrounded by tall, shady trees, creating a pleasant atmosphere. Most of the waste generated in this area consists of foliage from the surrounding trees. There is no leakage of resources and energy in the serving area. Only leftover food not finished by guests is disposed of in the kitchen. A small ditch that is too shallow and

sometimes overflows makes the area muddy. Most of the liquid waste from cleaning fish goes into the gutter in the serving area, as shown by the number of fish scales in the gutter serving area. This will undoubtedly affect guests' comfort visually and from the unpleasant smell.

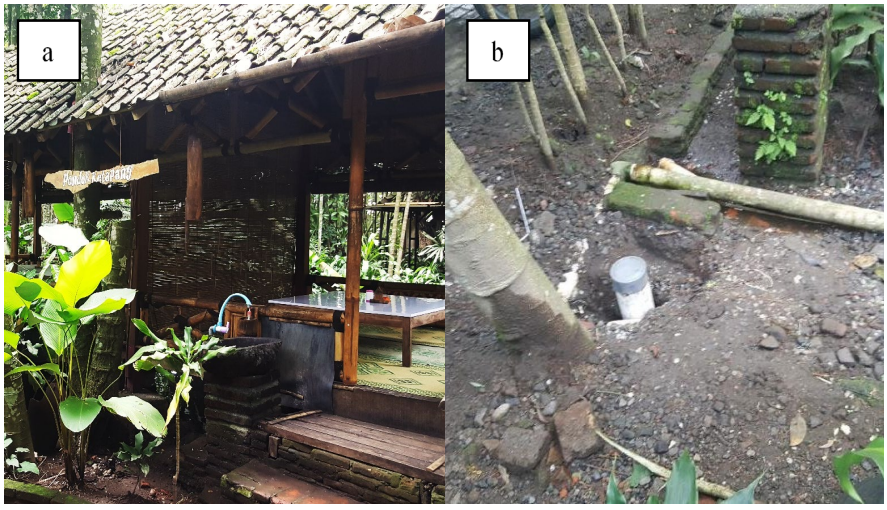

Figure 5. (a) Gazebo at TR Restaurant; (b) Wastewater from fish cleaning overflows into the serving area
Source: Own elaboration

4.3.3. Other Facility

This primary activity area includes six public toilets, one mosque, and a cashier room. The facilities are generally maintained in a clean and tidy condition. The toilets function well, and clean water is sourced from a reservoir. However, some of the faucets in the sinks were left dripping, indicating a need for minor maintenance. The technology used in the toilets and the mosque is up-to-date; all lights are energy-efficient LEDs. LED lighting is a good choice because it is more energy-efficient, durable, produces high-quality light, and is environmentally friendly. Lighting is the most dominant energy consumption in restaurants and is often inefficient, contributing to a high carbon footprint (Santiago, 2021). No leaks or excessive use of resources were detected in this area, ensuring that all resources were utilized appropriately. Liquid soap is provided in every sink, ensuring proper hygiene for users. All liquid waste generated in this area is directed into a septic tank, guaranteeing an efficient and environmentally friendly waste management system. In general, there are no energy or resource inefficiencies in this area. The restaurant only needs to carry out regular maintenance and checks because, over time, there will be damage to electrical equipment and other equipment.

Figure 6. Restroom condition in TR Restaurant
Source: Own elaboration

4.4. Area of Improvement

Based on the mapping area and inspection operation, one main activity has potential leakage and excess energy consumption. Of the three main activities, only the kitchen has the potential to save resources. Given the assessment findings, RECP practice options were developed and referred to in Table 1. In general, some options can be implemented immediately without much cost as they only require improving work patterns and complying with specific standards and options that require low cost as they need to purchase appropriate equipment. RECP practice options that can be implemented in restaurant TRs are presented in Table 3.

Table 3. List specific RECP options for consideration

No	Specific RECP options for consideration	Applicable RECP practice(s)	Cost / Action
1.	Record the weight of raw materials purchased.	GH, BPC	Immediate Action
2.	Recording the weight of solid waste generated	GH, BPC	Immediate Action
3.	Separate organic and non-organic waste	GH, BPC	Immediate Action
4.	Producing organic solid waste into fertilizer	UBP	Low cost
5.	installing a fire extinguisher	GH	Low cost
7.	Increase staff knowledge related to Occupational Health and Safety (OHS)	GH, BPC	Immediate Action
8.	Routine inspection of electronic equipment	GH	Immediate Action
9.	form a team to control the implementation of RECP	GH, BPC	Immediate Action

Source: Own elaboration

5. DISCUSSION

Based on the findings of resource leakage at the TR restaurant, as well as the results of the RECP analysis and options, the six recommended RECP options can be implemented immediately at no cost. Three options were developed concerning food waste to establish standardized operational procedures and practices (GH) and recording processes to achieve high efficiency and low waste generation (BPC). Recording the weight of raw materials, generating food waste, and segregating waste between organic and inorganic are urgent to see how far food waste can be reduced and measured quantitatively. RECP options related to food waste encourage restaurants to undertake food waste reduction. Food waste reduction is gaining attention due to its environmental impact and the relationship between waste and carbon emissions (Pirani & Arafat, 2016). The ecological and food security problems caused by food waste cannot be underestimated, so its handling has become an important issue (Lang et al., 2020). Apart from the environmental perspective, food waste reduction can be seen in terms of economic benefits for restaurants. Restaurants with effective food reduction strategies will operate leaner, be more cost-effective, and consume less food resources (Pirani & Arafat, 2016). Food waste can be prevented even before food waste is formed. Upstream, restaurants can ensure that the raw materials delivered are fresh and in good condition. This can be done by buying from the nearest supplier. Purchasing local raw materials can save transport and storage costs as products can be delivered daily or at least very frequently (Švec et al., 2023). In addition, restaurants need to limit the number of menu items and research how large portions are appropriate for guests without compromising quality and financial returns (Tatàno et al., 2017). The manager and chef should conduct the restaurant's operational planning well and rigorously. A menu-based approach makes it possible to design meals with carefully considered ingredients (Lévesque et al., 2024).

A further RECP option related to food waste and other organic materials is composting. Utilizing by-products (UBP) to become valuable products will cut off the waste pathway to landfills. Rashid & Shahzad (2021) argue that composting is the best option for food waste management from an environmental and economic perspective. Organic materials such as food waste and leaves should be considered raw composting materials (Masjhoer et al., 2023; Masjhoer & Vitrianto, 2024). Furthermore, food waste that goes through the composting process will be reduced in volume by half (Masjhoer et al., 2023). So, if every restaurant in Sleman applies food waste composting, it can help extend the landfill's life because its capacity is not total quickly. Through the simple activity of composting, restaurants contribute to preserving environmental assets. Recycling food waste in restaurants is vital in reducing environmental impacts (Zhang et al., 2019). Restaurant networks promoting sustainable practices usually incorporate several ecological, economic, and social practices (Kim & Hall, 2020). Reducing food waste provides a chance to cut costs while addressing significant environmental and social challenges, such as combating climate change and alleviating food insecurity (United Nations Environment Programme, 2024). It is essential for sustainable tourism development to have efficient resource management as this helps to preserve the environment and ecosystems while providing economic benefits (Cheng et al., 2023).

Besides food waste, RECP options that can be implemented immediately at a low cost are related to operational and staff management. Implementing RECP options requires a small team that monitors and evaluates restaurant operations. Therefore, it is necessary to increase the capacity of human resources at both the manager and staff levels. The knowledge of staff and managers in practicing food waste management needs to be improved. A low understanding of good waste management is one of the barriers to sustainable restaurant management (Masjhoer et al., 2020). Whereas restaurants produce more food waste than ordinary households and require more urgent disposal requests, restaurant owners' awareness of food waste management is essential (Lang et al., 2020). In addition to knowledge, low environmental awareness also exacerbates the condition of environmentally unfriendly management practices. Research by Lang et al. (2020) found that most restaurant owners have a low level of environmental awareness. On the other hand, workers need to be given training related to OHS because there are various potential work accidents in the kitchen. Fire prevention and regular maintenance of different electronic equipment are intended to anticipate all forms of energy leakage work accidents and maintain energy efficiency (Pandy et al., 2010). Water leakage from taps in sinks can be prevented by regular monitoring. This practice will reduce resource leakage so that water use does not create a high environmental footprint (Milindi et al., 2022). The water footprint is directly determined by the amount of water used in the restaurant's operations, and leaks at the sinks result in wasteful water use. Regular checks on electronic equipment can also minimize wastage in terms of energy. Light fixtures are a reliable source of lighting in restaurant operations, and based on Environmental Protection Agency (2015) data, an average of 13 percent of total restaurant energy use is in the form of lighting. This indicates that periodically checking the condition of the lights will affect the overall energy efficiency (Zhang et al., 2019). Options related to the competence and capacity of human resources in the restaurant can be implemented immediately and do not require enormous costs. The GH and BPC options in RECP can improve work pattern routines and increase knowledge for consistent implementation of RECP options.

The costly RECP options are installing fire extinguishers and setting up organic waste processing. Installing extinguishers is a form of complying with OHS in preventing work accidents in the form of fires. According to Pandy et al. (2010), managers and staff assume that the main work problems in restaurants are related to physical safety and food safety. Following the saying that 'bad days are not on the calendar,' installing extinguishers is necessary to avoid more significant losses in the future.

All RECP practices in restaurants require a solid commitment to implementation. A small team within the restaurant management must do regular monitoring and evaluation. Restaurants should implement energy and resource efficiency as restaurant operations have an impact. According to Farrukh et al. (2023), energy efficiency management should be at the forefront of sustainable tourism development strategies. Furthermore, technological innovation in resource utilization can reduce carbon dioxide emissions and improve ecological sustainability.

6. CONCLUSION, IMPLICATIONS, LIMITATIONS AND FUTURE RESEARCH OPPORTUNITIES

As part of the tourism industry, restaurants are significant energy consumers and generate high levels of waste, particularly food waste. Optimizing restaurant resource management is crucial to achieving sustainable tourism and meeting SDG 12.3. This involves maximizing output while minimizing resource input, akin to the principles of a circular economy. By applying life cycle assessment, restaurants can reduce food waste, enhance resource efficiency, and create additional value. TR restaurants have three main activities, each reflecting a function/process, using energy, resources, and materials and generating waste. The kitchen is the most potential activity area for energy and resource efficiency. There are several leaks and wastage of resources, such as oil spills, water drips, and uncontrolled volume of food waste. In addition, potential accidents such as falls and burns threaten workers. RECP options that are cost-effective and can be implemented immediately, such as recording the weight of raw materials, the amount of food waste generated, and segregating waste between organic and inorganic, are essential to see how much food waste can be reduced and measured quantitatively. Besides food waste, RECP options that can be implemented immediately at low cost related to operational management and staff are forming a team to control the implementation of RECP, improving staff knowledge associated with Occupational Health and Safety, and regular inspection of electronic equipment. The low-cost RECP options include setting up organic waste processing and installing fire extinguishers. The RECP method can describe the flow of resources and energy use from upstream to downstream. The effectiveness of RECP options in restaurants can be achieved through an in-depth evaluation of resource and energy use before and after implementation.

This research implicates the important role and great opportunity for restaurants to contribute to sustainability through better resource management. RECP implementation can start with simple, low-cost, yet beneficial measures to reduce environmental impacts and improve operational efficiency. More broadly, the implementation of green practices in restaurants will contribute significantly to the goal of sustainable tourism and the achievement of global targets related to food waste reduction.

However, the study is limited to a single restaurant, which may not represent the diversity of all restaurants. In addition, the second limitation of this research is the modification of the RECP method by using only a qualitative approach without any quantitative measurements. Therefore, a similar analysis needs to be done on different types of restaurants. Despite this limitation, the RECP assessment practices discussed can be applied across various restaurant types. The compiled best practices refer to environmentally friendly practices but need to be followed up with quantitative research that measures whether these practices can reduce waste generation and energy efficiency and have implications for saving restaurant operating costs. Future research should use more than one type of restaurant for a clear comparison. In addition, there needs to be a monitoring and evaluation study to measure the impact of best practice implementation on energy efficiency and

waste generation, the process of employee adaptation and restaurant owner resistance, and the challenges faced during the implementation process.

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Yazar(lar) Hakkında/About Author(s)

Jussac Maulana Masjhoer, jussacmaulana@stipram.ac.id
S.Kel., M.Sc., an Assistant Professor at Sekolah Tinggi Pariwisata Ambarrukmo Yogyakarta, is renowned for his expertise in tourism-related environmental issues. Over a decade, he's served as a tourism and environmental expert in government projects, advancing national development. Actively engaging in scientific conferences, he's currently researching the impact of tourism on waste management. His focus spans tourism impacts, responsible practices, sustainable development, environmental management, and nature-based tourism. Masjhoer's work signifies a dedicated pursuit of sustainable tourism practices and environmental stewardship.

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