

Green Innovation Strategies for Food Waste Reduction in Casual Dining Restaurants: Evidence from Naga City, Philippines

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ABSTRACT

The Philippines faces a pressing issue of food waste generation, producing a staggering 1,700 metric tons of food waste daily, equivalent to P23 million worth of food, enough to feed 4.3 million individuals. This study aims to propose Green Innovation Strategies for Food Waste for casual dining restaurants in Naga City, based on a comprehensive multi-level analysis of variables and the employment of various research methodologies. The objectives of the study include identifying the demographic profile of respondents, characterizing the food waste in casual dining restaurants, examining food waste management practices, understanding customer behavior regarding leftovers, analyzing food waste disposal in Naga City, and assessing the level of awareness of Green Innovation Strategies among casual dining restaurants. The study uses statistical methods such as Percentage, Frequency Distribution, and Weighted Mean to analyze the data collected from 100 selected employees of casual dining restaurants in Naga City. The results show that most respondents are college graduates, and daily food waste volume is comparable to a week's garbage from a single home. Additionally, the study employs the Mann-Whitney U-Test and the Kruskal-Wallis Coefficient of Concordance to compare the significance of food waste management practices and Green Innovation awareness when grouped by respondent profiles. The findings indicate that casual dining restaurants in Naga City need improvement in food waste management. While they excel in food waste minimization and energy recovery, they lack in prevention, re-use, and recycling practices. Moreover, customers generally dispose of their leftovers, leading to increased food waste. The study highlights the necessity of raising awareness and implementing Green Innovation Strategies to address this issue. To create a comprehensive food waste management program, the study introduces the Landsink Ladder, identifying the strengths and weaknesses of casual dining restaurants. This framework facilitates the development of strategies to prevent and minimize food waste, promoting sustainability in the industry. The research also stresses the need for a complete Waste Analysis and Characterization Study (WACS) to understand waste generation patterns fully, which can guide LGUs in formulating effective 10-Year Solid Waste Management Plans. This study reveals the critical importance of implementing Green Innovation Strategies to tackle the escalating food waste problem in Naga City's casual dining restaurants. By raising awareness, adopting ecological innovation practices, and engaging with key stakeholders, the food industry can contribute significantly to curbing food surplus and inching closer to a more sustainable future.

Keywords: food waste, green innovation, food waste management, recycle, food waste management plan

INTRODUCTION

Did you know that the Philippines produces about 1,700 metric tons of food waste a day? The Food and Nutrition Research Institute (FNRI), a government agency under the Department of Science and Technology, estimates that the Philippines produces 1,717 metric tons of food waste daily. This is equivalent to P23 million worth of food, enough to feed 4.3 million individuals. The International Rice Research Institute (IRRI) estimates that 23 million tons of rice are wasted every year in the Philippines. This is equivalent to 14% of the country's annual rice production. This alarming statistic sheds light on a pressing issue that extends beyond the borders of this archipelago nation.

Food waste has emerged as a significant issue in casual dining restaurants in the Philippines. Despite the prevalence of hunger and food insecurity in the country, a considerable amount of food is needlessly discarded, leading to deleterious effects on the planet Earth, economy, and society. In America, food waste has reached staggering levels. It is estimated that the United States (US) discards nearly sixty million tons, equivalent to 120 billion pounds of food, every year, making it the world's largest contributor to food waste (RTS, 2023). This equates to approximately 325 pounds of waste per person, a disheartening statistic considering that nearly 35 million Americans, including 10 million children, suffer from food insecurity (RTS, 2023). It is evident that there exists a stark contrast between the abundance of food and the dire need for it, highlighting the gravity of the food waste problem. Naga City, known for its rich cultural heritage and thriving culinary scene, is no exception to the challenges posed by food waste. In a study assessing the effectiveness of the solid waste management system in Naga City, it was found that information dissemination played a crucial role in shaping waste management behaviors (Nolasco, et al., 2019). This suggests that raising awareness and engaging the public in Naga City may hold the key to improving food waste management practices in the city's casual dining restaurants. With the awareness of the food waste crisis in casual dining restaurants in Naga City, Camarines Sur, the next step is to propose a comprehensive food waste management program that addresses this pressing issue sustainably. The goal is not just to minimize food waste but to create a culture of responsible consumption and waste reduction in the hospitality industry. To develop an effective food waste management program, it is essential to engage all relevant stakeholders, including restaurant owners, employees, customers, and local government authorities. By incorporating insights from the literature review on key stakeholders (Dhir et al., 2020), this research aims to craft a developmental plan that take into account the perspectives and interests of various parties involved. The plan involves multifaceted strategies, including education and training, waste auditing, menu engineering, food donation and diversion, composting, and government supports. This research's primary purpose is to study how these establishments manage food waste. It addresses issues and problems posed by improper food waste management in Naga City and the impact of food waste. The study also attempts to create and propose a Green Innovation on Food Wastage to lessen the impact of food waste. It aims to bridge the gap on mitigating food waste that will lead to sustainability among casual dining restaurants in Naga City.

Background of the Study

Food waste and food losses have become a global concern, occurring even as many families and children suffer from hunger. While some live in prosperity, countless individuals are thoughtlessly discarding food. The World Wildlife Fund (WWF) Philippines highlights that 70 percent of biodiversity loss on land and 69 percent of global freshwater use can be attributed to the food and agriculture industries, making food waste the most significant environmental threat today. Per the Food Agriculture Organization (FAO) in 2019, approximately 1.3 billion tons of food are wasted annually, indicating a substantial problem (Madanaguli et al., 2022).

The United States is a notable contributor to food waste, discarding around 40 million tons, or 80 billion pounds, of food each year. This amounts to approximately 219 pounds of waste per person and constitutes about 30–40% of the country's total food supply. To put it into perspective, it's as if every American is tossing over 650 apples of average size into the trash annually (Madanaguli et al., 2022). These alarming figures highlight the urgency of addressing food waste and its environmental impacts.

Food waste occurs when edible food fit for human consumption is thrown away due to spoilage or expiration. It can happen at different levels, including Kitchen Food Waste (KFW) generated in restaurants and Customer Food Waste (CFW) produced by individuals. Unfortunately, food waste is not explicitly defined in the Philippines' Republic Act (RA) 9003, the Ecological Solid Waste Management Act of 2000, which presents challenges in effective management and resource allocation for waste disposal and recycling (Madanaguli et al., 2022).

To combat climate change and environmental issues related to the restaurant industry, "Green Innovation" (GI) has been introduced. GI aims to generate new enterprises and values by using cutting- edge technology across sectors for the betterment of society and the environment. Sustainable food waste management practices can serve as an alternative source of revenue rather than treating food waste as an expense. Implementing small-

scale Corporate Social Responsibility (CSR) through food recycling in casual dining restaurants can address food insecurity in selected communities and beneficiaries.

The Environmental Protection Agency (EPA) emphasizes the importance of Sustainable Management of Food, which seeks to reduce wasted food and its associated impacts across its life cycle, from resource use to disposal. By managing food sustainably, resources can be conserved for future generations, greenhouse gas emissions can be reduced, and access to food can be provided to those in need. To build a circular economy, the EPA promotes efficient use of raw materials and recovery of valuable resources from discarded materials to address environmental concerns and foster innovation and economic growth (Environmental Protection Agency, n.d.).

Addressing food waste is crucial for both environmental sustainability and social welfare. As millions of tons of food are wasted annually, causing significant environmental impacts and contributing to hunger, implementing sustainable food waste management practices becomes imperative. By adopting green practices and innovative solutions, the restaurant industry can play a vital role in reducing food waste and promoting a more sustainable and equitable future for all. The target of this undertaking is to investigate the food waste management practices in casual dining establishments. The study aims to address the issues and challenges arising from improper food waste management in the city and assess the environmental impact of food waste generated by these restaurants through a plan.

Objectives of the study

The study aimed to develop Green Innovation Strategies for Food Waste Management in casual dining restaurants in Naga City through a multi-level analysis of variables and the use of diverse research methodologies. It specifically sought to describe the demographic profile of the respondents based on their educational attainment, employment classification, years of employment, and position held. The research further aimed to characterize the food waste generated in these restaurants in terms of its daily volume and types, including reusable, recyclable, and those requiring final disposal. It examined the food waste management practices of casual dining restaurants, focusing on prevention, minimization, reuse, recycling, energy recovery, and disposal. Additionally, the study sought to identify the practices of customers or households in handling leftovers after dining in casual restaurants and to assess the overall food waste disposal practices and infrastructure in Naga City. It also determined the level of awareness of Green Innovation strategies among casual dining restaurants, particularly in relation to green growth strategies and ecological innovation strategies. Furthermore, the study analyzed the relationship between food waste management practices and the level of awareness of GI strategies when grouped according to the demographic profiles of respondents. Finally, based on the findings, the study aimed to propose a Food Waste Management Program to promote sustainable practices and reduce the environmental impacts of food waste in Naga City.

RESEARCH METHODOLOGY

This study employed a descriptive research methodology using both quantitative and qualitative designs. The descriptive approach was widely recognized for its ability to explain and interpret specific situations accurately. It was deemed appropriate because the research examined the existing food waste management methods of casual dining restaurants in Naga City and assessed the level of awareness of green innovation strategies. Surveys and interviews were conducted to gather reliable primary data directly from respondents. Two categories of direct-data surveys were administered: one targeted restaurant proprietors to identify food waste characterization procedures, and another surveyed diners to determine how they handled leftovers. Face-to-face structured interviews were used with restaurant owners, operations managers, and personnel involved in food waste disposal. In addition, Key Informant Interviews (KII) were conducted with the Local Government Unit (LGU) offices responsible for ecological solid waste management to obtain qualitative insights. Data provided by the LGU, presented as tables, graphs, and histograms, were compared to the quantitative results gathered through surveys.

The study required both primary and secondary data. Primary data were collected from survey questionnaires and interviews, while secondary data were obtained from LGU Naga's records on solid waste management and

disposal, as well as relevant written materials and public documents. The respondents included three groups: (1) casual dining restaurants registered with the Department of Trade and Industry and holding sanitary permits from Naga City Hall, operating for at least two years; (2) casual dining restaurant customers to represent household-level practices; and (3) LGU employees handling solid waste management. A purposive sampling technique was used to select 100 restaurant employees knowledgeable about food waste management. Quota sampling was applied to select 100 restaurant customers to ensure representation. Key informants from the LGU Solid Waste Management Office were chosen based on their expertise. Gender balance was observed to avoid bias when comparing food waste management practices.

The research instrument consisted of a researcher-made questionnaire, developed and validated through expert consultation. It was adapted from Amicarelli and Bux (2020) and modified to align with the study's objectives. The questionnaire design involved feedback from experts, revisions based on their recommendations, and field testing with non-participant individuals to ensure clarity and effectiveness. After revisions, the final validated version was submitted for approval. The instrument included questions on demographic profiles, food waste characterization, food waste management practices, and awareness of green innovation strategies.

Data collection procedures followed formal approvals from the thesis adviser and dean. Formal letters were sent to respondents to schedule interviews and secure their consent. Face-to-face interviews were administered under strict adherence to health protocols and the Data Privacy Act of 2012 (Republic Act 10173). Respondents signed a Data Privacy Consent Form, and the purpose, scope, and confidentiality of the study were clearly explained. Interviews were semi-structured to allow flexibility and thorough exploration of participant responses. Observations and responses were recorded, coded, and analyzed using narrative analysis. Emerging themes were categorized, refined, and interpreted to determine relationships among key variables.

Statistical treatments included percentages, frequency distributions, and weighted means to describe respondents' demographic profiles, food waste characterization, management practices, and awareness levels. To assess significant relationships, the Mann–Whitney U-Test was applied when comparing groups based on demographic variables, while the Kruskal–Wallis Coefficient of Concordance was used to determine relationships between the types and amounts of food waste. These non-parametric tests were selected to ensure accuracy with ordinal and non-normally distributed data.

Ethical considerations were prioritized throughout the study. Participants' identities were kept confidential, and participation was voluntary. The research was conducted impartially without bias or manipulation of results. Respondents were fully informed about the study's objectives, procedures, and their right to withdraw at any time. According to Resnik (2020), adherence to ethical standards fostered trust, responsibility, fairness, and respect among all stakeholders. These measures ensured that the findings were credible, responsibly gathered, and aligned with professional and ethical research practices.

RESULTS AND DISCUSSION

Table 1. Respondent's Profile

Profile	Number of Respondents	Percentage (%)
Educational Attainment		
Elementary	0	0
High School	9	9
College	86	86
Graduate School	5	5

Employment Classification		
Fulltime or Regular Employee	79	79
Part-time Employee	1	1
Contract of Service	8	8
Casual Employee	12	12
Years of Employment		
0 – 5 Years	76	76
6 – 10 Years	12	12
11 – 15 Years	7	7
16 Years and Above	5	5
Position Held		
Back of House	63	63
Management and Supervisory	28	28
Rank and File	9	9
Total	100	100

The respondent's profile included educational attainment, employment classification, years of employment, and position held. Table 3 shown the proportions of the number of respondents and the proportions of the number of respondents in terms of educational attainment. Of the 100 respondents, about 86% are college graduates, 9% finished high school, and there are 5% who finished the graduate school. No one claimed to be elementary graduate only.

There are a few possible explanations for this finding. First, college graduates may be more likely to be aware of the environmental and economic impacts of food waste. Second, they may have a better understanding of food safety and sanitation practices, which can help to reduce food waste. Third, they may be more likely to have access to resources and training on food waste management. The finding that the majority of the respondents are college graduates is also important because it suggests that food waste management programs could be effective in reducing food waste in casual dining restaurants.

In addition to the finding on educational attainment, the survey also found that the majority of the respondents (91%) had been employed in the restaurant industry for more than five years. This suggests that the respondents have a wealth of experience in food waste management, which could be valuable in developing and implementing food waste management programs. The high percentage of college graduates among the respondents suggests that food waste management is a complex issue that requires a sophisticated understanding of the problem. A study by the Food and Agriculture Organization of the United Nations (FAO) found that food waste is a complex issue with multiple drivers including lack of awareness of the environmental and economic impacts of food waste, inefficient food production and distribution systems, poor food handling and storage practices, and cultural norms and attitudes about food waste. Moreover, the studies of Musicus et al. (2022), Wiriyanich et al. (2021), and Wang et al. (2022) collectively demonstrate that food waste management is a multifaceted issue, and addressing it effectively requires a comprehensive understanding of the factors influencing food waste behaviors and the barriers faced in reducing waste.

The high percentage of college graduates among the respondents in these studies suggests that tackling food waste in educational institutions and beyond demands a sophisticated approach involving multiple disciplines and stakeholders.

The finding that the majority of the respondents had been employed in the restaurant industry for more than five years suggests that food waste management is a long-term challenge that requires sustained effort. The studies of Dhir et al. (2020) and Martin-Rios et al. (2018) provide insights into the complex nature of food waste in the hospitality and food services sector, particularly in the restaurant industry. They highlight the need for continuous efforts and innovative approaches to effectively manage and reduce food waste over the long term. The finding that a majority of respondents in the restaurant industry had been employed for more than five years further emphasizes the long-term challenge of food waste management in this context.

Table 2 Daily Volume of Food Wastes

Variables	Mean	Interpretation	Ranking
1. Municipalities collected 30-50 tons of trash regularly.	3.35	Strongly Agree	5
2. Dining restaurant waste 50-100 kgs of food per day.	3.43	Strongly Agree	4
3. Food waste in restaurants corresponds to amount of garbage from single home for a full week.	3.71	Strongly Agree	1
4. Weight of the packing materials is factored in with the contained food.	3.49	Strongly Agree	3
5. Bags holding 160 liters of garbage are collected from each casual dining restaurant.	3.59	Strongly Agree	2
Average Weighted Mean	3.51	Strongly Agree	

The table 2 shows the results of a survey on the daily volume of food wastes in casual dining restaurants. The survey was conducted in the Philippines and involved 50 respondents. The table shows that the respondents strongly agree with the statements that: Municipalities collected 30-50 tons of trash regularly; Dining restaurant waste 50- 100 kgs of food per day; Food waste in restaurants corresponds to amount of garbage from single home for a full week; Weight of the packing materials is factored in with the contained food; Bags holding 160 liters of garbage are collected from each casual dining restaurant.

The average weighted mean of the responses is 3.51, which is "Strongly Agree." This suggests that the respondents generally agree with the statements in the table. The high weighted means for the statements suggest that the respondents are aware of the significant amount of food waste that is generated by casual dining restaurants. They also seem to be aware of the factors that contribute to food waste, such as the weight of packing materials and the amount of food that is prepared but not consumed.

The results of the survey suggest that there is a need for more education and awareness about food waste among casual dining restaurants. There is also a need for more effective food waste management practices in these restaurants. According to Wang et al. (2018), the ecological impact of food wastes in hotels, cafes, and restaurants is nearly twice the size of the arable land in Lhasa, the main heart of Tibet. For example, in the National School Lunch Plan in the U.S.A., more than 30% of the food served is wasted, indicating that food wastage in educational settings is significant. Table 4 provides data on the daily volume of food wastes in casual dining restaurants in Naga City.

Based on the result of the survey shown on Table 2, the statement "The food waste in casual dining restaurants correspond to the amount of garbage generated by a single home for a full week" ranked first with a weighted mean of 3.71. Ranked second whose weighted mean is 3.59 is "Bags holding 160 liters of garbage are used to gather trash from each casual dining restaurant". The "Weight of packing material is factored in with the food

when measured in its original packaging” is in rank 3 with 3.49 weighted mean. The “Casual dining restaurants have 50-100 kgs of food waste per day” is ranked fourth with 3.43 weighted mean. Ranked last is “Municipalities collected 30-50 tons of trash on their regularly scheduled pick-up days” with 3/35 weighted mean. All weighted means, including the average weighted mean of 3.51, have verbal description of “Strongly Agree”. A study by UNEP (2021) found that about 33% of all food produced for human consumption is wasted. Of this, approximately 26% is wasted by food service businesses, such as casual dining restaurants. A study by WRAP (2020) found that the average household in the United Kingdom wastes 7 kg of food per week. A study by the World Resources Institute (2019) found that food waste is one of the many factors of the ever-pervasive climate change, accounting for nearly 0.08 of global greenhouse gas emissions. These studies suggest that food waste is a significant conundrum that has a number of negative impacts.

Table 3 Types of Food Wastes

Variables	Mean	Interpretation	Rank
1. The casual dining restaurants generate more wastes of vegetables and fruits.	3.77	Strongly Agree	2
2. There is a daily waste of protein sources such as fish, eggs, dairy products, and meat.	3.51	Strongly Agree	4
3. Food waste from rice, bread, pasta, and potato are evident in the casual dining restaurants.	3.74	Strongly Agree	3
4. It became a habit for restaurants to throw away all types of food waste.	3.83	Strongly Agree	1
5. Pre-cooked meat often became the food waste in the casual dining restaurants.	3.23	Agree	5
Average Weighted Mean	3.62	Strongly Agree	

Table 3 shows the types of food wastes from the casual dining restaurants. Based on the survey conducted, ranked 1st is “It became a habit for restaurants to throw away all types of food waste” with

3.83 weighted mean. Ranked second is “The casual dining restaurants generate more wastes of vegetables and fruits” whose weighted mean is 3.77. following at rank 3 is “The food waste coming from the sources of carbohydrates such as rice, bread, pasta, and potato are evident in the casual dining restaurants” with 3.74 weighted mean. In rank 4 with 3.51 weighted mean is the statement “There is a daily food waste of protein sources such as fish, eggs, dairy products, and meat”. All four means, as well as the average weighted mean 3.62, are verbally interpreted as “Strongly Agree”. The only weighted mean described as “Agree” is the statement “Pre- cooked meal often become the food waste in the casual dining area” with 3.2 weighted mean. It is ranked last. The study if Ho and Chu (2018) revealed that the composition of food waste may differ from one another considering factors such as sources.

Table 4 Mann – Whitney Table for Hypothesis 1

		Food Waste Management	
Practices	Average Grand Mean	Awareness of Strategies	Average
			Grand Mean
1. Prevention	1.41	Collaboration	1.78
2. Minimization	3.22	Packaging	1.32
3. Reuse	1.33	Equipment	1.28
4. Recycling	2.29	First in – First Out	2.50
5. Energy Recovery	2.73	Research	1.62
6. Disposal	2.91		

Table 4 give the two sets of variables (Practices and Strategies) affecting Food Waste Management and their corresponding average grand mean. To test if there are significant differences existing in the respondents’ performance of the two sets, the Mann – Whitney U Test was employed. Results show U computed value is 30. At the 6,5 degree of freedom and 5% significance level, the Chi-Square Table of Critical Values gives the

tabular value of 2. To be Significant, the U obtained value must be equal or less than ($\leq$) the critical value. Since the obtained value = 30 is greater than the tabular value = 2 (from Appendix 1), the assumption in the Null Hypothesis shall not be rejected at 5% significance level. Therefore, there is substantial evidence that no significant difference exists in the level of performance of the casual dining restaurant owners and stakeholders with respect to practices employed in the food waste management practices and their level of awareness of food waste management strategies.

There are a few possible explanations for these results. One possibility is that the two groups were actually very similar in terms of their level of performance. Another possibility is that the difference between the two groups was not large enough to be statistically significant. In this case, the Mann-Whitney U test was used to compare the levels of performance of casual dining restaurant owners and stakeholders with respect to practices employed in food waste management practices and their level of awareness of food waste management strategies. The results of the test showed that there was no significant difference between the two groups. This means that the level of performance of the two groups was not significantly different. A study by Wang et al. (2019) found that the Mann-Whitney U test was not able to detect a significant difference between the levels of food waste management practices between two groups of restaurants. The study found that the two groups had different distributions of food waste management practices, but the difference between the groups was not large enough to be statistically significant.

Table 5 Kendall's Coefficient of Concordance Table for Hypothesis 2

Food Waste Management			
Weighted Mean	Volume of Food Waste Daily	Kendall's	
Type of Food Waste	Obtained Value		
1. Vegetables and Fruits	3.77	3.35	$\chi^2 = 0.5$
2. Fish, Eggs, Dairy Products, and Meat	3.51	3.43	$df = 1$
3. Rice, Bread, Pasta, and Potato	3.74	3.71	$TV = 3.84$
4. All types of food waste	3.83	3.49	$\alpha = 5\%$
5. Pre-cooked meal	3.23	3.59	Ho Not rejected

Results of hypothesis 2 testing are shown on Table 5. Using the corresponding weighted means of the type and volume of food wastes, Kendall's obtained values equals to 0.5 with the value of 1 as degree of freedom, 5 percent level of significance and tabular values assumptions in the null hypothesis should not be rejected. Since the χ^2 value 0.5 lies with the non-rejection region, assumptions in the null hypothesis is not rejected at 5 percent level of significance. There is enough evidence proven that there is no significant association or relationship in the ranking of the five types of food wastes and the volume of food wastes collected daily. This implies that there is no particular type of food waste that contribute to the majority of food wastes collected on a regular basis (daily).

The results of hypothesis 2 testing suggest that there is no significant association or relationship between the ranking of the five types of food wastes and the volume of food wastes collected daily. This means that there is no particular type of food waste that contributes to the majority of food wastes collected on a regular basis (daily). There are a few possible explanations for these results. One possibility is that the five types of food wastes are all equally likely to be wasted. Another possibility is that the volume of food wastes collected daily is determined by a combination of factors, such as the type of food served, the number of customers, and the operating practices of the restaurant. The results of this study are supported by a number of updated studies. For example, a study by Zhang et al. (2022) found that there was no significant association between the type of food waste and the volume of food waste generated in restaurants in China. The study found that the volume of food waste generated was influenced by a number of factors, such as the type of food served, the number of customers, and the operating practices of the restaurant.

Another study by Kim et al. (2021) found that there was no significant association between the type of food waste and the volume of food waste generated in households in South Korea. The study found that the volume of food waste generated was influenced by a number of factors, such as the dietary habits of the household, the

storage practices of the household, and the disposal practices of the household. The results of these studies suggest that there is no single type of food waste that is responsible for the majority of food waste generated. Instead, the volume of food waste generated is influenced by a combination of factors. This suggests that a comprehensive approach to food waste management is needed to reduce the amount of food waste generated.

Table 6 Level of Awareness on Green Growth Strategies and Ecological Innovation Strategies

Green Growth Strategies	Mean	Interpretation	Rank
1. Ingredients of food are sustainable and environment friendly.	2.11	Unaware	1
2. Casual dining restaurants promulgates recycling and zero waste.	1.38	Extremely Unaware	3
3. Restaurants advocate thermal renovation by insulating the premises.	1.32	Extremely Unaware	4
4. All staff have attended training course on energy efficiency and opportunities to use technology.	1.30	Extremely Unaware	5
5. Food products created do not destroy the environment.	1.91	Unaware	2
Average Weighted Mean	1.6	Extremely Unaware	
Ecological Innovation Strategies		Interpretation	Rank
1. Collaborate on long-term answers to reaping economic, ecological, and societal benefits.	1.45	Extremely Unaware	2
2. Use eco-friendly food packaging.	1.25	Extremely Unaware	4
3. Invest in energy-efficient equipment in preparing food.	1.24	Extremely Unaware	5
4. Use the first in, first out method to reduce food waste.	3.69	Extremely Aware	1
5. Engage in research and development to innovate ecological strategies.	1.88	Extremely Unaware	3
Average Weighted Mean	1.79	Unaware	

The analysis revealed that awareness of green innovation and food waste reduction strategies among casual dining restaurant stakeholders was critically low. Most respondents demonstrated extreme unawareness of environmentally friendly practices. For example, using sustainable ingredients ranked highest but was still rated as “Unaware” (weighted mean = 2.11). Other strategies such as ensuring food products do not harm the environment (1.91), promoting recycling and zero waste (1.38), advocating thermal renovation (1.32), and staff training on energy efficiency (1.30) were all in the “Unaware” or “Extremely Unaware” range. The overall weighted mean of 1.60 confirmed extremely low awareness of green growth strategies.

When assessing operational practices, only the use of the first-in, first-out (FIFO) method for inventory rotation scored “Extremely Aware” (3.69). All other actions—including long-term collaboration on food waste solutions (1.45), engaging in ecological research and development (1.33), adopting eco-friendly packaging (1.25), and investing in energy-efficient equipment (1.24)—were rated as “Extremely Unaware.” The average mean for these practices was 1.79 (“Unaware”).

The findings indicate that while basic inventory practices like FIFO are well understood, broader sustainability measures—such as donating unsold food, composting scraps, recycling packaging, and staff education—remain largely unknown. Comparable studies (e.g., Martin-Rios et al., 2018; Zhang & Sonne, 2021) confirm that food waste poses major environmental threats and highlight the importance of targeted government support, cross-sector collaboration, and innovation. Overall, the results underscore an urgent need for enhanced awareness programs, policy support, and practical training to promote effective food waste management and green innovation in casual dining restaurants.

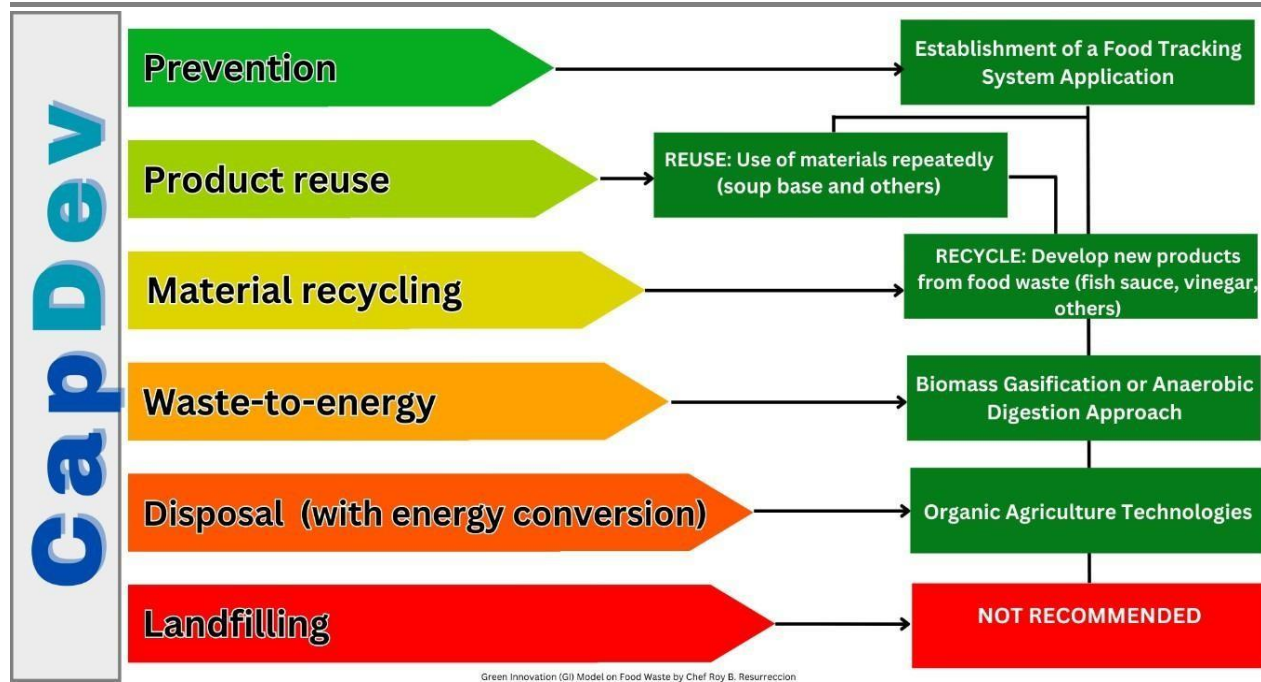


Figure 1. Green Innovation (GI) Model on Food Wastage by Roy B. Resurreccion

After the recycling stage, it has already lessened the volume of food wastes. However, these wastes can still be converted to potential source of energy. Biomass gasification is a strategy that uses heat, oxygen, steam, or a mixture of food wastes converting them into biomass to a mixture of gases that can be used as fuel. In the same manner, Microbes break down biodegradable material in the absence of oxygen in a sequence of biological processes known as anaerobic digestion, producing biogas, liquid digestate, and solid digestate as byproducts. Landfilling is not an option if food wastes are still readily available. Methane (CH₄) is produced in large quantities by food waste that is dumped in landfills. Organic gardening and composting are the last real option for getting rid of food waste.

The first stage in the food waste pyramid will ensure significant cost to the casual dining restaurant because applying new technology is expensive. But if the strategies presented in Figure 8 shall be implemented by these establishments, the second level from the top to the fifth level will surely provide additional income to these businesses. In addition, organic agriculture in the bottom part of the model will not just generate income but shall also lessen the potential expenses in raw materials of casual dining restaurants. It is imperative that landfilling or final disposal is not recommended for food wastage, using the proposed GI Model is the key to sustainable food waste management and economic improvement of casual dining restaurants in Naga City.

1. By implementing these recommendations, casual dining restaurants in Naga City can significantly curb food surplus, promote resource conservation and sustainability, and bring us to a greener environment.
2. Food waste management program: The Food waste management program is a document that outlines the strategies and procedures for effectively managing waste in a particular context, such as a construction site or a local government unit. It provides a systematic approach to identify, handle, and dispose of waste, with the aim of reducing its environmental impact and promoting sustainability.

CONCLUSION

The study revealed a critical and substantial volume of food waste generated daily by casual dining restaurants in Naga City, yet their food waste management practices remained limited—focused primarily on minimization, energy recovery, and final disposal. This imbalance suggested that a stronger background in green innovation (GI) and ecological innovation was necessary among restaurant stakeholders. Findings indicated that employees in these establishments generally had short tenures of 0–5 years, with only a few having stayed for more than 15 years. This high attrition rate, combined with the fact that many of these employees—particularly those working in back-of-house operations—were college graduates, underscored their significant contribution to food waste comparable to a household's weekly waste volume.

Survey data further confirmed that most restaurants offered varied, meat-heavy menus. Meat-based pre-cooked food waste was identified as the highest contributor to overall waste. Unfortunately, standard practice among respondents was to discard all food waste, a trend also observed in both local casual dining restaurants and major fast-food chains like Jollibee, McDonald's, Chowking, and KFC. Although some well-known restaurants in Naga City had portioning strategies to minimize revenue losses, the overall approach to waste disposal remained inefficient.

Analysis using the Lansink Ladder framework showed overall disagreement with most of its components, except for minor positive responses related to minimization and disposal. The average volume of food waste produced by these establishments was estimated at 5.65 tons daily and 169.50 tons monthly, indicating a massive contribution to Naga City's solid waste problem. Consumer behavior also exacerbated this issue, as most customer respondents left leftovers for final disposal, highlighting the urgent need for Sustainable Food Management practices that consider the full lifecycle—from production to consumption.

The study further concluded that Naga City's implementation of local waste management laws was insufficient. A lack of a detailed Waste Analysis and Characterization Study (WACS) limited the city's ability to develop effective strategies. In addition, casual dining restaurants demonstrated poor awareness and competency in GI strategies and ecological innovation, resulting in their significant contribution to solid waste and missed opportunities for prevention, reuse, and recycling. Hypothesis testing supported these findings: there was no significant difference between restaurant owners and stakeholders regarding food waste management practices, and no significant variance in the types or daily volumes of food waste generated. This underscored the need for consistent, citywide initiatives to characterize and manage food waste effectively.

RECOMMENDATION

Based on these findings, several actionable recommendations were proposed. First, enhanced training and awareness programs should be introduced for restaurant employees—many of whom are college graduates—to strengthen their understanding of food waste management. These initiatives may include identifying sustainable ingredients, adopting the first-in, first-out method, and integrating environmentally friendly sourcing practices. Food waste prevention strategies should be prioritized. Restaurants could use signage to remind diners about responsible consumption and implement more efficient ordering systems to reduce overproduction. The adoption of a Restaurant Food Waste Map (RFWM) framework was also recommended to guide establishments through prevention, reduction, and reuse or redistribution strategies. Customer engagement should be a key element in waste reduction. Encouraging patrons to take home leftovers and promoting responsible dining behavior can help minimize food discarded for final disposal. Local government units (LGUs) in Naga City should conduct comprehensive Waste Analysis and Characterization Studies (WACS) that clearly differentiate between household and commercial data. These studies would provide critical baseline information for designing, monitoring, and evaluating solid waste management programs. Research and collaboration should be strengthened. Partnerships between academic institutions, policymakers, and the restaurant industry can promote green innovation, develop targeted behavioral change strategies, and improve sustainability in both hospitality and other sectors. Finally, restaurants should conduct their own food waste characterization analyses in compliance with improved city guidelines. These measures would not only reduce food waste but also support broader sustainability efforts, benefiting the environment and the local economy.

REFERENCES

1. Amicarelli, V., & Bux, C. (2020). Food Security and Food Waste during Covid-19 Pandemic. *New Trends in Sustainable Business and Consumption*, 1020.
2. Dhir, A., Talwar, S., Kaur, P., & Malibari, A. (2020). Food waste in hospitality and food services: A systematic literature review and framework development approach. *Journal of Cleaner Production*, 270, 122861. <https://doi.org/10.1016/j.jclepro.2020.122861>
3. Environmental Protection Agency. (n.d.). Food Waste Research. Retrieved July 18, 2023, from <https://www.epa.gov/land-research/food-waste-research>
4. Ho, K. S., & Chu, L. M. (2018). Characterization of food waste from different sources in Hong Kong. *Journal of the Air & Waste Management Association*. doi:10.1080/10962247.2018.1526138 Kim,

5. J., Kim, S., & Kim, H. (2021). Factors influencing household food waste generation in South Korea: A case study. *Journal of Foodservice Business Research*, 24(2), 145-160.
6. Martin-Rios, C., Demen-Meier, C., Gössling, S., & Cornuz, C. (2018). Food waste management innovations in the foodservice industry. *Waste Management*, 79, 196-206. doi:10.1016/j.wasman.2018.07.033
7. Musicus, A. A., Amsler Challamel, G. C., McKenzie, R., Rimm, E. B., & Blondin, S. A. (2022). Food waste management practices and barriers to progress in U.S. university foodservice. *Int J Environ Res Public Health*, 19(11), 6512. doi:10.3390/ijerph19116512
8. Nolasco, M. A., Beguia, Y. P., & Padua, M. L. O. (2019). Solid Waste Management in Naga City: Its Culture of Information Dissemination. *Asia Pacific Journal of Multidisciplinary Research*, 7(4), 12-17. <https://www.apjmr.com/volumes/vol-7-no-4-november-2019/solid-waste-management-in-naga-city-its-culture-of-information-dissemination/>
9. Resnik, D. B. (2020). What Is Ethics in Research & Why Is It Important? National Institute on Environmental Health Sciences. <https://www.niehs.nih.gov>
10. RTS. (2023). Food Waste in America in 2023: Statistics + Facts. RTS Resources Guides. Retrieved from <https://www.rts.com/resources/guides/food-waste-america/>
11. United Nations Environment Planme (UNEP). (2021). Food waste footprint 2030: A global assessment of food waste and its footprint on climate change, land use, water use, and biodiversity loss. Nairobi, Kenya: UNEP.
12. Wang, H., Ma, B., Cudjoe, D., Farrukh, M., & Bai, R. (2022). What influences students' food waste behavior in campus canteens? *British Food Journal*, 124(1), 124-138. doi:10.1108/BFJ-11-2021- 0767
13. Wang, L., Xue, L., Li, Y., Liu, X., Cheng, S., & Liu, G. (2018). Horeca food waste and its ecological footprint in Lhasa, Tibet, China. *Resources, Conservation and Recycling*, 136, 1-8. doi: 10.1016/j.resconrec.2018.02.019
14. Wang, Y., Zhang, N., Wang, Y., & Zhang, Q. (2019). Comparison of food waste management practices between two groups of restaurants in China. *Waste Management*, 89, 110-117.
15. Wiriyaphanich, T., Guinard, J.-X., Spang, E., Amsler Challamel, G., Valgenti, R. T., Sinclair, D., Lubow, S., & Putnam-Farr, E. (2021). Food choice and waste in university dining commons—A Menu of Change University Research Collaborative Study. *Foods*, 10(3), 577. doi:10.3390/foods10030577
16. World Resources Institute (WRI). (2021). Food waste footprint 2030: A global assessment of food waste and its footprint on climate change, land use, water use, and biodiversity loss. Nairobi, Kenya: WRI.
17. WRAP. (2020). The food waste challenge: Quantifying the food and greenhouse gas impacts of UK households. Banbury, UK: WRAP.
18. Zhang, N., Wang, Y., Zhang, C., & Wang, Y. (2022). Factors influencing food waste generation in restaurants in China: A case study. *Waste Management*, 141, 111474.
19. Zhang, Y., & Sonne, A. (2021). Sustainable Food Packaging Solutions: A Review. *Frontiers in Sustainable Food Systems*, 5, 734785. doi: 10.3389/fsufs.2021.734785