

Effect of Food Waste Prevention on Green Logistics in Dodoma City, Tanzania's Small-Medium Restaurants

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Abstract

This study examined the effects of food waste prevention strategies on green logistics by small and medium-sized restaurants in Dodoma City, Tanzania. It applied a mixed-methods case study approach to collect data from 80 restaurants. It also used questionnaires, in-depth interviews with key informants, and direct observation methods in data collection. Data analysis employed regression and content analysis methods for quantitative and qualitative data. The findings reveal that while awareness of food waste prevention is moderate, significant positive impacts on green logistics are observed with proper demand forecasting ($B = 0.092$, $P\text{-value} = 0.000$), proper food storage ($B = 0.360$, $P\text{-value} = 0.000$), and regular inventory checks ($B = 0.441$, $P\text{-value} = 0.000$). The study concludes that proper demand forecasting, adequate food storage, and frequent inventory checks emerged as crucial factors in reducing food waste and promoting sustainability. These findings underscore the need for enhanced awareness, technological support, and infrastructure improvements to fully utilise these strategies for waste minimisation and sustainable restaurant operations.

Keywords: Food Waste; Green Logistics; Small-Medium Sized Enterprise

Introduction

Food waste is one of the challenging issues facing the world today, with restaurants producing a considerable amount of food waste every day. Mainly, restaurants are the fast food selling centres that generally fail to have proper operational management, resulting in missing sales that lead to food waste (Adan, 2023; De Rezende Alvares *et al.*, 2022; Ichwan & Cahyana, 2023). The global high generation of food waste, which amounts to about 13 billion tons per year, results in critical challenges environmentally, economically, and socially, enhancing the need for serious measures to reduce food waste (Lekavičius *et al.*, 2023).

In Europe, the European Union has issued a directive and the European Green New Deal to reduce food waste (Lekavičius *et al.*, 2023; Peppe & Peppe, 2023). Food waste challenges in Asian Countries are caused by several factors, including improper handling, poor technology,

and poor consumer behaviour such as planning, eating habits, purchasing, and storing (Diana *et al.*, 2023).

In Africa, food waste is more prevalent in the region's North, sub-Saharan, and Near East African parts (Berja *et al.*, 2018; El Bilali, 2018). With regard to Tanzania, an Eastern African country, several studies revealed the existence of a high generation of food waste. According to Mbuligwe and Kaseva (2006), Tanzania's industrial sector generates 39,000 tonnes of solid waste annually, of which 91.7% comes from food industries. Kamugisha (2023) reveals that the value of food loss in Tanzania is estimated at six trillion Tanzanian shillings annually. In Dodoma City, the study by Nyampundu *et al.* (2020) indicated that in Majengo, the largest food market in the city, approximately 20 tons of solid waste is produced daily; food waste constitutes 94.4% of the total waste.

In particular, studies by Maduhu and Makori (2019) and Nyampundu *et al.* (2020)

have indicated that small and medium-sized restaurants contribute to food waste in Tanzania through excessive food preparations, poor storage, food leftovers, spoiled ingredients, uneaten consumer food, and inadequate waste management practices which results to inefficiency of food waste management in the hotel industry in Tanzania, Dodoma inclusive.

While the challenge of food waste continues, the government of Tanzania and other stakeholders have taken measures to reduce food waste. On one side, legal measures such as the Environmental Management Act of Tanzania (2004) and the environmental regulation (2009) reinforce the need for sustainable environmental management, including reducing food waste, the primary source of environmental pollution (Maduhu & Makori, 2019). Additionally, empirical studies have promoted food waste reduction strategies in Tanzania, including green strategies like recycling and the promotion of methodologies that can reduce waste (Gikuri, 2021; Maduhu & Makori, 2019).

Despite legislative and awareness campaigns, the challenges of food waste continue. Thus, the effects of food waste prevention measures among small and medium-sized restaurants in Tanzania are still not known. Additionally, studies that focus collectively on three aspects of food waste prevention measures: proper demand forecasting, proper storage, and frequent inventory checks and their impact on green logistics, particularly among small and medium-sized restaurants in Dodoma City, are limited. Thus, to cover the gap, the study examines the effect of food waste prevention measures (food forecast, storage, and inventory checks) on green logistics in small and medium-sized restaurants in Dodoma, Tanzania. First, the study analyses the prevalence of food waste prevention strategies employed by small and medium-sized restaurants. Second, it examines the effect of food waste prevention methods on green logistics by small and medium-sized restaurants in Dodoma City.

Conceptually, this study adopted three independent variables: proper demand forecasting, proper food storage, and frequent inventory checks, which are believed to influence green logistics in small and medium-

sized restaurants. The independent variable, proper demand forecasting, involves accurately predicting customer demand to minimise food overproduction and wastage. (Corsini *et al.*, 2024). Proper food storage influences green logistics because by storing food in optimum conditions, restaurants can extend the shelf life of their inventory, reducing the need to dispose of perishable items prematurely (Gharakhani *et al.*, 2023). Moreover, frequent inventory checks allow restaurants to monitor their stock levels accurately and identify potential waste points in their operations (Islam *et al.*, 2022). This proactive approach enhances operational efficiency and supports green logistics by optimising resources and minimising waste.

Methods and Materials

The Study Location

The study is conducted in Dodoma City, Tanzania that lies between latitudes 6.000° and 6.300° South and longitudes 35.300° and 36.020° East, covering an area of 2,769 square kilometres with an altitude ranging from 900 to 1,000 meters above sea level. Dodoma City was chosen as a study area due to its rapid urbanisation and the recent government decision to relocate the capital city to Dodoma. This decision has prompted significant growth in various sectors, including the food industry. The increase in population and business activities, particularly in the food sector, makes Dodoma an ideal location for studying the impact of food waste prevention strategies on green logistics in small and medium restaurants.

Research Design and Approach

This study employed a case study design. The design allowed for a comprehensive exploration of the research subject and a detailed examination of the effect of food waste prevention strategies on environmentally friendly logistics within small and medium-sized restaurants in Dodoma City, Tanzania. Additionally, it allowed for examining qualitative and quantitative data to ensure a broad understanding of the difficulties and potential of managing food waste in this context.

Sample Size and Sampling Technique

The sample size was obtained from the total number of 391 restaurants (as per the Dodoma City Council Department of Finance and Trade) in the study area by using the Yamane mathematical formula as follows:

$$n = \frac{N}{1 + N(\varepsilon)^2}$$

Where,

n = sample size, N = the total number of restaurants, ε = marginal error, with, 10% (0.1) used to obtain manageable respondents (Yamane, 1967). Thus, $n = 80$ Restaurants.

The study employed a multi-pronged sampling approach to gather data on food waste management practices and green logistics adoption. A purposive sampling technique was used to seek key informants from restaurant owners or managers. This method ensured that participants had the knowledge and experience to reliably answer questions about food waste management within their establishments. These individuals were valuable sources of in-depth insights. A simple random sampling technique was employed to select restaurant staff. This approach aimed to obtain a representative sample of employee perspectives on food waste and green logistics within restaurants.

Data Collection Methods and Tools

To ensure a comprehensive understanding, the study employed a mixed-methods approach; this is also based on the nature of the study, which requires the collection of qualitative data to explore details and quantitative data to obtain figures and statistics to establish facts. A questionnaire survey was used as a data collection method to collect data from a larger population of small and medium-sized restaurants and to collect quantitative data. Questionnaires (80 distributed, with 17 open-ended and closed-ended questions) were the primary tool for gathering data from a large group of restaurant workers quickly and efficiently. Standardised questionnaires formulated helped to minimise data bias and enable easy analysis.

In-depth interviews (10) with key informants (restaurant managers) were also applied to collect qualitative data. Each interview used a minimum of 30, not exceeding 90 minutes, to give room for a detailed

exploration of in-depth information. The interview method used a guiding checklist tool (with 15 questions) to collect data that provided detailed information and allowed for follow-up questions. Finally, the direct observations method in restaurants helped capture real-world practices and behaviours related to food waste prevention, enriching the data collected through questionnaires and interviews. In direct observation, the researcher recorded in a notebook the methods and techniques used by restaurant workers to prevent food waste. This multi-method approach aimed to gather diverse and rich data for a well-rounded analysis.

Data Analysis

From the small and medium-sized restaurants as the unit of analysis, descriptive statistics, including frequencies, percentages, and means, were used to summarise the prevalence of various food waste prevention strategies employed by small and medium-sized restaurants to analyse the first specific objective. For the second specific objective, the following multiple linear regression model analysis was employed to assess the effect of food waste prevention methods on green logistics.

Where Y is the dependent variable "Green

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Logistics,

β_0 is the constant term

β_1 is the coefficient of the independent variable "proper demand forecasting."

β_2 is the coefficient of the independent variable "proper food storage."

β_3 is the coefficient of the independent variable "frequent inventory checks."

ε is the error term.

This helped determine if specific methods influence green logistics and the overall effectiveness of food waste management within small and medium-sized restaurants. Moreover, content analysis was used to analyse qualitative data from interviews. This approach identified key themes and patterns in the experiences and perspectives shared by restaurant managers, providing a more profound understanding beyond quantifiable data.

Data Reliability

The Cronbach's alpha coefficient for the questionnaire was used to test data reliability. The test results were 0.828, indicating good internal consistency of the scale data (Table 1). This means the 17 questions used to measure food waste prevention practices in small and medium-sized restaurants were highly reliable and produced consistent results.

Ethical Issues

effectiveness or implementation. The findings reveal that small and medium-sized restaurant owners and managers in Dodoma have varying levels of agreement on perception and implementing food waste prevention strategies. The typical response, with a mean of 2.98, falls just below the midpoint of the Likert Scale, representing general impartiality with a slight inclination towards agreement.

Table 1: Overall Reliability Analysis of Food Waste Prevention Measurement Scale

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.828	0.802	17

Source: Data analysis, 2024.

The researcher sought consent from participants to ensure they were willing to participate in the study and maintain the confidentiality of information, as some participants were not willing to incorporate their names openly in the study. Additionally, permission was sought from the Dodoma City Council before conducting the study.

Results and Discussion

Food waste prevention strategies by small and medium-sized restaurants in Dodoma City Table 2 presents findings on waste prevention measures used in small and medium-sized restaurants in Dodoma City.

The findings presented in Table 2 show the mean score of 2.98 which indicates that, on average, respondents are neutral to slightly positive about using food waste prevention strategies. This suggests that although some respondents recognise the importance of these strategies, there is still a significant proportion of uncertainty or disagreement about their

This neutrality is attributed to several factors revealed during in-depth interviews, including “limited awareness and knowledge”. There is a lack of comprehensive understanding of effectively implementing food waste prevention strategies. Other themes which described limiting factors to food waste prevention measures obtained during the in-depth interview were “market demand fluctuation” and “electricity reliability”, which endanger food storage and discourage restaurants from applying food prevention strategies. One of the restaurant owners said, “*Although we try our level best to forecast customer needs, sometimes we get fewer customers than our expectations, and we do not have good food storage facilities, highly skilled personnel...*”. The other one said, “*.. the electricity is sometimes cut without prior notification...*”

This finding implies that restaurant owners and managers might be aware of the benefits of forecasting and storing food properly but may find the effort required to implement food waste

Table 2: Respondents’ agreements of food waste prevention strategies used

Level of Agreement	Assigned Value	Frequency	Per cent	F x Value
Strongly disagree	1	10	12	10
Disagree	2	18	23	36
Uncertain	3	25	31	75
Agree	4	18	23	72
Strongly agree	5	9	11	45
Total		80	100	238
Mean				2.98

Source: Field data analysis, 2024

prevention strategies complex as they require skilled personnel on market analysis issues and relevant technological and reliable power resources. A further implication of the finding is the limited availability of tangible and non-tangible resources regarding technology and skills, as explained in an RBV Theory (Uyanik, 2023).

While the findings revealed a limited understanding of food prevention measures, the Kharola *et al.* (2022) study emphasised food waste prevention at the earlier stages of food supply as they would minimise challenges associated with food prevention measures down to small and medium-sized restaurants. Thus, as Kharola (2022) emphasised, training farmers on food waste prevention and the entire

Effect of Food Waste Prevention Strategies on Green Logistics in Dodoma

This section explores the effect of food waste prevention strategies on green logistics among small and medium-sized restaurants in Dodoma City. Regarding their implementation of different methods to prevent food waste, such as proper food demand forecasting, proper food storage, and frequent inventory checks by small and medium-sized restaurants, a regression analysis was used to determine the effect of these food waste prevention strategies on green logistics. Table 3 summarises the findings, which reflect a strong positive association between the two variables.

As indicated in Table 3, the regression

Table 3: Effect of food waste prevention strategies on green logistics

Regressor	Unstandardised Coefficients		t	Sig. (P-value)	95.0% Confidence Interval for B	
	B	Std. Error			Lower Bound	Upper Bound
(Constant)	0.223	0.079	3.246	0.000	0.132	0.579
Proper demand forecast	0.092	0.081	4.136	0.000	0.269	0.753
Proper food storage	0.360	0.079	4.573	0.000	0.204	0.517
Frequent inventory checks	0.441	0.094	4.708	0.000	0.255	0.627
Durbin-Watson =2.0		R-squared = 0.727	df=3	Adjusted R ² =0.719		

Source: Data analysis, 2024.

community should be prioritised. With this finding, other empirical studies, such as Corsini *et al.* (2024), also observed that product-related and technology-enabling variables influence the success of food prevention initiatives. Efforts to adopt technology and skilled personnel for preventing food waste include electronic cooling facilities, reliable electricity access such as standby generators, which might be very expensive to run due to fuel costs, and skilled personnel who might require larger salaries compared to unskilled ones; such is difficult for small and medium-sized restaurants in developing countries' cities like Dodoma Tanzania. A similar observation was made by Shah (2023), who established that running generators in developing countries is very difficult due to financial resource constraints.

analysis found an R-squared value of 72.7% ($R^2 = 0.727$), indicating that the food prevention strategies included in the model account for 72.7% of the variability in green logistics. This is a high value, indicating a strong explanatory power of the model. Also, Table 3 demonstrates the Durbin-Watson test (DW=2.0), indicating zero autocorrelation. Likewise, Table 3 presents the effects of food waste prevention measures, including proper food forecasting, storage, and frequent inventory checks on green logistics. The continuous value for the intercept is 0.223, and it has a 0.000 significance level at the confidence interval (LB = 0.132, UB = 0.579), indicating that it is statistically significant.

Moreover, findings reveal that proper demand forecasting showed a significant positive impact (B = 0.092, P-value = 0.000, t

(3) = 4.136) at the 95.0% confidence interval (LB=0.269, UB=0.753). It revealed that each unit increase in proper demand forecasting is associated with an increase of 0.092 green logistic practices while holding other variables constant, indicating that accurate forecasting can greatly enhance green logistics. Proper food storage had a strong positive influence ($B = 0.360$, $P\text{-value}=0.000$, $t(3)=4.573$) at the 95.0% confidence interval (LB=0.204, UB=0.517), meaning each one unit increase in proper food storage is associated with an increase of 0.360 green logistic practices, suggesting that effective storage practices are crucial for sustainability.

In addition, frequent inventory checks ($B=0.441$, $P\text{-value}=0.000$, $t(3) = 4.708$) at the 95.0% confidence interval (LB = 0.255, UB = 0.627) were also significantly impactful, underscoring the importance of regular inventory management in promoting green logistics. Findings in Table 3 indicate that each one-unit increase in frequent inventory checks is associated with an increase of 0.441 green logistic practices.

These findings imply that proper demand forecasting emerged as a significant factor in enhancing green logistics among small and medium restaurants in Dodoma. Thus, accurate forecasting allows restaurants to purchase only the necessary amount of food, reducing overstocking and subsequent waste. The substantial positive Beta value (0.092) and the significance level ($P\text{-value} = 0.000$) indicated in Table 3 underscore the importance of this strategy. Similar findings were observed by others, including Corsini *et al.* (2024), who found that accurate demand forecasting is crucial. Additionally, Drewitt (2013) highlighted that demand forecasting tools and techniques are crucial in reducing waste by aligning procurement with actual consumption patterns.

Conversely, “waste minimisation” was an identified theme obtained during in-depth interviews with most key informants. One restaurant manager in Dodoma noted, “By improving our demand forecasting, we have cut down on waste significantly. We now order based on actual demand, not just estimates, even though it cannot be so accurate for we continue to have food waste challenges, particularly with

unreliable waste collection system”. These findings support the quantitative finding that improved food forecasts reduce waste. However, it shows that it has not solved the entire food waste challenge but needs more improvement. It underscores the need for improving technology to enable restaurants to forecast food demands better per the assumption of RBV theory. Such technology includes not only know-how innovation but also skilled personnel. Moreover, challenges are intensified by the existing systems' untimely failure to collect SW.

Proper demand forecasting is crucial to avoid waste, particularly in developing countries like Tanzania, which are facing economic challenges. Thus, food waste prevention measures, of which proper demand forecasting is part, should incorporate economic aspects, as also referred to by Cristóbal *et al.* (2018) that decision-makers have to design a food waste prevention programme by considering limited economic resources to achieve the highest environmental impact prevention along the whole food life cycle. Thus, small and medium-sized restaurants need to make the right decisions on the quantity of food to purchase; similarly, Todd and Faour-Klingbeil (2024) emphasised that the retail and food service industries have critical roles in working with suppliers (farmers, producers, wholesalers, and transporters) and users (consumers) to provide enough food items for sufficient choice and quantity, but not to overestimate their needs.

The study findings on the positive significant effect of proper food storage influence ($B = 0.360$, $P\text{-value} = 0.000$) on green logistic, as indicated in Table 3, also reflect the importance of storing food properly to control food decay and contaminations, which may lead to food waste among small and medium-sized restaurants in Dodoma City. This was explained more by most of the restaurants' managers as one of them said: “The foods that we waste most of them are those which customers leave and those which are cooked and left out uneaten, but the raw food we keep in refrigerators and store rooms, this helps us to minimise food waste”. This finding shows the need to promote proper food storage mechanisms to restaurants and the food industry sector, in general, to minimise food waste

and attain environmental sustainability. This finding aligns with the observation by Nayik *et al.* (2023), who emphasised the importance of proper food storage to minimise biotic attacks and attain food security. Likewise, Tumbay *et al.* (2023) show the need to use evaporative cooler structure technology to extend the shelf life of foods and minimise food waste.

Further qualitative findings from key informants revealed “increased rodents” as a theme, which describes challenges associated with food storage among restaurants in Dodoma City. One participant reported, *“There is a huge problem of insects such as cockroaches and rats, even when we try to improve food storage rooms, particularly for foods that do not need to be refrigerated, but also we still do not know much about food security”*. This shows the need for skilled personnel in the food industry who know best how food can be stored and how many storage rooms these pests can not quickly attack. A study by Takhtfiroozeh (2018) emphasises that insects and rodents pose a significant threat to food storage in restaurants in developing countries. The challenges of poor knowledge of food security were also identified by Yerragudipadu *et al.* (2023), who emphasised that food industries require experts in forecasting using regression models.

Moreover, the findings in Table 3 reveal a significant impact of the frequent inventory checks on green logistics ($B = 0.441$, $P\text{-value} = 0.000$). These findings imply the need for restaurant managers and responsible personnel to monitor the quality and quantity of food stored regularly. This reduces food waste, helps improve storage, and makes proper demand forecasts. The finding concurs with Islam *et al.* (2022), who emphasised the need for period review checks to avoid food waste. However, while the findings of this study reveal the need for frequently monitoring the quality and quantity of food stored, Nikolicic *et al.* (2021) show that coordinated inventory management, when using modern ICT, can significantly contribute to improving the sustainability of the food supply chain and provide an exact quantification of the given contribution in the dairy industry.

Kamaikumaran (2023) also revealed the

need for more advanced monitoring systems equipped with sensors to control food decay, implying more advanced technology. Likewise, Stathers and Mvumi (2020) emphasise the use of technology by indicating that food waste in sub-Saharan Africa is caused by limited technology, among others. Thus, technology cannot be undermined in frequent inventory checks if food waste is to be minimised.

Generally, Table 3 revealed further that the t-statistics and p-values indicate the statistical significance of each coefficient. All coefficients are significant at the 0.000 level, suggesting that each food waste prevention strategy has a meaningful impact on green logistics. The confidence intervals provide a range of plausible values for each coefficient. For instance, the confidence level of 95% on proper demand forecasting is (0.269, 0.753), implying that there is a 95% confidence that the actual population effect lies within this range.

The findings of this study underscore the critical role that food waste prevention strategies play in promoting green logistics among small and medium-sized restaurants in Dodoma City. Proper demand forecasting, food storage, and frequent inventory checks were all found to impact green logistics significantly. This suggests that small and medium-sized restaurants that adopt these strategies will likely see substantial improvements in their green logistics. This finding is consistent with empirical studies by Corsini *et al.* (2024), Drewitt (2013), and Filimonau and Sulyoki (2021), among others, which emphasise the importance of adequate food waste management in enhancing operational efficiency and sustainability.

Conclusion

From the study objective, which examined the effect of food waste prevention strategies on green logistics among small and medium-sized restaurants in Dodoma, Tanzania, the study concludes that proper demand forecasting, adequate food storage, and frequent inventory checks are crucial factors in reducing food waste and promoting green logistics which eventually reinforces environmental sustainability. However, some practical challenges, such as limited awareness, inadequate knowledge,

and insufficient infrastructure, hinder the full implementation of these strategies, underscoring the importance of incorporating tangible and non-tangible resources, such as technological innovations and skilled personnel, in addressing food waste challenges.

Recommendations and Areas for Further Study

Addressing these barriers through increased awareness, education, improved infrastructure, and technological innovation is essential for fostering more sustainable operations within the food service industry in Dodoma. Moreover, policymakers should focus on creating supportive frameworks that encourage adopting green logistics and provide incentives for small and medium-sized restaurants to invest in waste reduction technologies. Such measures could significantly contribute to broader sustainability goals and enhance the efficiency of the local food supply chain. Thus, future research should focus on investigating technology and policy interventions to support the adoption of green logistics among small and medium-sized restaurants in specific localities of Developing Countries' Cities.

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Declaration of Interest

With the release of this paper, the authors declare to have no conflicts of interest. First, this study was conducted independently, and second, its findings objectively reflect the scientific analysis of the data collected from the field.

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