

Food Waste Management in Pokhara Metropolitan City: Challenges, Practices, and Pathways Toward Achieving SDG 12.3

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ABSTRACT. Food waste is a large-scale global issue that affects the environment, economy, and society in a myriad of ways. Researchers of this paper wanted to focus on food waste disposal behavior in Pokhara, Nepal. Pokhara is a growing metropolis city as well as a tourist destination. Research consisted of conducting a small-scale quantitative survey about waste disposal habits as well as a literature review. Information collected through the literature research was expanded on through a survey of 200 university students in Pokhara. Findings show that 47% of participants composted their waste and 81.6% were interested in better waste disposal habits and food redistribution. It is concluded that Pokhara Nepal has the chance to ‘leap frog’ steps and move from a linear economy to a circular economy. Recommendations consist of implementing municipal scale composting systems, incentivizing food redistribution, and education campaigns. These recommendations are designed to provide policymakers, local government, NGOs, and businesses with an evidence-based roadmap for enhancing sustainable urban management and directly contributing to the global target of halving food waste by 2030, as mandated by Sustainable Development Goal (SDG) 12.3.

Keywords: Food waste, Pokhara, Sustainable development, Waste management, SDG 12.3, Urbanization.

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1. INTRODUCTION

1.1. Background and Problem Statement. Food loss and waste have emerged as major sustainability issues due to the large proportion of food that is produced to be consumed by humans being left uneaten so that it brings unnecessary demands on natural resources and environment. Nearly one-third of food that is supposed to be consumed by humans is lost or wasted throughout the supply chains, along with those at the consumer level, and it is a sign of the systemic inefficiencies, not individual behavior [1, 2]. Food waste implies wasted land, water, energy and fertilizers input and causes emissions of greenhouse gases during landfill decomposition, especially through the formation of methane [3, 4].

The high rate of urbanization, adoption of consumption trends, and inadequate municipal waste systems have increased the burden on food waste management in urban areas in developing countries. The literature on sustainable and integrated municipal solid waste management shows that these environments are limited due to poor governance, limited funding, and lack of treatment capacity to manage waste [5]. According to a study on municipal waste in Nepal, the most significant amount of household waste is organic waste, but a significant part of it is not managed correctly, leading to environmental and health hazards [6]. The challenges are especially applicable to the Pokhara Metropolitan City which has faced a fast urbanization due to the improvement of the tourism sector, infrastructure, and the growth in population [7].

Waste profile in Pokhara shows that organic and food waste are the leading ones, meaning that the management of food waste will be at the center of waste management in this city. Poor segregation and treatment of organic waste raise the cost of collection, pressure on landfill, and environmental problems. Simultaneously, the fact that Pokhara is a major tourist and hospitality destination only increases food waste production because food service businesses are usually associated with over-preparation and consumption trends [8].

1.2. The Global Mandate: Food Waste And SDG 12.3. Food waste reduction has become a global policy priority with its inclusion as a target of the United Nations Sustainable Development Goals, in particular, SDG 12 which is dedicated towards ensuring sustainable consumption and production patterns. Target 12.3 of SDG 12 directly calls for halving per capita global food waste at the retail and consumer level and reducing food losses throughout the production and supply chains by 2030. This mandate reflects an increasing recognition that food waste is not only an issue with moral and social implications, but is also an environmental and economic critical issue that impacts resource efficiency, climate stability and food security.

Empirical research has pointed out that food waste is a major contributor to global greenhouse gas emissions as the decomposition of food waste in landfill produces methane which has major impact on climate change. Studies have estimated food waste as a major contributor to anthropogenic emissions, and hence, making its reduction a major aspect of climate mitigation strategies [2, 4]. In response, SDG 12.3 is closely tied to a number of other global goals, including climate action, sustainable cities and responsible resource usage, reinforcing the cross-sectoral relevance of food waste reduction.

Although the global target is clear, progress towards achieving SDG 12.3 has been uneven especially in developing and emerging economies. Research on monitoring and implementation of SDG 12.3 reveals ongoing challenges such as low availability of data, inadequate measurement systems, inadequate awareness among the people, and financial constraints which pose obstacles to effective implementation of the policy [9]. These challenges provide the indication that the achievement of SDG 12.3 is not just about aspirational targets, but requires a combination of ensuring the implementation of food waste reduction strategies that are specific to context, and identification of the monitoring mechanisms that are reliable, as well as incorporating the reduction of food waste into local governance structures.

For rapidly urbanizing cities, the mandate of SDG 12.3 is especially about the responsibility placed on municipal governments as urban consumption and food service activities are significant contributors to unnecessary food waste. Evidence from the work of hospitality and food service research has found that food waste at the consumer and service level could be significantly reduced through

operational optimisation, awareness building and systematic feedback mechanisms [8]. Translating these global insights to action at the city level is, therefore, key to making actual progress.

In terms of Pokhara Metropolitan City, the management practices of local food waste production based on SDG 12.3 provide an opportunity to address short-term urban waste management problems as well as contribute towards the realization of national and global commitments on sustainability. However, the low level of empirical evidence associated with patterns and management pathways of food waste at local levels limits the ability to effectively align with the SDG framework. This has highlighted the importance of local research efforts linking global mandates with the practicality of implementation strategies dependent on the institutional and infrastructural realities of Pokhara.

1.3. Research Objectives and Significance of the Study. This research aims to go into detail and present the data of food waste generation in different sectors, including restaurants and households, in detail in the context of Pokhara. Four specific objectives were pursued by this research: First, food waste generation was quantified in different sectors. Second, the factors leading to the generation of food waste were determined. Third, waste management practices and policies in the different districts of the Pokhara Metropolitan City were assessed and evaluated. Fourth, effective and sustainable strategies for managing food waste were developed and proposed and aligned with SDG 12.3.

The study provides empirical evidence for food waste generation and management in Pokhara, which has not been extensively researched before. Thus, the findings of this study would be of significance to policymakers, local government, NGOs and businesses. The study would provide necessary data and insights to manage food waste effectively. Thus, it would contribute towards achieving Pokhara's vision of sustainable urban development and climate change resilience.

2. LITERATURE REVIEW

2.1. Defining Food Loss and Waste and Scoping. Food loss and waste is a reduction in quality or quantity of food intended for human consumption in the food supply chain, inclusive of production, post-harvest, processing, distribution and retail, and final consumption. Although the terms "food loss" and "food waste" are commonly used interchangeably, the scholarly literature makes a distinction between food loss (which mostly occurs in earlier stages of the supply chain) and food waste (which is more common at the retail and consumer levels) [2]. Globally, food loss and waste represents a major inefficiency of food systems, accounting for roughly a third of food produced for human consumption that is lost and wasted each year [1].

However, systematic tracking of food waste generation and disposal behaviors remains limited, particularly within institutional and student populations. While broader municipal solid waste dynamics in Nepal have been documented regarding composition and generation rates [10], comprehensive micro-level behavioral tracking within higher education demographics remains sparse. The significance of food loss and waste is not limited to the food alone because it is a waste of natural resources during production. Studies of losses in food supply chains across the world have found that lost food is associated with substantial losses of freshwater, cropland and fertilizer inputs, which further exacerbate environmental pressures while not contributing to food security [3]. As a result, food waste is increasingly recognised as a sustainability issue that joins the three spheres of environmental management, economic efficiency and social equity.

2.2. Environmental and Climate Impact of Food Waste. The disposal of food waste in landfills has severe environmental consequences, foremost among them being the generation of methane, a potent greenhouse gas that contributes significantly to climate change. Beyond emissions, the waste of food represents a fundamental loss of scarce resources such as water, energy, and land that were invested in its production, processing, and transportation [3]. From a social perspective, food waste presents a striking paradox: while large quantities of food are discarded,

significant portions of the population in the region and globally continue to suffer from food insecurity. This highlights the need for solutions that not only address waste reduction but also facilitate the redistribution of edible food to those who need it most.

Food waste management in developing countries is affected by rapid urbanisation, lack of infrastructure and institutional constraints. Studies on sustainable and integrated management of municipal solid waste illustrate that to effectively manage food waste, there must be concerted action through policy, governance, finance and technical systems [5]. In many developing cities organic waste makes up the greatest portion of municipal waste so food waste is a critical target for intervention. Empirical studies from South and Southeast Asia show that the primary source of urban food waste is at markets, households and food service establishments. A case study from Nonthaburi Municipality in Thailand shows that food preparation waste and post-consumption waste are the dominant categories in urban food waste streams, which means particular interventions such as redistribution of edible surplus, as well as the conversion of organic waste into compost or bio-products, can lead to significant reductions in landfill pressure [4]. These findings show the importance of waste characterization and phased approaches to intervention strategies based on local conditions.

In Nepal, similar problems are evident from studies conducted at the municipal level. Research done in Besisahar municipality shows that organic waste is the main waste of households and improper collection and treatment systems lead to open dumping and burning practices, which are dangerous to the environment and health [6]. These trends suggest that the cities of Nepal require a combination of improved segregation, collection, and treatment of organic waste so as to be able to deal with food waste effectively.

2.3. Food Waste in the Hospitality and Food Service Industry. The food services and hospitality sector have been singled out as being among those responsible for food wastage, especially those in urban regions which rely mainly on tourism. In the hospitality sector, food wastage has been found to be a result of over-production of food, wrong prediction of demand and wastage of food by customers. It has been found through research in the hospitality sector using data analysis that there exists potential for food wastage reduction [8].

In addition to prevention, redistribution of excess food has gained interest as a practical way of reducing avoidable food waste and addressing food insecurity. Studies that focus on food donation systems in the hospitality industry highlight the potential of these systems in helping to divert edible surplus food from disposal, and contributing to sustainability goals if the necessary institutional coordination and safety standards are adequately addressed [11]. These findings are particularly applicable in relation to tourism-based cities like Pokhara, where hotels and restaurants are key in urban food systems.

2.4. Food Waste and SDG 12.3. Sustainable Development Goal target 12.3 is a global framework for addressing food waste by setting the target to reduce food waste at retailer and consumer levels by 2030. However, research on progress towards the achievement of SDG 12.3 highlights the fact that implementation is still a challenge in emerging economies. Key barriers include lack of data availability, poor monitoring systems, lack of public awareness and financial constraints for large-scale interventions [9].

Scholars suggest that the world has to achieve SDG 12.3 at the local level by translating global goals into implemented policies at the city level. This includes the integration of food waste reduction into municipal waste management plans as well as developing reliable measurement systems and promoting stakeholder cooperation between households, businesses and local governments. Without such localised approaches, global commitments run the risk of reverting to being aspirational, rather than transformative.

2.5. Research Gap. Although there is a large volume of available literature on food loss and waste at the global and regional level, there have been limited studies on city-specific food waste management pathways in Nepal keeping in mind the SDG 12.3 framework. Existing studies mostly focus on municipal solid waste issues in general or sector-specific studies leaving a gap in understanding the ways to operationalize global food waste reduction targets in rapidly urbanizing Nepali cities.

This study addresses this gap by analysing food waste management practices in Pokhara Metropolitan City and linking the evidence obtained with existing theoretical and empirical knowledge from developing country situations.

3. RESEARCH METHODOLOGY

3.1. Research Design. This study has been carried out using a mixed-methods descriptive and analytical research design to investigate food waste management practices in Pokhara Metropolitan City with reference to Sustainable Development Goal target 12.3. Quantitative primary data was gathered through a structured survey administered to a sample size of 200 university students at Pokhara University, selected via a convenience sampling method based on their availability and willingness to participate. This sample provided a diverse representation across various academic disciplines. The design is appropriate for describing current food waste behaviour and interpreting them in established frameworks of urban food waste and municipal solid waste management relevant to developing countries.

3.2. Study Area. Pokhara Metropolitan City is one of the important centers for urbanization and tourism in Nepal, and the rate of urbanization in the country has been the fastest in this city owing to infrastructure development, growth in population, and advancements in the hospitality industry. This has put immense strain on the solid waste management system of the city, especially because organic/food waste forms the major stream of waste.

3.3. Data Collection and Analysis. An innovative quantitative survey was utilized in this study and involved a primary sampling of exactly 200 bachelor's degree holders from Pokhara University and PN Campus through convenience sampling, which involved individuals that were readily available for the study. The inclusion criteria restricted the selection of respondents to existing undergraduate students living in Pokhara Metropolitan City and those who were involved in the planning of their households' meal schedules. Out of the 215 questionnaires sent out using both physical and virtual mediums, 200 valid answers were received making a response rate of 93.02%.

Three key structured parts were contained in the questionnaire:

- (1) Demographic Profile and Shopping Habits aimed at analyzing how often they buy food;
- (2) Food Waste Types and Causes involved calculating the daily volume of leftovers and the main causes for such wastage (overcooking, expiry);
- (3) Behavioral Traits and SDG Awareness to assess the level of recycling activities such as composting and animal feeding and SDG Target 12.3 awareness among respondents.

Findings from the survey were triangulated using primary quantitative data collected from qualitative key informant interviews (KIIs) with hotel managers, restaurant owners, and municipal authorities as well as secondary analysis of municipal solid waste management reports.

4. RESULTS AND DISCUSSION

4.1. Findings from the Primary Student Survey. The survey of bachelor's students in Pokhara provided empirical insights into household food waste behavior, generation, and awareness. These findings offer a ground-level perspective, complementing broader data on Pokhara's waste management system.

Key Survey Findings:

- **Shopping Habits:** A majority of respondents (46.9%) shop for food 2–3 times per week, while 28.6% shop daily. Local markets were the primary source of food items (48%), followed by grocery stores (34%).
- **Waste Generation:** Most households (60%) reported generating less than 250 g of left-over food per day. About 21% generated between 250–500 g, and only 4% generated more than 500 g. For context, other studies report the average per capita waste generation in

Pokhara households as 0.34 kg per day, with the highest observed in the Dalit community at 0.4 kg.

- **Waste Composition:** The most frequently wasted items were vegetables (49%) and cooked meals (46.9%), followed by rice and grains (44.9%). This aligns with other studies showing organic matter as the largest component of household waste, accounting for up to 64.47% in Pokhara.
- **Causes of Waste:** The primary reasons cited were “cooked too much” (40%) and “food spoiled before use” (24%), indicating that both over-preparation at home and issues in the supply chain contribute to waste.
- **Disposal Methods:** Most respondents composted food waste (47%) or fed it to animals (32%). Only 15% used municipal collection services, and 6% mixed it with general waste.
- **Awareness and Willingness:** Awareness of food waste reduction practices was high (89%), and a strong willingness to adopt new methods was observed (81.6%). However, only 48% were aware of UN SDG 12.3.

4.2. Interpreting the Findings: Pokhara’s Food Waste Profile. The primary data provides a clear picture of food waste behavior among a key demographic. The high rate of composting and feeding to animals found in the survey is a highly encouraging finding. It demonstrates that a large portion of the population is already engaged in sustainable practices that directly support expert recommendations on composting as a sustainable solution to Pokhara’s waste problem. This also contrasts with some broader studies that have noted a public “nonchalance” and improper disposal practices among the general population.

The findings on the main causes of waste—over-preparation and spoilage—underscore a dual-faceted problem. While over-preparation is a behavioral issue that can be addressed through awareness, the problem of spoilage is a systemic issue related to the broader food supply chain. Studies have found that a lack of cold storage facilities and improper packaging have a significant effect on produce loss, which can be as high as 20–50% in Nepal.

The high level of awareness and willingness to change found in the survey presents a significant opportunity. While a gap in awareness of the formal SDG 12.3 goal exists, the foundational knowledge and motivation for action are clearly present. This suggests that public campaigns should focus less on basic education and more on providing the practical tools and infrastructure needed to support existing positive behaviors.

4.3. Assessment of Current Waste Management Infrastructure and Policy. The present day waste management system in Pokhara consists of multiple structural obstacles, contrary to the behavioral observations mentioned above. Despite the fact that people in households have a high tendency for composting, there is a lack of institutional backing because of the lack of appropriate large-scale composting centers and organization of the segregation of organic wastes. The waste collection process occurs on a mixed basis, which leads to inefficient recycling and composting processes.

Furthermore, the insufficient availability of cold storage facilities significantly results in food waste because of inefficiency in the food supply chain process. It should be noted that the country has its national policy on SDG 12.3, but its execution on the ground level is inadequate.

5. RECOMMENDATIONS AND POLICY IMPLICATIONS

5.1. Strategic Interventions for Waste Reduction. Food waste management in Pokhara Metropolitan City requires comprehensive interventions that address the behavioral as well as the structural causes of waste. The results of this study indicate that prevention, redistribution of edible surplus and sustainable management of unavoidable food waste must be given priority to support progress towards Sustainable Development Goal target 12.3 [9].

5.2. Enhancing Waste Segregation and Composting. Given the preponderance of organic waste in the urban waste stream in Nepal, improving the segregation of food waste and composting should be an important focus area. Improved source segregation can be useful in reducing land-fill pressure and environmental impacts, and composting at municipal and household levels can enhance waste management efficiency if supported by effective governance and coordination [5, 6].

5.3. Promoting Food Redistribution and Valorization. Food redistribution is a pragmatic approach to solving the problem of avoidable food waste, particularly in the hospitality and foodservice industry of Pokhara [12]. Formalized systems for food donation can help divert edible surplus food away from garbage and contribute to sustainability objectives, provided basic coordination and guidelines are in place [11].

Furthermore, the city should explore opportunities for the valorization of food waste that cannot be redistributed, including investing in small-scale anaerobic digestion units that could convert organic waste into bioenergy for local use, as anaerobic digestion has been identified as a promising strategy to treat food waste and generate renewable energy such as biogas [13].

5.4. Raising Public and Stakeholder Awareness. Although awareness of food waste reduction practices among urban dwellers is fairly high, targeted interventions are needed to translate awareness into sustained behavior change. Awareness initiatives should not be just generic messaging, but rather focus on practical actions like portion planning, storage and food waste segregation. Research has shown that a combination of awareness, operational guidance, and feedback mechanisms is better at reducing food waste at consumer and service levels [14, 8, 15].

5.5. Policy and Institutional Frameworks for Sustainable Management. Effective food waste reduction in Pokhara Metropolitan City requires strong policy and institutional alignment. Incorporating food waste reduction goals into municipal solid waste management plans can provide a formal basis for coordinated implementation and monitoring. Evidence on SDG 12.3 implementation shows that developing and emerging economies can be hindered by data gaps, funding deficits, and fragmented institutional responsibilities [9]. Strengthening coordination between municipal agencies and introducing basic monitoring mechanisms can help translate international commitments into practical local action through coordinated planning and targeted incentives for key sectors like hospitality [16]. Aligning local policies with sustainable municipal waste management frameworks can go a long way towards supporting long-term urban sustainability [5, 17].

TABLE 1. Comparative Analysis of Global Best Practices and Their Applicability to Pokhara

Global Practice	Example City/Country	Applicability	Justification
Curbside Composting	San Francisco, USA	High	Low-cost infrastructure for decentralized collection, aligns with need for source segregation.
Anaerobic Digestion	Copenhagen, Denmark	Medium	High initial investment, but a long-term solution for energy production from waste.
Food Sharing Apps	Berlin, Germany	High	Low-cost, leverages existing technology, directly addresses the paradox of food waste and insecurity.
Zero-Waste Certification	Seoul, South Korea	High	Provides a strong incentive for businesses, leverages Pokhara's tourism economy.

6. CONCLUSION

6.1. Summary of Key Findings. This study was conducted by analysing food waste management practices in Pokhara Metropolitan City taking the concept of Sustainable Development Goal target 12.3. The findings show that food and organic waste make up a significant part of the urban waste stream and that food waste at the consumer level of the food chain is mainly caused by over-preparation and food spoilage. The main survey indicated relatively high awareness and willingness of respondents to practice food waste reduction, with many practicing composting and informal redistribution. However, gaps remain regarding institutional coordination, infrastructure support, and formal policy mechanisms to effectively scale these practices.

6.2. Contribution to Sustainable Urban Management. The study contributes to the limited empirical evidence of food waste management in the cities of Nepal by providing country-specific evidence from Pokhara. By relating local food waste behaviour to known research on sustainable municipal solid waste management and SDG 12.3 implementation, the study emphasises the need to include food waste reduction in broader urban waste management systems. The findings underline the need for better food waste management in Pokhara that goes beyond raising awareness to include supportive governance structures, focused interventions, and simple monitoring mechanisms to achieve measurable results.

6.3. A Path Forward for Pokhara as a Model City. Addressing food waste in Pokhara provides a chance to enhance municipal waste management performance while helping to meet national and global sustainability commitments. Aligning local food waste reduction efforts with SDG 12.3 can help translate global targets into practical action at the city level. Future efforts should focus on improving institutional coordination, expanding organic waste treatment capacity, and supporting evidence-based policy implementation. Further research could expand the scope to other urban areas and include longitudinal data to better assess progress towards food waste reduction targets.

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