Solid Waste Management Practices in the Jammu & Kashmir Towns - A Case Study of Kupwara Town of North Kashmir

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Abstract: ***Generation of municipal solid wastes has been increasing throughout irrespective of its nature and locations. Besides cities, growing towns, peripheral urban and rural areas are also facing the challenges of solid waste generation and proper management. The entire Kashmir valley is facing extreme challenges with regard to waste management and Kupwara town is no exception. Our main objectives include studying about generation and current waste management practices in Kupwara town and to conduct SPSS modelling of waste. A door-to-door survey was conducted followed by direct measurement of waste using a weighing balance. More waste is produced during summer and larger proportion of waste is of biodegradable nature. The current waste management practices are inappropriate due to lack of machinery and proper landfill site. The waste is being openly dumped in a locally available area adjacent to Pohru river. The modelling of waste revealed that, with increase in income slab, family members, the waste generation rates also increase. There is need to speed up the construction work of new landfill site, in order to sustainably manage the waste.***

Keywords: Waste Generation, Solid waste Management, SPSS Modelling

1. Introduction

Solid waste is the unwanted or useless Solid material generated from combined residential, commercial and industrial activities in a given area (Manoj Katyar 2016) Solid waste management is one of the most pressing issues of the 21st century. With increasing population, urbanisation and lifestyle changes, the volume of waste generated has increased significantly posing a threat to public health and environment sustainability. A report published by UNEP in Global Waste Management Outlook 2024 Municipal solid waste generation is predicted to grow from 2.1 billion tonnes in 2023 to 3.8 billion tonnes by 2050. Effective waste management techniques and practices are essential to reduce impacts on various domains of environment and public health. Solid waste is generated from main four sources viz Residential, Commercial, Industrial and Institutional. The majority of solid waste constituents include a range of materials including plastics, garbage, rubbish, metals, glass, textiles and paper. Solid Waste Management is essentially a process in which waste is collected, treated and disposed off in an environment sustainable manner. Solid waste management is a process that involves controlling the generation, storage, collection, transport, processing and disposal of Solid wastes (Ver Singh 2024). The lack of proper landfill site is posing a major strain on solid waste management in the town. The current waste management practices are inappropriate due to lack of proper well equipped landfill site but the construction work of new landfill site is going on, as stated by Municipal Committee it will be fully functional by the year 2025.

2. Findings

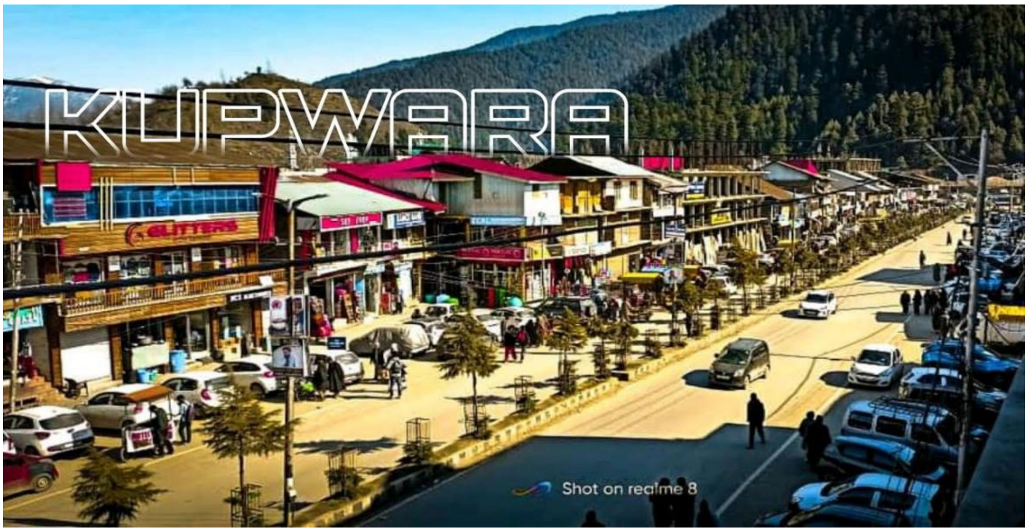
- To Study waste generation and management practices in the Town
- To conduct the SPSS modelling of waste

3. Study Area

Kupwara town, located in the northern part of Jammu and Kashmir, serves as the administrative headquarters of the Kupwara district. It is characterised by its picturesque landscapes and strategic significance, nestled amidst the lush green hills of the Himalayas. The district sprawls between 4° 31' 54.948" N and 74° 15' 57.78 E with an area of 2,379 square kilometers. The entire area of Kupwara town is 22 sq kms. The average elevation of the Kupwara district is 5300 feet above sea level. The major establishments within the Kupwara town includes two Degree Colleges, Civil Administrative Headquarter, various schools, etc. Kupwara is situated approximately 90 kilometres from Srinagar, the summer capital of Jammu and Kashmir. The town is surrounded by several villages and is a gateway to the scenic valleys and tourist destinations in the region. The population of Kupwara is predominantly rural, with agriculture being a primary source of livelihood.

A total of 13 wards come under the jurisdiction of Municipal committee. As per 2011 census the entire population of town is 21771 with 15120 males and 6651 females. However, urbanization is gradually increasing, leading to challenges in infrastructure and public services, particularly in solid waste management. Kupwara has a humid subtropical climate. Winters are extremely cold with a day time temperature averaging 2°C and drops below freezing point at night. Moderate to heavy rainfall occurs during winters. Summers are moderately hot with average temperature ranging from 25-33 °C. Kupwara typically receives about 33.85 millimetres (1.33 inches) of precipitation and has 49.47 rainy days (13.55% of the time) annually.

Kupwara town is an amalgamation of high-income groups, low-income groups and mixed people. The current waste management practices are extremely inappropriate due to lack of proper dumping site, technology, inefficient systems and resources. The majority of waste generated is of organic nature. There is low proportion of non-biodegradable waste generated.



Picture showing the main town of kupwara

Picture showing current waste disposal practice

Our area of concentration comprised of thirteen (13) municipal wards within the confines of the main district which comes under the jurisdiction of Municipal Solid Waste Committee Kupwara. Kupwara market consists of cluster of shops. This market was founded by Sikh Families after the partition in 1947.This market serves as a central place for adjoining areas of Kupwara district to sell and purchase products

4. Methodology

The present study was aimed at to investigate the generation and management of solid waste in town of Kupwara district.

A comprehensive methodology was employed to collect and analyse data on the quantity and composition of MSW generated across the town. Since 13 wards come under the municipality, a total of 30 households were selected from each ward. These wards include a population of around 3000 people. A structured questionnaire was carefully designed to collect comprehensive data on waste generation in town followed by a door to door survey was conducted. The survey was conducted in two seasons -Winter & Summer

In addition to the questionnaire, the study employed a direct measurement approach to accurately quantify the waste generated at the household level. Portable weighing balances were utilized to weigh the solid waste produced by the sampled households. To give the collected data a mathematical shape SPSS (Statistical Package for Social Sciences) modelling was conducted. The SPSS approach aims to find correlation and regression among different variables. The software used to conduct modelling IBM 2019.

5. Results and discussion

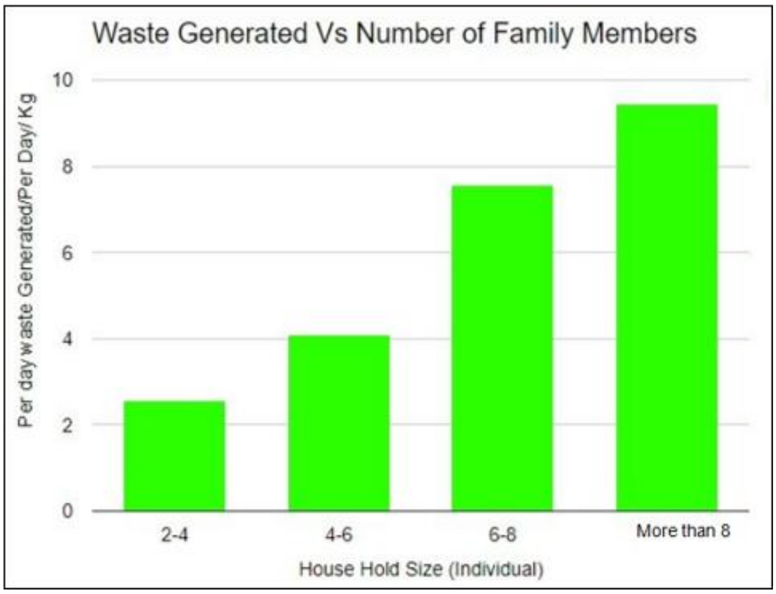


Figure 1: Relationship Between House Hold Waste Generation and Family Size

The graph (Fig.1) illustrates how the amount of waste generated increases with the number of family members in a household. Same was found by Surrendra et al. (2014). The x-axis represents household size categories (2-4, 4-6, 6-8, and more than 8 individuals), while the y-axis shows the average waste generated per day in kilograms. The bars clearly demonstrate an upward trend, with larger households producing more waste. The tallest bar corresponds to households with more than 8 members, indicating they generate the most waste on average.

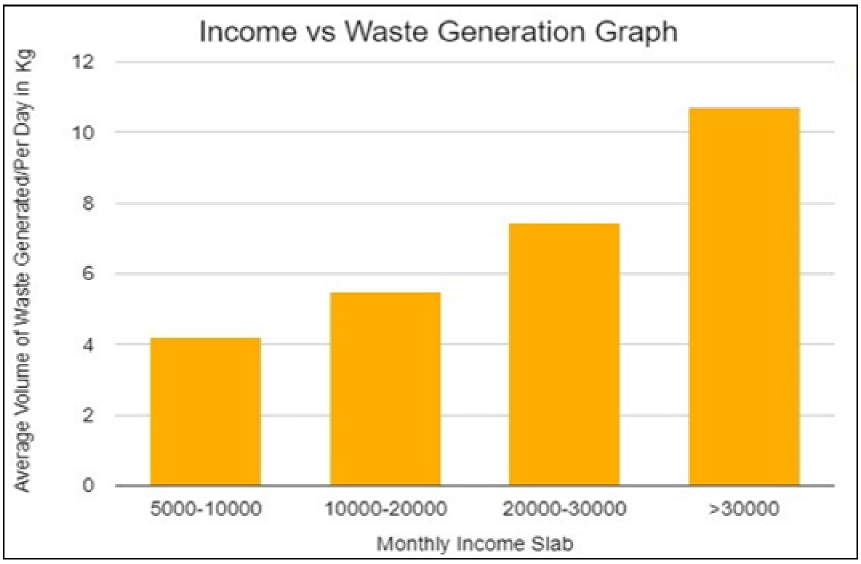


Figure 2: Relationship Between House Hold Waste Generation and Income Slab

The figure (Fig.2) illustrates how household waste generation correlates with monthly income levels. The graph effectively shows that households with higher incomes tend to generate more waste, with a significant jump in waste production for the highest income bracket. Similar observations have been revealed by van et al.(1999)while analysing urban solid waste in developing countries

The data collected during the study showed that Commercial units in the Kupwara town generate the largest portion of waste at 50%, while Vegetable Vendors, Fruit Vendors, and Restaurants/Hotels each contribute between 15-18% of the total waste. Restaurants and Hotels have the highest average daily waste generation per establishment at 5 kg/day. The diagram below (Fig.3) depicts waste generation data for the Winter Season across different commercial categories – Vegetable Vendors generate the least waste per unit Fruit Vendors and Restaurants/Hotels produce more waste per unit - Other Commercial units contribute the largest total amount Targeted waste reduction strategies may be developed for high-waste sectors Incentives or regulations could be introduced to encourage lower waste generation across all sector.

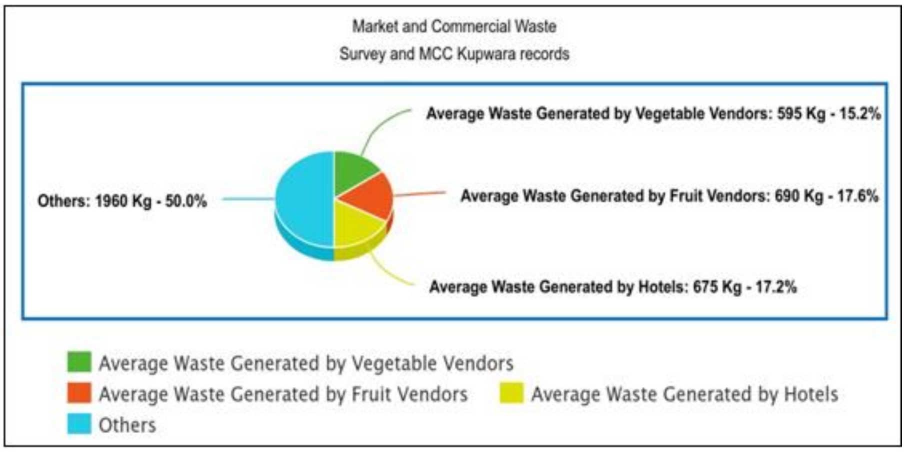


Figure 3: Market and commercial waste generation during winter season

The data shows waste generation during the Summer Season across different commercial categories (Fig.4). Compared to the Winter Season, there's a slight increase in waste generation during Summer, particularly for fruit vendors and restaurants /hotels. This could be due to increased consumption of fresh produce Other Commercial Units consistently generate about half of the total waste in both seasons, suggesting a need for targeted waste management strategies for this sector Despite having the highest count, Vegetable Vendors generate the least waste per unit, indicating relatively efficient practices or the nature of their products: Fruit Vendors and Restaurants/Hotels generate more waste per unit, possibly due to the nature of their products (perishables) and services.

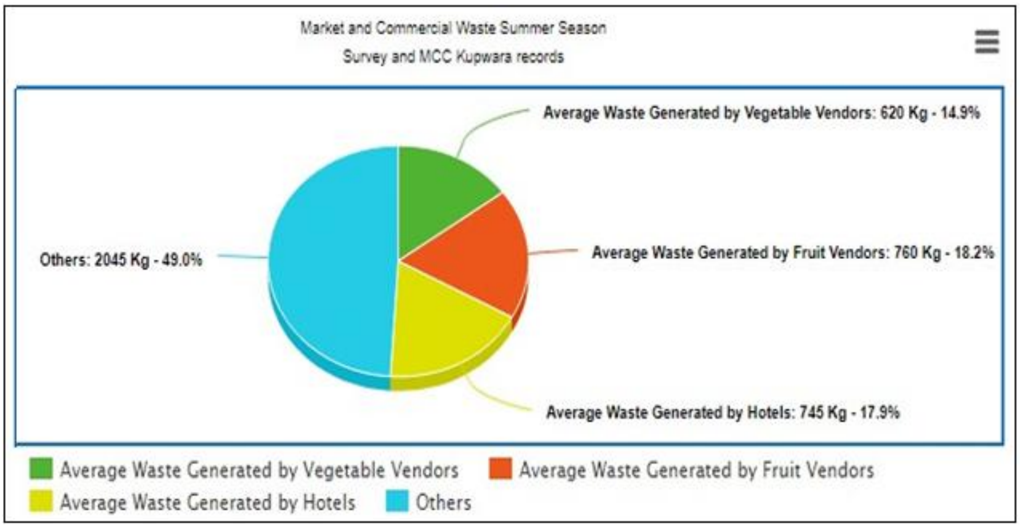


Figure 4: Market and commercial waste generation during summer season

As depicted in the figures (Fig. 5 and Fig. 6), the high percentage of biodegradable waste suggests that a significant portion of the waste collected during winter and summer is organic and can potentially be composted or processed through other biological methods. Proper management of biodegradable waste can reduce landfill use and promote recycling of organic matter into useful compost, the same was found by Ashootosh et al (2020). General comparison of seasonal variation in waste suggested that during summers the waste generated is much more as compared to waste generated in winters. In general, similar trend of waste generation was reported by Senthamil (2015). The non-biodegradable waste, though a smaller portion, still represents a considerable amount of waste that needs to be managed. Recycling programs and waste reduction strategies are essential to handle this type of waste Mandpe et al. (2020) highlighted how non-biodegradable waste could be safely disposed.

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Total Waste collected during Summer in Kg	Biodegradable in Kg	Non-biodegradable in Kg
1326	729	597

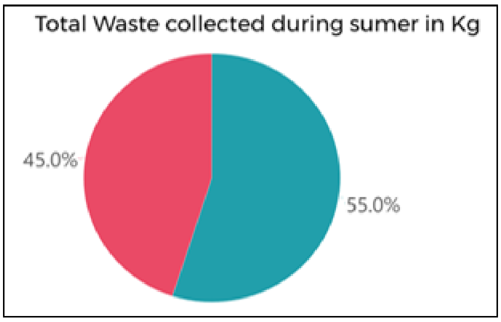

Figure 5: Proportion of total waste collected during summer season

Waste collected during Winters in Kg	Biodegradable in Kg	Non-biodegradable in Kg
907	572.8	334.2

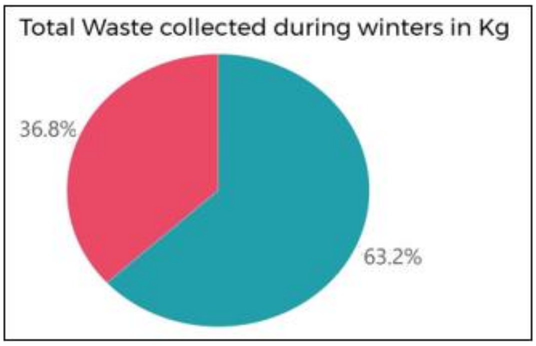

Figure 6: Proportion of total waste collected during winter season

The table 1 presents the correlation coefficients among family members, income slab, and DPI (Disposable Proportionality Index) with the biodegradability index as the control variable. The correlation between family members and the biodegradability index is 0.609, which is statistically significant ($p < 0.001$) with 296 degrees of freedom. The correlation between income slab and the biodegradability index is 0.029, not statistically significant ($p = 0.624$) with 296 degrees of freedom. The correlation between DPI and the biodegradability index is 0.016, also not statistically significant ($p = 0.778$) with 296 degrees of freedom. This suggests a strong, significant positive correlation between the number of family members and the biodegradability index, while the correlations of income slab and DPI with the biodegradability index are weak and not significant

Table 1: Correlation coefficients among family members, income slab, and DPI

Control Variable			Family Member	Income Slab	DPI
Biodegrability Index	Family Members	Correlation	1.00	.609	
		Significance (2 tailed)	.	.00	
		df	0	296	
	Income Slab	Correlation	.609	1.00	0.29
		Significance (2 tailed)	.000	.	.624
		df	296	0	296
	DPI	Correlation	.016	.029	1.000
		Significance (2 tailed)	.778	.624	.
		df	296	296	0

The coefficient of determination (Table 2) indicates the proportion of the variance in the dependent variable (waste) that is predictable from the independent variables (Income Slab, DPI, Family Members). An R Square of 0.055 means that approximately 5.5% of the variance in waste is explained by these predictors

Table 2: Coefficient of determination

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
Constant	.234	.055	.045	.15263

The results of a regression analysis examining the relationship between the biodegradability index (dependent variable) and three predictors: Disposable Personal Income (DPI), number of family members, and income slab are shown in table 3. The constant term has an unstandardized coefficient of 0.533 with a standard error of 0.028, and it is highly significant with a t-value of 18.789 ($p < 0.001$). DPI has an unstandardized coefficient of 0.047 and a standardised coefficient (Beta) of 0.148, indicating a positive and statistically significant relationship with the biodegradability index ($t = 2.618$, $p = 0.009$). The number of family members shows an unstandardized coefficient of 0.013 and a standardised coefficient of 0.171, also suggesting a positive and statistically significant impact on the biodegradability index ($t = 2.381$, $p = 0.018$). However, the income slab has an unstandardized coefficient of 0.001 and a standardised coefficient of 0.005, indicating no significant effect on the biodegradability index ($t = 0.073$, $p = 0.942$) The general formula of regression equation is $Y=ax+by+cz+d$ where Y=Biodegradability index x=DPI (Disposable Proportionality index) z= income slab. d= constant Given the coefficients from the table we have a=0.047 b=0.013 c=0.001 d=0.533 Thus the regression equation becomes $Y=0.047x+0.013\ y+0.001z+0.533$ DPI and the number of family members have a positive and statistically significant impact on the biodegradability index. The income slab does not significantly affect the biodegradability index. The model suggests that increasing DPI or the number of family members will lead to a higher biodegradability index, while changes in the income slab do not have a significant impact.

Table 3: Regression analysis examining the relationship between the biodegradability index and three predictors

Model	Unstandardized Coefficients B	Coefficients Standardized Error	Standardized Coefficients Beta	t	sign
Constant	.533	.028		18.789	.00
DPI	.047	0.18	.148	2.618	.009
Family Members	.013	.005	.171	2.381	.018
Income Slab	.001	.011	.005	0.73	.942

6. Conclusion

The study of Municipal Solid Waste (MSW) generation, management, and statistical modelling using SPSS has provided significant insights into the current state and future potential of waste management practices. Our analysis revealed that the generation of MSW is steadily increasing due to population growth, urbanisation, and changing consumption patterns. The current management practices, although somewhat effective, are strained by the rising volume of waste, leading to inefficiencies and environmental concerns. Key findings include: The study identified clear trends in waste generation, influenced by demographic and socio-economic factors. Residential areas were the highest contributors to MSW, followed by commercial and industrial sectors Current waste management practices, including collection, segregation and disposal, vary significantly in efficiency. While some wards demonstrate high levels of effective waste segregation at source while others mix waste at source. The statistical modelling using SPSS highlighted the relationships between various factors affecting waste generation and management. Predictive models suggested that without significant improvements in waste management infrastructure and practices, the system will become increasingly unsustainable.

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