

Assessment of Socio-Economic Conditions of Stakeholders and Their Influence on Municipal Solid Waste Generation in Bengaluru City.

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Abstract: The quantity of municipal solid waste (MSW) generated in a large metropolitan city like Bengaluru is closely linked to the socio-economic characteristics of various stakeholders, including residents, hotels, marriage halls, industries/companies, and pourakarmikas. MSW quantification is largely an empirical exercise, and the generalization or normalization of average waste generation rates may not always be appropriate, as waste generation in urban areas is influenced by a complex interplay of multiple factors.

The present study provides a comprehensive socio-economic analysis of different categories of stakeholders based on parameters such as gender, age, educational qualification, occupation, income, and other relevant factors associated with MSW generation. Bommanahalli Zone and South Zone of Bengaluru city were selected as the study areas. A total of approximately 500 stakeholders representing five categories were surveyed. The average waste generation rates were estimated as 5 kg/day for residents, 15 kg/day for hotels, 20 kg per function for marriage halls, and 8 kg/day for industries, factories, and companies.

The study highlights that sustainable urban solid waste management can be achieved only through the adoption and integration of best management practices tailored to the socio-economic conditions of stakeholders.

Keywords: Municipal Solid Waste, Socio-Economic Analysis, Waste Management, Sustainability

1. Introduction:

The management of Municipal Solid Waste (MSW) is one of the most pressing environmental and urban governance issues globally, especially in fast urbanizing developing countries[1]. The amount and complexity of municipal solid waste (MSW) generation have significantly grown due to a combination of factors, such as population growth, urban migration, industrialization, and an evolving lifestyle and consumption of goods[2,3]. The amount of waste produced by residents, commercial and institutional buildings, industries and recreational activities is increasing at an alarming rate and causing problems for urban local bodies (ULBs) everywhere[4]. Municipal solid waste management has led to serious environmental, public health, land, water, air pollution and urban living conditions problems. Therefore, the issue of sustainable solid waste management has become a fundamental part of environmental sustainability, urban planning, and public health protection[5]. Urbanization is now happening at an unprecedented rate all over the world, and its consequences are especially felt in developing countries where the development of infrastructure is not always commensurate with the rate of urbanization and population growth. Rapid



rural to urban migration due to job opportunities and improved living has intensified the development of metros[6]. Urbanisation has grown due to migration from rural areas for better living and employment opportunities. This change has contributed to the production of municipal solid waste (MSW) significantly because of the growth of economic activity, consumerism and lifestyle changes[7]. In developing countries, the situation is even more difficult because waste management services, technological solutions, funds and public awareness are still insufficient. In the current municipal solid waste management systems in some urban centers, open dumping and inadequate segregation is still dominant, whereas the regular collection system is unmet and the scientific aspects of treating and disposing waste are lacking. This translates into the pollution of the environment, transmission of infectious diseases and clogging of drainage systems and emission of greenhouse gases[8].

India is among the most urbanizing countries in the world with huge problems in the field of MSW management. Due to the fast pace of economic development, migration to urban areas, industrialization and modernization, the amount of solid waste produced in Indian cities has significantly increased[7]. Urban centres across India produce huge amounts of municipal solid waste (MSW) daily and this waste is projected to be greatly escalating over the next few decades. Although the per capita waste production in India is lower when compared to developed countries, the amount of waste produced in Indian cities is alarming owing to their high population density and poor waste management systems[9]. Municipalities are often grappling with a range of issues including: Limited collection infrastructure, source separation is often not occurring, treatment facilities are often inadequate, financial constraints and poor public engagement[10]. Moreover, waste management charges levied by many urban local bodies are too low to enable them to achieve sustainable waste management infrastructure[11]. The involvement of informal workers, lack of scientific disposal, open waste transport and inadequate recycling facilities make municipal solid waste management even more complex in India. Many cities dispose of MSW in unmanaged landfills that do not have engineered systems for the treatment of leachate[12]. These practices lead to groundwater pollution, bad odor, infestation of pests and vectors and serious health risks to the surrounding community. Furthermore, the municipal solid waste has been changing due to the growth of commercialization and urban consumption habits, which leads to the addition of a higher volume of plastics and packaging waste, food waste, and hazardous waste to the waste stream. The waste characteristics change, so that a holistic and technologically advanced waste management concept is needed[13]. Named the “Silicon Valley of India”, Bengaluru city is one of the fastest growing metropolitan cities in the Indian subcontinent and it is a key case study on urban municipal solid waste management. Over the past few decades, the city has experienced growth like never before in the information technology sectors, businesses, schools, hospitals, and infrastructure. The urbanisation and migration has turned Bengaluru into a dense metropolitan city with a variety of economic and social activities[14]. This increase has also led to a significant increase in the production of municipal solid waste from households, hotels, restaurants, industries, marriage halls, shopping complexes, health care institutions and commercial businesses[15]. The rise in waste production on a daily basis has put huge strain on the Bruhat Bengaluru Mahanagara Palike (BBMP) which is tasked with managing municipal waste and administration in the city. The efficiency of municipal solid waste management systems is not just a function of technological and infrastructural capabilities but also of socio-economic characteristics, level of awareness, behavior and stakeholder participation in wastes generation and management[1]. Residents, hotel owners, industries, marriage hall owners, pourakarmikas are stakeholders who have a direct impact on waste generation, segregation, recycling activities and waste disposal mechanisms. So that, it is important to know the socio-economic situation of stakeholders along with their behavioral characteristics when designing effective and sustainable waste management strategies[16].

The generation of MSW is strongly correlated with socio-economic factors like income, occupation, educational qualification, family size, consumption pattern, food habit and life style. The quantity and composition of waste produced by various stakeholders' depends on socio-economic variations. Wealthier people tend to consume more, and produce more packaging waste, food waste and disposable materials[17]. Likewise, there is a significant amount of biodegradable waste produced by hotels, marriage halls and other commercial enterprises because of the food preparation processes and hospitality activities[18]. In addition to domestic sources, there are also industrial and commercial sources of solid wastes, which depend on the types of manufacturing and activities in the operation. Thus the generalization of waste generation rates without taking into account socio-economic parameters may not be a true

reflection of urban waste generation patterns. In the past few decades, a greater interest has been observed in the importance of stakeholders' involvement in municipal solid waste management. A proactive engagement is essential from waste generators, municipalities, private entities, sanitation workers, and the public for effective SWM[19]. Efforts to reduce waste generation, to recycle waste, to compost waste, and to behave in an environmentally responsible way at the point of waste generation have a significant impact on the efficiency of waste management systems, and these efforts are highly participative in nature. In most developing countries including India, however, Municipal Solid Waste (MSW) is still viewed as the exclusive domain of Municipal Corporations. This narrow environmental consciousness and low level of public involvement still hinders the implementation of sustainable waste management systems[20].

This study addresses the evaluation of the socioeconomic conditions of the stakeholders and its impact on MSW generation in Bengaluru city. The study focuses on the five big groups of stakeholders, namely residents, hotels, marriage halls, industries/ companies/ factories and pourakarmikas. These stakeholders were chosen because they are important contributors and participants in the municipal solid waste management system. The amount of household waste generated by the residents is significant and the amount of biodegradable and food waste generated by hotels and marriage halls is significant. Process related and commercial waste is provided by industries and pourakarmikas provide the operational backbone in waste collection, transportation and sanitation services. This is because it is crucial to recognize the socio-economic features and the behavior of these stakeholder groups to design targeted waste management interventions and sustainable urban environmental policies. The study was done in the Bommanahalli Zone and South Zone of BBMP. These zones were chosen based on the knowledge of the demographic diversity, commercial activities, residential density, industrial presence, and waste generation attributes of these zones. The methodology used in this study was an empirical approach with a sampling technique of simple random sampling participants who were around 500 respondents who were grouped into various categories of stakeholders. Primary data collection on socio-economic profiles, waste generation pattern, consumption behavior, occupational characteristics, educational status, family size, income level, and attitudes of the respondents towards the MSW management was done through structured questionnaires and interview schedules. The significance of the variations in stakeholder responses between the selected zones was assessed using statistical analyses, such as chi-square tests. A key dimension explored in the study has to do with the socio-economic characteristics of residents. To understand the influence of the parameters such as gender, age, marital status, education qualification, occupation, family size, income level and consumption expenditure on MSW generation were analysed. The study shows that women are more actively engaged in household activities and in the handling of wastes than men, which means that, they play a significant role in household wastes generation and management practices. Likewise, residents' educational levels and awareness also affect their understanding and implementation of sustainable waste management systems, including segregation, recycling, and composting.

The socio-economic status of the hotel owner and the role he played in the generation of municipal solid waste is also studied. Large scale food preparation and hospitality activities generate a significant amount of food waste and biodegradable waste in urban areas, especially in hotels[21,22]. Customers' eating habits, food waste behavior, and the way a food is used in an operation have a major effect on food waste in hotels. Likewise, during social events, marriages and public events, marriage halls create a lot of waste[23]. It is important to understand the characteristics and socio-economic conditions of the marriage hall owners in order to know the specific measures which can be taken to minimize waste and promote sustainable waste handling. Industries and commercial establishments also contribute to the generation of MSW and pollution[24]. The industrialization and technological progress have accelerated the solid, liquid and hazardous waste produced by manufacturing and processing processes. While some environmental laws require industries to scientifically manage its waste, there are still environmental risks arising from the improper disposal of the waste in many urban areas[25]. The present study thus explores socio-economic factors, type of manufacturing operations, and waste disposal pattern of industries/ companies in the identified zones. Pourakarmikas play an especially important role in the management of municipal solid waste since they are the ones who are in close contact with the collection, transportation, street sweeping and sanitation process. Although their working conditions are difficult and they have to endure social discrimination, hazards on the job, and a lack of safety, they are very

important for maintaining cleanliness and environmental hygiene in the city[26,27]. The impact of socio-economic status, salary conditions, employment security and working environment on the effectiveness of the municipal solid waste management system is very high for pourakarmikas. It is therefore important to evaluate their socio-economic status and operating issues for enhancing efficiency and sustainability of the municipal sanitation system[28]. The other concept which is discussed in the study is the “4R Approach” which stands for Reduce, Reuse, Recycle and Recover. The 4R concept is believed to be a sustainable model to reduce waste generation and enhance the efficiency of resource use. The first step in reducing waste is to reduce it at source (at the point it is created), as this will reduce the burden on waste collection, transport, processing and disposal systems[29]. The concepts of reusing or recycling help prolong the use of products and reduce pollution to the environment. Sustainable waste management is also achieved by the numerous recovery processes related to energy generation and by-product utilization. Decentralised and stakeholder-led 4R practices can be a solution to alleviate strain on the municipal waste management infrastructure and to encourage the principles of the circular economy[30]. The study also emphasizes different types of waste treatment and disposal technologies such as incineration, gasification, pyrolysis, composting, anaerobic digestion and biomethanation. Waste volume reduction, energy recovery, recycling of nutrients and protection of the environment are all opportunities presented by these technologies if they are applied in a scientific manner[31]. But technology can not be an enabler for sustainable waste management without involving stakeholders awareness, changing their behaviors and coordinating institutions.

The current study thus seeks to give a holistic empirical evaluation of the socio-economic condition of stakeholder and the impact of stakeholder on municipal solid waste generation in Bengaluru city. The conclusions of this research will help the Policy makers, Urban Administrators, Environmental Planners, and Cities to formulate evidence-based and stakeholder-oriented waste management strategies. The study highlights the need for integrated solutions that adopt a technological approach, engage stakeholders, consider socio-economic aspects, raise awareness of the environment and the city, and plan for the long-term to achieve sustainable management of MSW.

2. Literature Review

The rapid urbanization, industrialization, population growth and lifestyle changes have created a huge problem called Municipal Solid Waste Management (MSWM)[1]. There are several researchers who pointed out that improper handling of MSW results in environmental pollution, public health threats and loss of natural resources. In developing countries like India, waste collection, segregation, transportation, recycling, treatment and disposal is a great challenge because of less public participation and less infrastructure for waste collection[32]. Socio-economic factors like income, education, occupation, family size and consumption behavior have been shown to play a significant role in the amount and type of MSW produced in urban areas[33]. However, it is believed that sustainable waste management systems could be achieved if stakeholders are involved, public awareness is raised and environmental education is promoted[34]. In addition, waste reduction measures like the 4R (Reduce, Reuse, Recycle, Recover) concept, decentralized waste processing, composting, biomethanation and waste-to-energy technologies have all been highlighted[1]. To achieve environmental sustainability and efficient urban governance, integrated solid waste management systems are essential in the fast-growing metropolitan cities like Bengaluru, where the involvement of stakeholders and scientific planning play crucial roles.

3. Details of the Study and Technical Analysis

The study as briefed in introduction is focused on gathering empirical data through field surveys amongst the stakeholders namely residents, hotels, industries, pourakarmikas and marriage halls. The data analytics is cited as here under

3.1 Residents:

Today the major aspect of worry for humanity is the issues involved in waste management. Community involvement plays a vital role in economical SWM. BBMP has tried to gather the stakeholders and arrange awareness campaigns to people on the need for proper handling of waste and right practices of storing the waste in their dustbins

near the corner of the roads everywhere. Absence of basic facility to assort the MSW created open dumps on the streets, open areas, drains, and water bodies thereby leading unhealthful conditions. Residents often apprehend falsely that the wastes dumped on the roads or streets would eventually be hand-picked up by the pourakarmikas at the time of sweeping. SWM cannot be successful without the involvement of residents and hence the residents have a significant role to play in flourishing implementation of the theme. It is prudent to look at a number of the vital stakeholders during this regard; residents play a big role in bringing up the changes and reframing the policies, strategies, and pointers to resolve the MSW problems within the town. Residents of that particular region would understand the situation and analyze the problems being faced by them over a period of time. Thus, in both zones of research area 320 residents are randomly selected to know their socioeconomic status with respect to their age, the status of residence, marital status and educational qualification. Further, it would be very helpful for the researcher to understand the socioeconomic condition better towards garbage issue. It also helps us to assess the attitudes of the residents, behavior, and perception towards managing the MSW and to examine the socio-economic influences responsible for the worst situation of MSW, working system of BBMP in managing the MSW.

3.2 Socio

Economic profile of Residents: Assessment of Resident's socio-economic profile is indeed a very significant and necessary step as the resident is the person who resides permanently somewhere for a long period in the same region. It is value noting that data on the socio-economic standing is of great importance to the solid waste planning process. We know that social parameters like Gender, age and marital status of residents also influence the process of SWM. In view of examining the socio-economic profile of residents, the data is exhibited in the following table. 1.1 Gender is known to have played an important role in quantity of MSW generated in the in the study area. Analysis of gender helps to find the extent of male and female contribution in SWM. As per the details of gender-wise representation: majority 79.40% of respondents are females and 20.60% of respondents are male in the two zones. The p-value of 0.097 (≥ 0.05) as obtained by chi-squared tests clearly indicates that there is insignificant differences in the opinion of respondents belong to two different zones. Usually, men go to work and women are often homemakers and spend more time in the house. This may be because females have a closer engagement with SWM at the household level. It indicates that females are more involved in kitchen activities than men and are responsible for the generation of wastes in the houses.

Bengaluru is a metropolitan city and a place for more of job opportunities, with this 88.40% of respondents are Kannadigas, being residents for more than 15 years and the 11.60% are Non-Kannadigas in the two zones. The p-value of 0.382 (≥ 0.05) obtained by chi-square test clearly indicates that there exists not much of a difference in the opinion of respondents belonging to two different zones. In these two zones the majority of the populations are basically originated in the city. The result indicates that permanent residents in these places are dominating and contributing more to the generation of MSW in the two zones. Age is a factor which reflects the behavior and nature of people towards MSW. 58.10% of respondents are found in the age group of 36 to 45 years and 26.90% of respondents are from the age group of 26 to 35. The p-value of 0.948 (≥ 0.05) obtained by chi-square test indicates that the differences in the opinion of respondents belonging to two different zones

is quite insignificant. Further, the respondents between 25 to 45 years of age group are more in these particular zones. This may be because this age group has a greater desire to conserve the resources for future generations. The government should focus on this particular age group while framing the policies and practices on SWM. Education builds and moulds the personality of any individual in general. In the current study, the educational qualification of the respondents has been divided in four different levels i.e, below Class X, Class XII, Degree and Post-graduation. With regard to the level of education, it is seen that majority 39.40% of residents have studied up to Class X. Only 13.80% of respondents have studied Class XII. This indicates that people have studied below Class X are unaware of the issue. The p-value of 0.319 (≥ 0.05) obtained by chi-square test clearly specifies that, there exists no significant difference in the view of respondents belonging to two different zones. Marriage may be a socially or ceremonially recognized union between spouses that establishes rights and obligations. It is a legal mandate for spouses to live together in the society. It is quite evident from the table 1.1 that the majority i.e. 93.10% of respondents are married and living together in the families; only 5.30% of the respondents are unmarried or bachelors. The p-value of 0.611 (≥ 0.05) obtained by chi-squared test clearly indicates that, there differences in the opinion of respondents belonging to two different zones is not significant. It further indicates that families play a major role in the source of the MSW generation in the two zones.

Table 1.1 Details of Residents Socio-Economic Profiles.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X ²	df	P Value	Result
1	Gender	Male	39	24.40	27	16.90	66	20.60	2.75	1	0.097	NS
		Female	121	75.60	133	83.10	254	79.40				
2	Status of Resident	Kannadiga	139	86.90	144	90.00	283	88.40	0.76	1	0.382	NS
		Non-Kannadiga	21	13.10	16	10.00	37	11.60				
3	Age Range (in Years)	15 to 25	14	8.80	12	7.50	26	8.10	0.36	3	0.948	NS
		26- to 35	41	25.60	45	28.10	86	26.90				
		36 to 45	94	58.80	92	57.50	186	58.10				
		≥ 46	11	6.90	11	6.90	22	6.90				
4	Educational Qualification	Below Class X	56	35.00	70	43.80	126	39.40	3.51	3	0.319	NS
		Class XII	22	13.80	22	13.80	44	13.80				
		Degree	50	31.20	37	23.10	87	27.20				
		Post-Graduation	32	20.00	31	19.40	63	19.70				

5	Marital Status	Unmarried	7	4.40	10	6.20	17	5.30	3.58	5	0.611	NS
		Married	151	94.40	147	91.90	298	93.10				
		Divorced	1	0.60	0	0.00	1	0.30				
		Widow	1	0.60	1	0.60	2	0.60				
		Separated	0	0.00	1	0.60	1	0.60				
Total Number of Respondents			160	100.00	160	100.00	320	100.00				

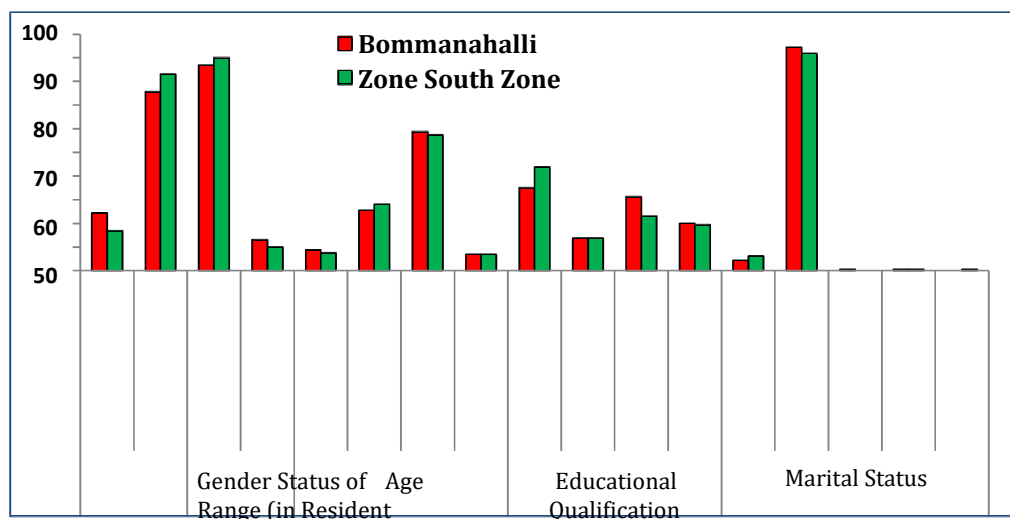


Figure 1 Socioeconomic profiles of Residents.

The overall analysis of this survey reveals that females are more engaged in household activities than men in both the zones with minimum educational knowledge. This signifies that females have found it difficult to understand the SWM system. It shows that only 11.60% are Non-Kannadigas which are very less in number so the majority of permanent residents who are married play a crucial role in solving the solid waste issue in the two zones.

3.3 Occupation, Size of the family and Income of the residents

Occupation is a reflection of the social status pertaining to an individual. In the present research/study, occupation of the respondents has been categorized into 4 types i.e self- employed, a private employee, government employee and others. The status of occupation, size of the family and income of residents are exhibited in the Table: 1.2. As per the details of occupation, 38.10% of respondents are private employees and 35.60 % of respondents belong to another job category. It is also found that self-employed people and people employed in the private sector are not bothered about MSW. The p-value of 0.020 (<0.05) obtained by chi-square test clearly indicates that there exists significant differences in the opinion of respondents belonging to two zones. The result tells us that people who are working in private sectors are more and busy with their job responsibilities assigned to them and least bothered towards the issue in the two zones.

Size of the family matters a lot in deciding the temperament of a private. A high sized family has additional care and responsibilities whereas smaller families produce the stable atmosphere and have less stress. Family Size is the reflection of responsibility, care, identity, and happiness. Generally the character and kind of house additionally mirrors the economic standing of the individual. Size of the

family determines the quantity of MSW generated from particular individuals in the society. Considering these factors, information about the size of the family is collected from respondents. Majority 88.80% of respondents belong to family size of 3 to 5 members and 3.80 percent are just couples but hardly 1.20 percent is from the joint family system. It can be noted from table 1.2 that the average size of the family with 3 to 5 members are nuclear families. The p-value of 0.067 (≥ 0.05) obtained by chi-squared test indicates that, there is insignificant differences in the opinion of respondents belong to two different zones.

Income is the decisive factor and purchasing power of the individuals. It is lime lighted from the table:

1.2 that 43.60% of the respondents are earning an average monthly income of below Rs.10,000 and 38.60% of respondents are earning between Rs.10,001 to Rs.30,000. A meager 3.10% of respondent's earnings is below Rs.90,000 and 3.80% of respondents are above Rs.90,000 i.e economically sophisticated in the city. It is evident that people do not want to disclose their exact income due to personal reasons. From the table: 1.2, we can notice that 43.60% of respondents are living in Bengaluru with below average level of income to run their families. Using chi-square test, the p- value 0.014 (< 0.05) level of significance test indicates that there exists higher significant differences in the opinion of respondents belonging to two different zones.

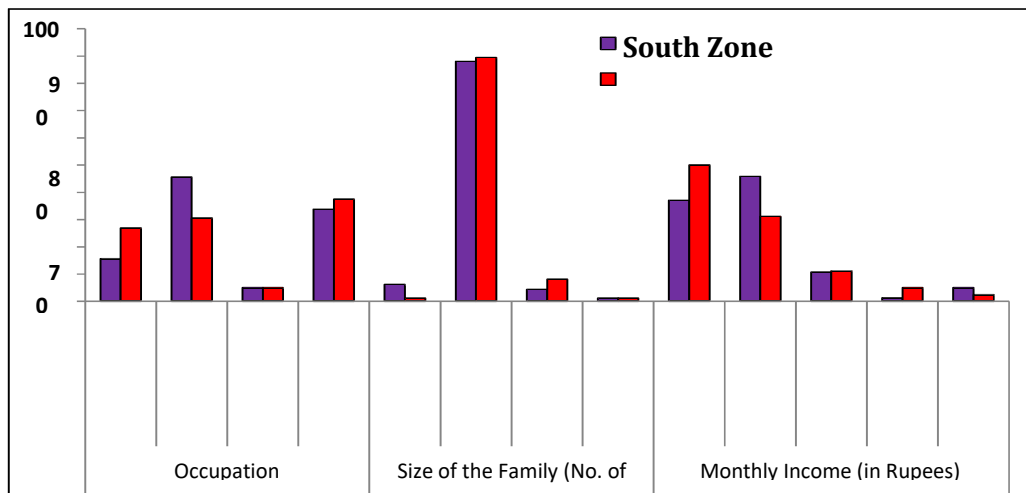


Figure 2: Details of Occupation, Size of the family and Income of the residents

Table 1.2: Occupation, Size of the family and Income of the residents

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X ²	df	P-Value	Result
1	Occupation	Self Employed	43	26.90	25	15.60	68	21.20	9.802	3	0.02	HS
		Private Employee	49	30.60	73	45.60	122	38.10				
		Govt. Employee	8	5.00	8	5.00	16	5.00				
		Others	60	37.50	54	33.80	114	35.60				

2	Size of the Family (No. of Members)	0 to 2	2	1.20	10	6.20	12	3.80	7.147	3	0.067	NS
		3 to 5	143	89.40	141	88.10	284	88.80				
		6 to 8	13	8.10	7	4.40	20	6.20				
		>8	2	1.20	2	1.20	4	1.20				
3	Monthly Income (in Rupees)	<10,000	80	50.00	59	37.10	139	43.60	12.432	4	0.014	HS
		10,000 to 30,000	50	31.20	73	45.90	123	38.60				
		30,001 to 60,000	18	11.20	17	10.70	35	11.00				
		60,001 to 90,000	8	5.00	2	1.30	10	3.10				
		>90,000	4	2.50	8	5.00	12	3.80				
Total Number of Respondents			160	100.00	160	100.0	320	100.0				

3.4 Consumption pattern and Expenditure of Residents

The expenditure incurred by residents on domestic consumption and behavior of residents is an important factor to assess the sources of the SWM generation in the two zones. Higher the consumption of people, larger would be the quantity of SWM generated in the city. The Consumption pattern and Expenditure of residents are exhibited in the Table: 1.3.

Brief Comments: With regard to eating habits, it is realized that majority 70.50% of respondents are having the habit of both vegetarian and non-vegetarian and 17.90% of respondents are only vegetarian. The p-value obtained 0.406 (≥ 0.05) obtained by chi-square test implies that, there exists no significant difference in the opinion of respondents belonging to two different zones. It is noted that respondents with the habit of both vegetarian and non-vegetarian are contributing for the waste generation in the two zones.

With this 70.30% of respondents are spending less than Rs.3000 for vegetables and 26.90% of respondents are spending more than Rs.4000 for their vegetable purchase. Henceforth their p-value 0.210 (≥ 0.05) obtained by chi-square implies that the difference in the opinion among two zones respondents is not significant. Nevertheless another data shows that 81.10 percent of respondents possess eating habits of non-veg and spending below Rs.4000 per month. Their p-value 0.706 (≥ 0.05) obtained by chi-square test indicates that difference in the opinion of two zones respondents is not significant.

It is noteworthy that 45.70% of respondent's spending for their livelihood purchases are below Rs.5,000 and 30.60% of respondents are spending below Rs.10,000. In these two zones the respondents have lower income or fall under middle-class group. The p-value of 0.493 (≥ 0.05) obtained by chi-square test signifies that the difference in the opinion of respondents amongst the two zones is not significant. The consumption pattern as well is one of the reasons for the generation of waste from these two zones. From table 1.3, it is quite conclusive that both people having vegetarian and non-vegetarian have the tendency to generate more waste in the city.

Table: 1.3 Eating Habits, Consumption and Expenditure profile of Residents.

Sl. No.	Indicators	Particulars	Bommanah alli Zone		South Zone		Total		Chi-SquareTest			
			No.	%	No.	%	No.	%	X2	df	P Value	Result
1	Eating Habits	Vegetarian	24	15.00	33	20.80	57	17.90	1.805	2	0.406	NS
		Non-Vegetarian	19	11.90	18	11.30	37	11.60				
		Both	117	73.10	108	67.98	225	70.50				
2	Monthly Expenditure for Vegetables (in Rupees)	≤3000	119	74.40	106	66.20	225	70.30	4.530	3	0.210	NS
		3,001 to 5,000	36	22.50	50	31.20	86	26.90				
		5,001, to 6,000	5	3.10	3	1.90	8	2.50				
		6,001 to 8,000	0	0.00	1	0.60	1	0.30				
3	Monthly Expenditure for Non-Vegetarian(in Rupees)	≤4000	114	83.20	101	78.90	215	81.10	1.396	3	0.706	NS
		4,001 to 5,000	19	13.90	23	18.00	42	15.80				
		5,001 to 6,000	2	1.50	1	0.80	3	1.10				
		6,001 to 8,000	2	1.50	3	2.30	5	1.90				
4	Consumption Expenditure for a month(in Rupees)	≤5000	69	43.10	76	48.40	145	45.70	2.406	3	0.493	NS
		5,001 to 10,000	55	34.40	42	26.80	97	30.60				
		10,001 to 20,001	31	19.40	35	22.30	66	20.80				
		20,001 to 30,000	5	3.10	4	2.50	9	2.80				
Total number of Respondents			160	100.00	160	100.00	320	100.00				



Figure 3: Eating Habits, Consumption and Expenditure profile of Residents.

The analysis of this survey revealed that the majority of residents are possess the habit of consuming both veg and non- vegetarian and lower income group spend very less for their consumption expenditure in a month. Furtherit is evident that the respondents with higher monthly expenditure contributes more towards generation of MSW which

is proved with their tendency of spending more towards non-vegetarian foods and less for vegetarian by the residents in both the zones.

Hotels: In the recent past, the hotel business has become the strong driving force behind the incredible growth of Indian GDP. It has also powered the surge in the number of hotels in and around the city. Hotels are the key customers of resources and contribute heavily towards the waste generation, as compared to others. Hotels are the commercial unit that has for services similar to accommodations, meals, and alternative services for travelers and tourists. An edifice could be a place whose final goal, mission and vision are to supply you a lingering expertise and confirm you're feeling thus smart that you simply wish to come back as shortly as potential. Hotels area unit one among the key sources of solid waste generation, for reducing the degree of the waste, centered on minimizing waste within the operation, recycle and recycle and waste disposal by the edifice to fulfill environmental responsibility and cut back the burden of waste. The role of hotel business in terms of waste generation and therefore the quick growth of the trade, adopting variety of environmental best practices with quantitative measures area unit help in deciding on SWM

3.5 Social Profile of Hotel Owners

Brief Comments: Gender of hotel owners helps to assess the extent of male and female participation in the hotel sector. As per the table 1.4, gender-wise representation: majority 83.30% of respondents are males and 16.70% of respondents are females in the hotels of two zones. The p-value of 0.079(≥ 0.05) obtained by chi-square test clearly indicates that the difference in opinion of hotel owners belonging to two different zones is insignificant. It shows that males are more interested in the hotel business than females. It also indicates that hotel businesses are very difficult to run because it involves many hard handling activities and difficult to manage the cooks, chefs, laborers in the hotels.

With this connection majority i.e. 78.30% of respondents have given no responsibility for their educational level and to notice further 5.00% of hotel owners had educated below Class X level, then 6.70% of respondents are degree holders. The p-value of 0.248(≥ 0.05) obtained by chi-square test signifies that the opinion differences among respondents belonging to two different zones is not significant.

It is evident that hotel owners in these two zones are under the matriculation level or they do not want to disclose their level of literacy. Albeit there is no mandate or rule which necessitates the hotel owner to be a degree holder, people usually acquire the knowledge of running hotel business before they start it. When the duration of hotel is considered about 46.70% of respondents are running the hotel business from 5 to 10 years and 25.00% of hotel owners own this business below 5 years. The p-value of 0.569(≥ 0.05) obtained by chi-square test reveals that the difference in the opinion of respondents amongst two zones is insignificant. It is found that the majority of hotels are owned by owners with a minimum level of experience in the hotel sector.

Table: 1.4 Social Profiles of Hotel Owners.

Sl. No.	Indicators	Particulars	Bommanahalli Zone	South Zone	Total	Chi-Square Test
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			No.	%	No.	%	No.	%	X2	df	P-Value	Result
1	Gender	Male	26	86.60	24	80.00	50	83.30	2.749	1	0.079	NS
		Female	4	13.40	6	20.00	10	16.70				
2	Educational Qualification	Below Class X	2	6.70	1	3.30	3	5.00	7.865	4	0.248	NS
		Class XII	3	10.00	2	6.70	5	8.30				
		Degree	3	10.00	1	3.30	4	6.70				
		No Response	21	70.00	26	86.70	47	78.30				
3	Duration of Hotel (in Years)	0 to 5	6	20.00	9	30.00	15	25.00	1.129	2	0.569	NS
		5 to 10	14	46.70	14	46.70	28	46.70				
		>10	10	33.30	7	23.30	17	28.30				
Total Number of Respondents			30	100.00	30	100.00	60	100.00				

The analysis of this survey revealed that hotels are the business with more profitability, the majority of hotel owners hesitate to reveal their educational status as almost all the hotels in these two zones are managed and controlled by illiterates. It can

be concluded that hotel owners lack the awareness and find it difficult to realize the fundamental technologies of SWM system in the two zones.

3.6 Consumption pattern and Behaviour of Customers in Hotels:

In order to review the source of the generation of waste from hotels, it is essential to analyze the consumption pattern of customers in the hotels. It helps us to assess

- The behavior of customers in hotels with respect to their wastage of food
- Reasons for wasting the food
- Whether the wastes are segregated or not by the hotel owners.

Ideally, the customers should not waste the food for which they have paid the hard earned money, but the customers tend to leave the side dishes more often than not and the accumulation of the residues leads to generation of waste post consumption of food. The Consumption pattern and behaviour of customers in the hotels with respect to number of customers and other parameters is cited in Table: 1.5 For the purpose of this study, the average number of customers expected in a day to the hotel was calculated. For this instance, 33.30% of respondents had expected 40 to 120 customers on an average to the hotel. Only 11.70% of respondents had expected above 120 customers in a day. The p-value of 0.011 (<0.05) obtained by chi-square test clearly specifies, there exists highly significant difference in the opinion of respondents belonging to two different zones. It can be inferred that customers with their busy schedules in work-life find very little time to prepare and have the food at home, so they prefer and visit hotels more frequently

Table:1.5 Consumption pattern and behaviour of Customers in Hotels.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X ²	df	P Value	Result
	Average	10 to 40	8	26.70	5	16.70	13	21.70				
		41 to 80	9	30.00	11	36.70	20	33.30				

1	Number of customers visiting the hotel in a day	81 to 120	6	20.00	14	46.70	20	33.30	11.09	3	0.011	HS
		>120	7	23.30	0	0.00	7	11.70				
2	Consumption Pattern	Low	2	6.70	1	3.30	3	5.00	2.453	3	0.484	NS
		Medium	23	76.70	27	90.00	50	83.30				
		High	4	13.30	1	3.30	5	8.30				
		Very high	1	3.30	1	3.30	2	3.30				
3	Wastage of food	Yes	22	73.30	21	70.00	43	71.70	0.082	1	0.774	NS
		No	8	26.70	9	30.00	17	28.30				
Total Number of Respondents			30	100.00	30	100.00	60	100.00				

Source: Field Survey

It is also evident from the table: 1.5, majority i.e 83.30% of respondents have opined that consumption pattern of customers in the hotel are medium but hardly 3.30% of respondents have complained the customers have high level of consumption. The p-value of 0.484 (≥ 0.05) obtained by chi-squared method indicates that the differences in the opinion of respondents belonging to two different zones is not significant. The result reveals that respondents in these two zones who had visited the hotels often have the medium level of consumption pattern. About 71.70% of respondents are of the opinion that customers waste their food and rest of 28.30% respondents' state otherwise. The p-value of 0.774 (≥ 0.05) obtained by chi-squared test imply that the difference in the opinion of respondents belonging to two different zones is quite insignificant. Based on the result, hotel owners conclude that customers waste their food in the plates because of their disliking of the food or the customer may find different taste and this leads to the generation of more wet waste in the hotels.

Pourakarmikas : Pourakarmikas play a pivotal role in collection, transformation, handling and disposal of MSW. Pourakarmikas are the real challengers working continuously for the growth and cleanliness of environment in Bengaluru city. The pourakarmikas are being criticized and discriminated without any mercy due to their social and cultural background.

The problems being faced by pourakarmikas are of prime concern for the general public as well as government owing to the fact that

- Pourakarmikas are serving the society and the public genuinely by eliminating the garbage
- Cleaning the roads lane to lane, street to street and public toilets from one corner to the other.

Pourakarmikas are working in a challenging role of the civic society to maintain cleanliness. The approach of empowerment and immediate reforms in strengthening the pourakarmikas is the need of the hour. Henceforth, it would be prudent and imperative to study the socio-economic status of pourakarmikas which indeed influences the collection, handling and disposal of MSW.

3.7 Socio Economic Profile of Pourakarmikas

Brief Comments: The socio-economic profiles of pourakarmikas are provided in Table: 4.6. It is noticed that 53.30% of pourakarmikas are females and 46.70% of

pourakarmikas are males. The p-value of 0.121 (≥ 0.05) obtained by chi-square test is indicative of the fact that there exists no significant difference in the opinion of pourakarmikas belonging to two different zones. It can be observed that the government has provided equal job opportunities gender wise without any discrimination in BBMP. In actual, results indicate that females have outnumbered males because of the fact that they are more accustomed to sweeping, cleaning and conserving hygiene which are the important attributes in the process of SWM.

In this connection, 50.80% of pourakarmikas are aged in the range of 31 to 40 years and 27.10% of pourakarmikas lie to the age group of 20 to 30 years. The p-value of 0.244 (≥ 0.05) as obtained through chi-square test leads to an implication that differences in the opinion of pourakarmikas belonging to two different zones is perhaps insignificant. Furthermore, it is seen that female pourakarmikas are working continually hard to solve the menace of MSW in the zones.

Table: 1.6 Social Profile of Pourakarmikas.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X2	df	P Value	Result
1	Gender	Male	17	56.70	11	36.70	28	46.70	2.411	1	0.121	NS
		Female	13	43.30	19	63.30	32	53.30				
2	Age (in Years)	20 to 30	5	17.20	11	36.70	16	27.10	4.168	3	0.244	NS
		31 to 40	15	51.70	15	50.00	30	50.80				
		41 to 50	7	24.10	3	10.00	10	16.90				
		>51	2	6.90	1	3.30	3	5.10				
3	Marital Status	Single	11	36.70	11	36.70	22	36.70	1.027	2	0.598	NS
		Married	19	63.30	18	60.00	37	61.70				
		Widowed	0	0.00	1	3.30	1	1.70				
4	Nature of Job	Permanent	18	60.00	20	66.70	38	63.30	0.287	1	0.592	NS
		Temporary	12	40.00	10	33.30	22	36.70				
Total Number of Respondents			30	100.00	30	100.00	60	100.00				

Further, marital status of pourakarmikas is considered because their social life has an impact on the efficiency of collection of waste in these two zones. About 61.70% of pourakarmikas are married and happily living with their families and 36.70%

of pourakarmikas are still unmarried. The p-value of 0.598 (≥ 0.05) obtained by chi-square test specifies that there is no significant difference in the opinion of pourakarmikas amongst two zones. Out of these pourakarmikas, 63.30% of workers are permanent/regularized in their roles/jobs and 36.70% of pourakarmikas are working on temporarily/ contractual basis although the government has so far assured them of permanent job in future. The p-value of 0.592 (≥ 0.05) obtained by chi-square test

leads to the probable scenario where there is no significant difference in the opinion of pourakarmikas amongst the two zones

The overall analyses of this survey reveal the empirical fact that pourakarmikas are very unhappy with the nature of the job as

- They are ignored and neglected with social deprivation by the society.
- Proper PPE's (Personal Protection Equipment) are not provided in time
- Safety Protocols are often ignored the most

The marital status of pourakarmikas shows that still, 36.00% of workers are unmarried which might affect their social life and lead to a negative impact on the efficiency in collection of MSW in the city.

Economic status of Pourakarmikas and Role of Contractor in BBMP: The economic status of pourakarmikas and role of the contractor in BBMP reflects the financial conditions within the society. It is observed that 23.30% of pourakarmikas are getting the salaries below Rs.10,000 and 76.70% percent of pourakarmikas are drawing the salaries in excess of Rs.15,000. The p-value of 0.222 (≥ 0.05) obtained by chi-square test indicates that there differences in the opinion of pourakarmikas belonging to two different zones is quite insignificant

Table 1.7 Economic Status of Pourakarmikas and Role of Contractor in BBMP.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X2	df	P Value	Result
1	Monthly Salary (in Rs.)	5,000 to 10,000	9	30.00	5	16.70	14	23.30	1.491	1	0.222	NS
		10,000 to 15,000	21	70.00	25	83.30	46	76.70				
2	Satisfied with salary	Yes	11	36.70	1	3.30	12	20.00	10.41	1	0.001	HS
		No	19	63.30	29	96.70	48	80.00				
3	Payment and Salary	BBMP	13	43.30	9	30.00	22	36.70	1.148	1	0.284	NS
		Contractor	17	56.70	21	70.00	38	63.30				
4	Reduce the role of Contractor	Yes	20	66.70	22	73.30	42	70.00	0.317	1	0.573	NS
		No	10	33.30	8	26.70	18	30.00				
Total Number of Respondents			30	100.00	30	100.00	60	100.00				

Brief Comments: Irrespective of the salary payer, be it BBMP, be it the contractor, 80.00% of Pourakarmikas are unhappy. The p-value of 0.001 (≤ 0.05) obtained by chi-square test leads us to infer that, there would be highly significant differences in the opinion of the Pourakarmikas belonging to two different zones. With the results, it is conclusive that Pourakarmikas are dissatisfied with the salaries paid to them. Recently, Government of Karnataka (GoK) had promised a hike in the salaries of Pourakarmikas who are working with lots of risks and struggles continually towards management of MSW in the city.

Out of the total number of *Pourakarmikas*, about 63.30% of them are paid by contractors and the balance i.e 36.70 % of them are paid by BBMP or Government. The p-value 0.284 (≥ 0.05) by chi-square test implies that there is insignificant difference in the views of *Pourakarmikas* amongst two different zones.

With regard to this *Pourakarmikas* request for payment of their salary directly by state government or be routed through BBMP along with health policies. The fact to be noted is that 70% of *Pourakarmikas* have sought removal of contractors who are earning exorbitant margins by playing the role of middlemen between *Pourakarmikas* and BBMP or Government. In

this way, substantial budget/revenue of BBMP/Government is being dissipated to contractors. The p-value of 0.573 (≥ 0.05) as obtained by chi-squared test enables us to infer that the difference in opinion of respondents belonging to two different zones is insignificant.

Industries/Factories/Companies

Rapid industries have resulted in the generation of the wastes in enormous quantities in the form of solid or fluid. The major industries contributing to waste generation are

- The manufacturing industries in mechanical segments which produce sugar, pulp and paper
- Processing industries like distilleries, poultries, fruit and food processors, dairies, tanneries, slaughter houses and so on

Despite the environmental laws necessitate for accommodating pollution control measures, in practice, these wastes unit often drop onto land or discharged into water bodies without proper treatment and thus turn into an outsized supply of environmental pollution and risk. Industries generating MSW must be constrained to oversee such waste without anyone else and are mandated to obtain approvals from different State Pollution Control Boards (SPCBs) underneath relevant policies and rules. Industries are a result of rapid developments in technology and also the ever increasing demands of our daily lives. These industries are essential to the progress of human civilization.

The industries and factories produce goods at one end but they create tonnes of waste on daily basis at the other end. In a way, the industries are polluting air, water and land relentlessly which is being currently witnessed globally as climate change posing threats to Earth's biodiversity

Unfortunately, the growth of industries and factories has contributed much to the generation of a huge quantity of chemical waste mixed with sanitary wastes and wet waste in the city. There are a number of garment factories and medium-sized industries/factories in these two zones. It is also necessary to understand the different category of groups affects the environment and general public health.

3.8 Socio-Economic Profile of Industries/Companies Owners

Nowadays, both male and female participation in the industrial sector is quite common. It is very vibrant from the table 1.8 that, 80% of male respondents are controlling and managing the small and medium-size industries in the study area. The p-value of 0.114 (≥ 0.05) obtained via chi-square test implicate the fact that the opinion of respondents belonging to two different zones is insignificant

Majority i.e 90% of respondents are basically originated from Karnataka and 10% of respondents are migrated from other various places in the study area.

The p- value of 1.00 (≥ 0.05) obtained by chi-square test clearly is indicative of the insignificant differences in the opinion of respondents amongst two different zones.

Brief Comments: With respect to age, 50.00% of industrialists or factory owners are aged between 36 to 45 years, 25.00% of respondents fall into the group of 26 to 35 years and 22.50% of respondents are above 46 years. It indicates that maximum industries or factories or companies are being owned and controlled by youngsters contributing much to the economy of the country. The p-value of 0.319 (≥ 0.05) obtained by means of chi-square test clearly indicates that the differences in the opinion of respondents belonging to two different zones is not significant

In order to understand the educational level of industrialists, it is observed that 60.00% of the respondent had completed their graduation, 12.50% of respondents have got post-graduate degree and 25.00% of respondents had completed class XII. The p- value of 0.753(≥ 0.05)obtained through chi-square test specifies that there is no significant difference in the opinion of respondents amongst two different zones.

To understand the marital status of industrialists, it is observed that 90% of respondents had married and 10% of them are not married. The p-value of 0.292 (≥ 0.05) obtained by chi- square test signifies that there is no significant difference in the opinion of respondents belonging to two different zones.

Table: 1.8 Socio-Economic Profile of Industries/Companies Owners.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X ²	df	P-Value	Result
1	Gender	Male	14	70.00	18	90.00	32	80.00	2.500	1	0.114	NS
		Female	6	30.00	2	10.00	8	20.00				
2	Resident of Karnataka	Karnataka	18	90.00	18	90.00	36	90.00	0.000	1	1.000	NS
		Non-Karnataka	2	10.00	2	10.00	4	10.00				
3	Age (in Years)	15 to 25	0	0.00	1	5.00	1	2.50	3.511	3	0.319	NS
		26 to 35	7	35.00	3	15.00	10	25.00				
		36 to 45	8	40.00	12	60.00	20	50.00				
		≥ 46	5	25.00	4	20.00	9	22.50				
4	Educational Qualification	Below Class X	0	0.00	1	5.00	1	2.50	1.200	3	0.753	NS
		Class XII	5	25.00	5	25.00	10	25.00				
		Degree	12	60.00	12	60.00	24	60.00				
		Post-Graduation	3	15.00	2	10.00	5	12.50				

5	Marital Status	Single	3	15.00	1	5.00	4	10.00	1.111	1	0.292	NS
		Married	17	85.00	19	95.00	36	90.00				
Total Number of Respondents			20	100.00	20	100.00	40	100.00				

3.9 Nature and duration of Industries/Companies

It is important to assess the nature and duration of industries/factories/companies because the longevity and manufacturing process of industries helps us to know the contribution of waste generated by these industries.

The observations from data cited in Table 4.9 are summarized as follows

Brief Comments: With respect to duration of the industries

- 50.00% of them have been in existence since 5 to 10 years
- 27.50% of them are older than 10 years
- The p-value of 0.160 (≥ 0.05) has been obtained by chi-square test

From the above facts and figures, one can infer that differences among the opinions of respondents between two zones is inconsequential

With respect to nature of manufacture

- 35.00% of industries/factories are manufacturing clothes
- 17.50% of industries are producing iron and steel,
- 40.00 % of industries / factories are involved in making of other business related items
- The p-value is 0.600 (≥ 0.05) as derived from chi-square test

The above facts indicate that there exists insignificant difference in the opinion of respondents amongst two zones. With regard to outlets of hazardous waste,

- 20% of respondents have admitted that they let out the hazardous waste
- 80% of respondents have stated otherwise
- The p-value is 1.000 (≥ 0.05) computed by chi-square method

Table: 1.9 Nature and duration of Industries/Companies.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X ²	df	P-Value	Result
1	Duration of Factory (in Years)	0 to 5	7	35.00	2	10.00	9	22.50	3.669	2	0.160	NS
		5 to 10	8	40.00	12	60.00	20	50.00				
		>10	5	25.00	6	30.00	11	27.50				
2	Nature of	Clothes	9	45.00	5	25.00	14	35.00	1.869	3	0.600	NS
		Chemicals	1	5.00	2	10.00	3	7.50				
		Iron & Steel	3	15.00	4	20.00	7	17.50				

	manufacture	Others	7	35.00	9	45.00	16	40.00				
3	Outlets the Hazardous Waste	Yes	4	20.00	4	20.00	8	20.00	0.000	1	1.000	NS
		No	16	80.00	16	80.00	32	80.00				
Total Number of Respondents			20	100.00	20	100.00	40	100.00				

From the above facts and figures, one can infer that differences among the opinions of respondents between two zones is inconsequential

With respect to nature of manufacture

- 35.00% of industries/factories are manufacturing clothes
- 17.50% of industries are producing iron and steel,
- 40.00 % of industries / factories are involved in making of other business related items
- **The p-value is 0.600 (≥ 0.05) as derived from chi-square test**

The above facts indicate that there exists insignificant difference in the opinion of respondents amongst two zones. With regard to outlets of hazardous waste,

- 20% of respondents have admitted that they let out the hazardous waste
- 80% of respondents have stated otherwise
- **The p-value is 1.000 (≥ 0.05) computed by chi-square method**

The above analytics indicate there is no significant differences in the opinion of respondents belong to two different zones. Further, it clearly indicates that industries/factories also contribute to the generation of MSW and Hazardous waste.

Marriage Halls: A perform hall, reception hall, or banquet hall may be a space or building for the aim of hosting a celebration, banquet, wedding or different reception, or another event. The multi- purpose hall is a built upspace meant to accommodate several categories of occasions or activities like wedding rituals, social gatherings, get to gathers, spiritual activities, symposia, seminars and conferences. The events inside a multi-purpose hall generate large quantities of MSW. The cookery activities generate both organic and non-organic solid wastes. These wastes need proper handling and disposal as the wastes lead to nuisances, like odors, flies, rodents and different pests. A load of waste is generated once wedding functions are performed at their premises and causes unhealthful conditions. Proper holders with covers which can coordinate with the main combination or establishment of ULBs should be given by these organizations at their cost and furthermore the destinations of their arrangement should be concluded in interview with ULBs to encourage better SWM. It is necessary to understand the socio-economic profile of marriage halls owners where randomly 20 wedding halls are investigated in these two zones.

3.10 Socio-Economic profile of Marriage Halls Owners

It is essential to examine the socio-economic profile of marriage halls owners in respect of their age, educational qualification and duration of their ownership as owners in the two zones.

Table: 1.10 Socio-Economic Profiles of Marriage Hall Owners.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X ²	df	P-Value	Result
		26 to 35	1	10.00	0	0.00	1	5.00				

1	Age (in Years)	36 to 45	9	90.00	7	70.00	16	80.00	4.250	2	0.119	NS
		≥46	0	0.00	3	30.00	3	15.00				
2	Educational Qualification	Below Class X	2	20.00	4	40.00	6	30.00	5.524	2	0.063	NS
		Class XII	2	20.00	5	50.00	7	35.00				
		Degree	6	60.00	1	10.00	7	35.00				
3	Duration of Ownership (in Years)	0 to 5	1	10.00	0	0.00	1	5.00	3.943	2	0.139	NS
		5 to 10	4	40.00	1	10.00	5	25.00				
		>10	5	50.00	9	90.00	14	70.00				
Total Number of Respondents			10	100.00	10	100.00	20	100.00				

The details provided in table 4.10 are summarized as follows

Brief Comments

With respect to age of Marriage Hall Owners, the following aspects are noteworthy

- Majority i.e 80% of respondents are in the age group 36 to 45 years,
- 15% of respondents are above 46 years of age
- Just 5 % of respondents are between 26 to 35 years
- **The p-value obtained is 0.119(≥ 0.05) as calculated via chi-square test**

The above analysis of data leads us to infer that there is difference in the opinion of respondents amongst two zones is insignificant.

With respect to the educational background, following aspects are to be noted

- 35% of respondent are degree holders
- 35% percent of respondents have passed their Pre-University (PUC) or Class X
- 30% of respondents are below matriculation level or Class X.
- **The p-value of 0.063 (≥ 0.05) is obtained through the means of chi-square test**

The data gathered above is indicative of the fact that the differences in opinion amongst the respondents in two zones is not significant

With respect to duration of ownership, the following consolidated data is presented herewith

- 70% of respondents are running their marriage halls from more than 10 years
- 25 percent of respondents are holding the marriage halls between 5 to 10 years.
- **The Chi-Square test yields a p-value of 0.139 (≥ 0.05)**

The consolidated data as cited above clearly indicate that the difference in opinion of respondents amongst two zones is not significant.

Nature and Capacity of Marriage Halls

It is important to have understanding on the nature and capacity of marriage halls to examine the quantity of waste being generated by marriage halls. In similar to the previous survey, the parameters like food habits (vegetarian & non-vegetarian)

and capacity of hall in numbers and the frequency of programmes/functions being conducted at the halls. The nature and capacity of marriage halls are detailed in table 1.11. The details provided in table 1.11 are summarized as follows

Brief Comments

With respect to nature of Marriage halls, the extract of data is as follows

- 70% of Marriage Halls host functions or programmes involving people who possess eating habit of vegetarians
- 30% of Marriage Halls host functions or programmes involving people who possess eating habit of both vegetarians and non-vegetarian
- The p-value obtained through chi square method is 0.329 (≥ 0.05)

The extract of the data as cited above indicate that the difference in opinion of respondents belonging to two different zones is not so significant.

With respect to capacity of Halls in terms of Number of members

- 60% of marriage halls fit on average of 300-600 members with sophisticated facilities
- 25% of the halls are of larger size of marriage halls can accommodate 600 to 800 members.
- The p-value of 0.001 (< 0.05) has been obtained by chi-squared test

Table: 1.11 The Nature and capacity of Marriage Halls.

Sl. No.	Indicators	Particulars	Bommanahalli Zone		South Zone		Total		Chi-Square Test			
			No.	%	No.	%	No.	%	X2	df	P-Value	Result
1	Nature of Marriage Halls	Vegetarian	6	60.00	8	80.00	14	70.00	0.952	1	0.329	NS
		Both	4	40.00	2	20.00	6	30.00				
2	Capacity of Marriage Hall (in Number of Members)	100 to 300	3	30.00	0	0.00	3	15.00	13.330	2	0.001	HS
		301 to 600	2	20.00	10	100.00	12	60.00				
		601 to 800	5	50.00	0	0.00	5	25.00				
3	Average No. of Marriages/ functions held in Marriage Hall	0 to 20	1	10.00	0	0.00	1	5.00	1.200	3	0.753	NS
		21 to 40	2	20.00	3	30.00	5	25.00				
		41 to 60	4	40.00	4	40.00	8	40.00				
		>60	3	30.00	3	30.00	6	30.00				
Total Number of Respondents			10	100.00	10	100.00	20	100.00				

The analysis of the data above indicates that there exists highly significant difference in the opinion of respondents belonging to two different zones.

Frequency of functions matter a lot in calculation of Solid Waste Surge and average quantity of MSW generated. Thus, it is prudent to calculate the average number of functions taking place in these marriage halls. The data on incidences of functions is interpreted as below

- 25% percent of respondent have stated 21 to 40 functions on average
- 40% of respondents had answered 40 to 60 functions
- 30% percent of marriage halls report more than 60 functions
- The chi-squared test has resulted in the p-value of 0.753 (≥ 0.05)

The data summarized above indicates that difference in the opinion of respondents belonging to two different zones is not significant. Further, it is worthy to note that people are quite generous in celebrating their customs, traditions and marriages. These functions in turn contribute largely towards accumulation of MSW in larger quantities

Results and Discussion

The exhaustive study of economic and social status of residents is summarized, interpreted and discussed as follows

Residents: The overall analysis of this survey revealed that majority of residents are working in private sector and rest of respondents are working in a different sectors; the family size of 3 to 5 members are more in these two zones. This helps us to frame the rules and guidelines for the families to impart the knowledge of SWM. It also shows that their family income is less than Rs.10,000/- which means the government needs to focus on this category of people in implementing certain policies towards betterment of SWM.

Hotel Owners: The overall analysis of this survey, hotel owners are aware of the fact that

- Majority of customers waste the food in the plate,
- Hotels generate more of wet waste

The wet waste is not being recycled by hotel owners as they lack the knowledge of 4R's concept (Reduce, Recycle, Reuse, Recover). There exists a lot of scope for management of wet waste in hotels by incorporation of technologies like biogas plants, composting units which enable transformation of waste to energy and compost.

Pourakarmikas: As per the overall analyses of this survey, *Pourakarmikas* feel that the salaries being paid to them is not satisfactory and are insisting on the eliminating the contractor in SWM of both the zones. The *Pourakarmikas* are quite demotivated with their existing socio-economic status in the society which has a direct bad impact on the cleanliness of this environment. Offering better salaries with additional perks like free of cost health policies and medication to *Pourakarmikas* will enhance their mindset and passion towards achieving better SWM and public health in the city on a long run.

Pourakarmikas are the prime movers of SWM working continually on carrying out the iterations of collection, segregation, transport, recycling and ultimate disposal of MSW. They are often exposed to higher health risks, social discrimination are deprived of social justice and basic amenities. The success of SWM is totally dependent on *Pourakarmikas* and the ULBs need to ensure that these selfless ambassadors of SWM are given proper facilities and comfort so that the waste is properly managed

Industries/Companies: The analysis of this survey revealed industries are solely focused on the assembly and making profit out of the business and these entrepreneurs in all probability do not have the fundamental data of SWM system. So, the government needs to have some type of program that may encourage and educate them concerning the consequences of commercial perishable waste.

We would like industries for contemporary life and it is obvious that they generate waste. We have a tendency to simply ought to increase awareness concerning the waste treatment. There are many private organizations operating in the arena of waste treatment and management. The industries need to source the waste material to SWM systems. There is a desire to determine central treatment plants instituted by the government for every zone. BBMP should impose significant penalties on the industries which do not comply with the prevailing rules and regulations established by competent authorities like SPCBs, CPCBs and relevant ISO standards

Marriage Hall Owners: The analysis of this survey revealed that almost all the marriage halls are vegetarian which fit into average members of 300 to 600 in these two zones. The people spend lavishly on their weddings thereby generating more of food waste.

The government needs to bring in stringent rules and regulations on marriage hall owners. Further, the entire responsibility of managing the waste generated at the halls should be handed over to the respective owners by suggesting and recommending the micro composting facility to ensure processing of food waste in a decentralized manner.

3.11. Socio-economic impact of stakeholders on solid waste generation

It is quite necessary to know the socio-economic impact of stakeholders on solid waste generation, for which the variables considered are

- Gender classified into male denoted with (M) and female (F)
- Status of Residence {S(R)} divided into Kannadigas (K) and Non-Kannadigas (NK)
- Food habits classified into Vegetarian (V) and Non-Vegetarian (NV)
- Income Group (IG) considered: Rs.10,000 to Rs.20000,
- Consumption Expenditure (CE) grouped into Rs.10,000 to Rs.20,000 per month
- Average Quantity of Waste Generated (AQWG) by stakeholders is multiplied by number of respondents {n(R)} to compute the total quantity of waste generated (TQWG).

Table 1.12 Socio-economic impact of stake holders on MSW generation.

Stake Holders	Socio Economic Indicators										
	G		S(R)		FH		IG	CE	A Q W G	n(R)	TQWG
	M	F	K	NK	V	NV	10-20k	10-20k			
	No.	No.	No.	No.	No.	No.	No.	No.	kg	No.	kg
Residents	66	254	283	37	58	262	262	242	5	320	1,600
Hotel Owners	50	10	44	16	35	25	42	35	15	60	900
Marriage Hall Owners	12	8	15	5	16	4	-	-	20	20	400
Industries/ Factories	32	8	36	4	-	-	42	32	8	40	320
Total	160	280	378	62	109	291	346	309	48	440	3,220
%	36.30	63.70	85.90	14.10	24.70	66.10	78.60	70.20			

It is important to notice the following points

Gender: Females play a significant role in quantity generation of MSW, proven with 63.70% of females are engaged in the waste activities who are caretaker of their entire family, 36.30% of the male are involved in the waste quantum.

Status of Residence: Considering another social variable which influences the solid waste generation is the status of resident belongs to that region for more than 30 years, for this 85.90% of permanent residents are the prime

reason for generating more quantity of MSW in the city, followed by 14.10% of Non-Kannadigas are aware of the rules and regulations of SWM.

Food Habit of respondents is also the reason for generation of waste in larger quantities, the majority of 66.10% of non- vegetarian people are more in the contribution of waste generation.

Income and Consumption Expenditure: It is also necessary to check the impact of income variables on solid waste generation since income stimulates consumption habits of people and is decisive in determining expenditure on certain commodities also influences the quantum of wet and dry waste in the city; 78.60% of respondents fall into the group of Rs.10,000 to Rs.20,000 which indicates the economic constraints of solid waste generation; however 70% of respondents spend between Rs.10,000 to Rs.20,000 for their consumption purpose.

The response of stakeholders on average quantity of waste generated as admitted respectively is as follows

- Residents segment: 5 kg/day
- Hotels:15kg/day,
- Marriage Halls : 20 kg/function and
- Industries/factories/companies: 8 kg/ day.

In the two different zones, it is observed that although the residents are higher in number, still the quantity of waste generated by residents is 5kg/day which is less as compared to other stakeholders i.e hotels generate 15kg/day, marriage halls generate 20 kg of food waste for per function and industries/factories are 8 kg/day but another aspect to consider is that hotels generate more of wet waste, marriage halls too generate the wet waste or food waste more in the premises, while industries tend to generate the dry waste in higher quantities

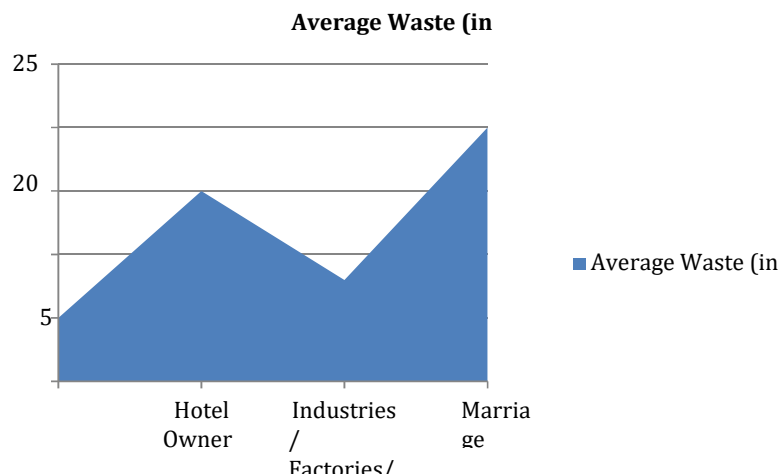


Figure 4 MSW Generation Profile of various stake holders.

The analysis of this survey revealed that hotels and marriage halls generate more of wet waste which are not being recycled or recovered owing to the lack of awareness in imparting the 4R (Reduce, Reuse, Recycle, Recover) facilities among stakeholders who are impacting the SWM in the city negatively. BBMP needs to focus on these segments of society and draft the policies and bring in successful methods to solve the solid waste problem in the city.

4. Conclusion

This study underscores the importance of the socio-economic factors of the stakeholders in the generation of municipal solid waste (MSW) in Bengaluru city. The study conducted in Bommanahalli Zone and South Zone showed that demographic parameters like age, gender, education, occupation, income level, food habits and residential status

have a significant role in the amount and nature of waste produced. The survey was carried out among almost 500 stakeholders of the city that includes residents, hotel owners, marriage hall operators, industries/companies, and pourakarmikas, which gave a comprehensive overview of the scenario of existing waste generation and management in the city.

The study noted that the wet waste contribution from hotels is much higher than that of the residential and industrial sectors, and that of marriage halls is higher than that of the residential and industrial sectors. The average amount of waste generated was estimated to be 5kg per person, 15kg per hotel, 20kg per marriage hall and 8kg per industry or company. It was found that food related activities in the hotels and marriage halls were the main source of wet waste generation while comparatively higher volume of dry waste was generated by industries. The results are evident that the stakeholders tailored waste management approaches are critical to effective waste management of MSW in metros like Bengaluru.

The study also highlights the fact that the improper segregation and low level of recycling, along with the low awareness about the 4R principles (Reduce, Reuse, Recycle and Recover) among the stakeholders still affects the solid waste management system in a negative way. The results indicate that the Bruhat Bengaluru Mahanagara Palike (BBMP) should focus on awareness creation, policy implementation and scientific waste handling mechanisms in specific to commercial establishments like marriage halls and hotels that generate significant amount of biodegradable waste.

The socio-economic evaluation of pourakarmikas highlighted their significance in ensuring environmental sustainability and cleanliness in the city. The study revealed the lack of social security, empowerment, and better working conditions, and recognition of their services in the waste management system. The socio-economic status of the pourakarmikas could be improved, leading to an increase in the efficiency of the waste collection, segregation, transportation and disposal processes in Bengaluru city.

Based on the study results, it is concluded that there is no universal solution that can be implemented to achieve sustainable municipal solid waste management. Rather, it necessitates the inclusion of integrated stakeholder involvement, socio-economic consideration, scientific waste processing procedures and proper institutional assistance. Improvements in the efficiency of urban solid waste management systems and a bid towards environmental sustainability in cities like Bengaluru, can be done significantly by implementing decentralized waste management, source segregation, public awareness programs and policies aimed at a specific target group.

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