



Qualitative Investigation on Effectiveness of Municipal Solid Waste Management in Household Perspective

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Abstract—The present study attempts to examine the effectiveness of Household Solid Waste Management of Municipalities. In urban areas, as the commitment of people are too low, the efforts of the State Government and Urban Local Bodies for an organized Solid Waste Management System are not hitting the target. Municipal Solid Waste Management is really a burning issue in state. It is a subject which needs immediate attention of the Government, different agencies and groups of people because of the potential health threats and environmental damage it can cause. In this context, it is considered appropriate to conduct a study on the problems of existing methods of Solid Waste Management of Municipalities in MP and to gather suggestions from the general public regarding the waste management practices of various Municipalities. Being an area, which should be highly prioritized by Government, but currently receiving very little attention, a study based on the effectiveness of Municipal Solid Waste Management is highly relevant. The general objective of the study is to get an overall idea about the waste management practices of Municipalities. Stratified Random Sampling is used for selecting the respondents as Solid Waste Management for the study. The findings of the study show that households are the major contributors of Municipal Solid Waste. Awareness levels regarding waste

management are comparatively better among public.

Keywords:—Solid Waste Management, Waste Management System Effectiveness, Stratified Random Sampling, Statistical Analysis, Factor Analysis, ANOVA.

1. INTRODUCTION

Every human activity creates waste in one form or another. Due to population increase and unplanned urban development, unlike in the past, a slight mismanagement of waste will invariably damage human health and environment. Experts are yet to find out productive solutions to the ever-growing solid waste issues. Most of the technological options put forward for waste treatment and disposal are either impracticable due to many reasons or just transform waste in one form into another. The quantum of waste generation in most of the countries is unmanageably huge and is increasing constantly. In urban areas, issues related to solid wastes are intensified due to high density of population and unplanned development. Especially in developing countries, where resources are limited, waste problems are really burning issues. It seems that the slogan ‘waste generators are responsible for waste treatment and disposal’ has not yet reached the hearts of the people. All success stories of Municipal Solid Waste

Management may be traced to public participation.

1.1 Classification of Solid Wastes

Solid wastes are generally classified as the following on the basis of source of generation, as:

1. Residential

Residential waste refers to wastes from dwellings, apartments, etc., and consists of leftover food, vegetable peels, plastic, clothes, ashes, etc.

2. Commercial

Commercial wastes consist of leftover food, glasses, metals, ashes, etc. generated from stores, restaurants, markets, hotels, motels, auto repair shops, medical facilities, etc.

3. Institutional

Institutional waste consists of paper, plastic, glasses, etc., generated from educational administrative and public buildings such as schools, colleges, offices, prisons, etc.

4. Municipal

Municipal waste includes dust, leaf matter, building debris, treatment plant residual sludge, etc. generated from various municipal activities like construction and demolition, street cleaning, landscaping, etc.

5. Industrial

Industrial wastes mainly consist of process wastes, ashes, demolition and construction wastes, hazardous wastes, etc., due to industrial activities.

6. Agricultural

This mainly consists of spoiled food grains and vegetables, agricultural remains, litter, etc., generated from fields, farms and granaries.

1.2 Role of Stakeholders in Solid Waste Management

Community participation is the key to the success of an Integrated Solid Waste Management System. Stakeholders are the parties who are affected by or involved directly or indirectly in the MSWM system. The following groups are considered to be parties who can play an important role in the system:

Residents' Associations

Being agencies in close contact with residents, these associations can perform significant contributions in the field of MSWM. Definitely, active participation from their part will support and supplement Municipalities in their efforts for a perfect SWM system.

Self-Help Groups

Self-Help Groups like are actively involved in waste collection and treatment, with the support of Municipalities. These types of agencies can play a prominent role in MSWM.

Non-Government Organizations

These form another group involved in waste management. They are making immense contributions in waste collection and treatment of MSW.

Community-Based Organizations

They can also play a very serious role in managing MSW.

Private Companies

Private companies are widely involved in waste collection, treatment and processing. Municipalities do not have the required infrastructure facilities to manage solid wastes. So, the task is often contracted to private companies.

Political Parties

Political parties are capable of influencing people mostly. Being socially oriented groups, they can be involved in campaigning and education programs for SWM.

2. REVIEW OF LITERATURE

Fan et al (2019) used theory of planned behavior (TPB) to construct a “motivation–intention–behavior” theoretical model for the systemic illustration of the antecedents of household solid waste sorting behavior. A comparative study was performed to explore the similarities and differences between the determinants of sorting behavior in Shanghai and Singapore. Findings indicated that general and specific environmental motivations substantially influenced behavioral intention. Moreover, the direct influence and moderating effect of contextual factors on waste sorting behavior are significant. Habitual factors also have a significant effect on behavior.

Meng et al (2019) investigated the decision-making mechanism of residents’ HSW disposal behaviors by merging the theory of planned behavior and the Attitude-Behavior-Condition theory. In this study the main factors that affect residents’ HSW disposal behaviors and their degree of influence were analyzed, followed by discussion on decision-making mechanisms.

Rajesh et al (2019) conducted a choice experiment (CE) survey to determine household preferences for a household waste collection system in Ilam municipality in eastern Nepal. CE is considered reliable and has increasingly been used to elicit preferences for goods and services.

Dehghani et al (2018) carried out an analysis based on macro policies of the municipality in order to optimize the waste collection and transportation system in the city of Bumehen. The data of this research, the average weights, time taken for collection and transportation of municipal solid waste

(MSW) was measured and each of these criteria was calculated and evaluated from environmental and time perspectives under the current management system.

Elimelech et al (2018) presents a new measurement method that offers a solution to quantification of household food waste by measuring daily produced food waste at the household level. This method is based on four main principles: (1) capturing waste as it enters the stream, (2) collecting waste samples at the doorstep, (3) using the individual household as the sampling unit, and (4) collecting and sorting waste daily.

Alex et al (2018) aims to investigate socio-economic effects on recycling behavior in a sample of subsidized rental housing estates. It constitutes an improvement from previous studies by using the entire estate as a unit of analysis and analyzing actual recycling outcomes, which have received limited attention from researchers. Results suggest that recycling outcomes vary with a limited set of socio-economic factors.

Wang et al (2018) uses Probit regression to examine the factors that influence rural residents' solid waste disposal behaviors. The results suggest that the presence of any organized garbage disposal site strongly encourages proper disposal behavior, most commonly at levels of compliance in the 80% and above range. This paper provides practical implication for researchers and policy maker on solid waste management in developing countries.

Mustafa Ali et al (2017) determined the environmental impact of different waste disposal scenarios in a major city of Pakistan. Existing studies on the subject of waste management in Pakistan fail to account for the environmental burden of waste processing technologies. To counter this, in this paper Emergy based accounting procedures to obtain a donor or nature based perspective for environmental foot printing is used.

Bassi et al (2017) quantified the environmental performance in the different countries, in order to analyze the sources of the main environmental impacts and national differences which affect the results. Sensitivity analysis and a data quality assessment identified a range of critical parameters, suggesting from where better data should be obtained. The study concluded that household waste management is environmentally the best in European countries with a minimum reliance on landfilling, also induced by the implementation of the Waste Hierarchy, though environmental performance does not correlate clearly with the rate of material recycling.

2.1 Research Gap

From the review of available literature, it can be seen that, internationally, Solid Waste Management is a highly discussed subject. But, in state, no serious deliberation has been made regarding Municipal Solid Waste Management. All operational areas of MSWM require critical attention to its potential for degrading environment and human health. Most of the Municipalities in the State are currently unable to fulfill their duty to ensure environmentally sound and sustainable ways of dealing with waste generation, and its collection, transport, treatment, and disposal. In this context, it is attempted to study all the operational areas of MSWM, including Waste Collection, Storage, Transportation, Treatment and Disposal. In addition, the Planning, Controlling, Financial and Accounting aspects are also examined. The Awareness Levels of the public are also evaluated. The above said variables are examined by applying appropriate statistical techniques.

2.2 Problem Statement

Failure of efficient delivery of solid waste services could be disastrous. As far as Municipal solid waste is concerned, a major chunk of it emanates from households. Even though people are well aware about the

problems and issues that improper Solid Waste Management can create, they are highly reluctant to participate in the work for a Sustainable Solid Waste Management System.

2.3 Objectives of the Study

The general objective of the study is to get an overall idea about the Solid Waste Management practices of Municipalities. The specific objectives are:

- To study the nature, magnitude and composition of solid waste generated in Municipal limits.
- To have a glimpse into the methods and technologies used for the treatment of solid waste.
- To study the problems faced by the public with regard to management of solid wastes.
- To enquire into the effectiveness of managing solid waste by Municipalities.
- To study the problems confronted by Municipalities with regard to disposal of solid waste.
- To offer fruitful suggestions for improving the existing system of Solid Waste Management by Municipalities.

3. RESEARCH METHODOLOGY

The design of the present study is descriptive and analytical in nature. The study attempts to describe and analyze the effectiveness of Solid Waste Management of Municipalities.

3.1 Data Source

The study requires both primary and secondary data. Secondary data is collected from different published sources of various Government Departments, other Agencies and Municipal Authorities. For the purpose of collecting primary data, the research area is divided into three types, viz., Class-A (High

Population), Class-B (Medium Population) and Class-C (Low Population). Out of the total Municipalities in state, three Municipalities are selected from each type.

3.2 Research Instruments

A well-structured survey schedule was prepared with the objective of getting information from the public relating to the Solid Waste Management practices followed by different Municipalities.

3.3 Population

Population for the study of Solid Waste Management of Municipalities includes all members coming under households dwelling or operating within the Municipal limits who are generating solid waste directly or indirectly.

3.4 Type of Analysis and Statistical Tools

The tools used for analysis of primary data consist of descriptive statistics like Arithmetic Mean, Standard Deviation, and Variance etc. The tools used include ANOVA and Factor Analysis.

3.5 Important terms used

Hazardous Waste

Hazardous wastes refer to wastes that cause or tend to cause adverse health effects on the ecosystem and human beings.

Electronic Waste

Any type of discarded electrical or electronic equipment, devices or parts, can be designated as electronic waste.

Biodegradable Wastes

Biodegradable wastes mainly refer to substances consisting of organic matter such as leftover food, vegetable and fruit peels, paper, textile, wood, etc., generated from various household and industrial activities.

Non-biodegradable Wastes

Non-biodegradable wastes consist of inorganic and recyclable materials such as plastic, glass, cans, metals, etc.

Zero Waste Collection

For the purpose of this study, 'Zero waste collection' means complete absence of waste collection or no waste collection.

Segregation

Segregation in SWM means separation of biodegradable and non-biodegradable waste.

Landfilling

Landfilling generally refers to an engineered deposit of wastes either in pits or trenches or on the surface.

Composting

A composting process is an environmentally sound and beneficial means of recycling organic material and not a means of waste disposal.

Biomethanation

In bio gasification (biomethanation), biogas (a mixture of methane, carbon dioxide, hydrogen and hydrogen sulphide) originates from bacteria in the process of biodegradation of organic material under anaerobic (without air) conditions.

Recycling

Recycling is the most widely recognized form of source reduction involving the process of separating, collecting, processing, marketing and ultimately using a material that would have otherwise been discarded.

Stakeholders

Stakeholders are the parties who are affected by, or involved directly or indirectly in, the MSWM system.

4. DATA ANALYSIS

Table 1: Area wise Waste Profile

Type of Waste	Type of Municipality										
	Class-A			Class-B			Class-C			ANOVA	
	M	SD	N	M	SD	N	M	SD	N	F	Sig.
Kitchen Waste	4.30	2.09	74	5.00	1.21	93	4.62	1.89	73	22.03	0.000
Garden Sweepings	3.66	1.75	74	2.74	1.50	93	2.83	1.58	73	7.85	0.000
Paper Books & Cardboards	3.54	1.36	74	4.69	1.59	93	3.53	1.70	73	15.51	0.000
Plastic, Synthetic fibres	3.20	1.68	74	4.08	1.65	93	3.51	1.88	73	5.51	0.005
Glass, Bulb	1.43	0.70	74	1.62	1.13	93	1.88	1.17	73	3.41	0.035
Rubber, Leather	1.39	0.81	74	1.48	1.05	93	2.00	1.32	73	6.94	0.001
Metal, Cans	1.46	0.89	74	1.46	1.12	93	1.86	1.33	73	3.24	0.041
Clothes	1.81	1.24	74	1.60	1.15	93	2.86	1.92	73	16.92	0.000
Hazardous Waste	1.35	0.71	74	1.24	0.77	93	1.92	1.35	73	11.01	0.000
Electronic Waste	1.28	0.67	74	1.18	0.55	93	1.85	1.15	73	15.21	0.000
Others	1.18	0.60	74	1.30	0.82	93	1.67	1.08	73	6.77	0.001

Table 2: Different Aspects of Awareness of Waste Management

Awareness Regarding	Type of Municipality										
	Class-A			Class-B			Class-C			ANOVA	
	M	SD	N	M	SD	N	M	SD	N	F	Sig.
Consumer Consciousness	3.84	1.51	74	4.12	1.24	93	4.32	1.27	73	5.80	0.003
Need of Education	4.50	1.33	74	4.38	1.73	93	4.12	1.57	73	0.45	0.641
Environmental Impact	4.22	2.38	74	4.46	1.95	93	4.56	2.15	73	3.58	0.029
Health Problem	4.12	1.08	74	3.80	1.35	93	4.26	0.90	73	9.46	0.000
Technologies	3.86	2.68	74	3.77	2.72	93	4.05	3.36	73	1.35	0.260
Fund Contribution	4.62	1.75	74	4.38	1.52	93	3.92	1.47	73	15.36	0.000
Legal Measures	3.94	1.78	74	4.16	2.14	93	3.83	2.28	73	1.75	0.176
Waste Composition	4.15	0.51	74	3.97	0.51	93	3.67	1.19	73	7.80	0.001
Social Impact	4.28	1.55	74	4.14	1.86	93	3.98	2.00	73	14.54	0.000

Table 3: Estimated Means Performance of Municipalities in Waste Disposal System

Waste Disposal Options	Type of Municipality					
	Class-A		Class-B		Class-C	
	M	SE	M	SE	M	SE
Efficiency in Landfilling	3.82	0.32	4.22	0.28	3.88	0.32
Efficiency in Composting	3.64	0.37	4.08	0.33	3.80	0.37
Efficiency in Biomethanation	3.34	0.70	3.66	0.62	4.28	0.70
Efficiency in Recycling and Reusing	4.36	0.61	4.12	0.54	3.98	0.61
Efficiency in use of Latest Technology	3.54	0.52	3.68	0.47	3.94	0.53

Table 4: Estimated Marginal Means – Residents' Association

Dependent Variable	Municipal-ity	Mean	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste Collection (WC)	Class-A	1.351	0.085	1.183	1.519
	Class-B	1.119	0.076	0.969	1.269
	Class-C	1.096	0.086	0.927	1.265
Waste Treatment (WT)	Class-A	1.214	0.064	1.088	1.339
	Class-B	1.013	0.057	0.901	1.125
	Class-C	1.093	0.064	0.967	1.220
Waste Disposal (WD)	Class-A	1.148	0.044	1.061	1.235
	Class-B	1.044	0.039	0.966	1.121
	Class-C	1.040	0.044	0.953	1.128
Campaigning (C)	Class-A	1.081	0.049	0.984	1.177
	Class-B	1.044	0.044	0.958	1.130
	Class-C	1.069	0.049	0.972	1.166

Table 5: Estimated Marginal Means – Involvement of Private Companies

Dependent Variable	Municipal-ity	Mean	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste Collection (WC)	Class-A	1.294	0.076	1.144	1.444
	Class-B	1.120	0.068	0.986	1.254
	Class-C	1.106	0.077	0.955	1.257
Waste Treatment (WT)	Class-A	1.146	0.062	1.024	1.268
	Class-B	1.045	0.055	0.936	1.154
	Class-C	1.106	0.062	0.983	1.229
Waste Disposal (WD)	Class-A	1.240	0.047	1.147	1.334
	Class-B	1.023	0.042	0.940	1.107
	Class-C	1.065	0.048	0.972	1.159
Campaigning (C)	Class-A	1.265	0.077	1.113	1.418
	Class-B	1.036	0.069	0.900	1.172
	Class-C	1.282	0.078	1.129	1.436

Table 6: Estimated Marginal Means – Involvement of Political Parties

Dependent Variable	Municipal-ity	Mean	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste Collection (WC)	Class-A	1.219	0.067	1.087	1.352
	Class-B	1.214	0.060	1.096	1.333
	Class-C	1.005	0.068	0.872	1.139
Waste Treatment (WT)	Class-A	1.217	0.070	1.079	1.354
	Class-B	1.055	0.062	0.932	1.177
	Class-C	1.084	0.070	0.946	1.223
Waste Disposal (WD)	Class-A	1.162	0.038	1.087	1.236
	Class-B	1.055	0.034	0.988	1.122
	Class-C	1.014	0.038	0.938	1.089
Campaigning (C)	Class-A	1.136	0.085	0.969	1.304
	Class-B	1.022	0.076	0.872	1.171
	Class-C	1.290	0.086	1.121	1.459

Table 7: Estimated Marginal Means – Community based Organizations

Dependent Variable	Municipality	Mean	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste Collection (WC)	Class-A	1.253	0.139	0.980	1.527
	Class-B	1.552	0.124	1.308	1.796
	Class-C	1.297	0.140	1.021	1.573
Waste Treatment (WT)	Class-A	1.237	0.071	1.096	1.378
	Class-B	1.218	0.064	1.093	1.344
	Class-C	1.129	0.072	0.987	1.271
Waste Disposal (WD)	Class-A	1.351	0.122	1.112	1.591
	Class-B	1.283	0.108	1.069	1.496
	Class-C	1.300	0.122	1.059	1.542
Campaigning (C)	Class-A	1.486	0.166	1.159	1.814
	Class-B	1.874	0.148	1.582	2.166

Table 8: Estimated Marginal Means – Self-Help Groups

Dependent Variable	Municipality	Mean	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste Collection (WC)	Class-A	2.330	0.195	1.946	2.714
	Class-B	2.581	0.174	2.239	2.924
	Class-C	1.300	0.196	0.913	1.686
Waste Treatment (WT)	Class-A	1.931	0.152	1.630	2.231
	Class-B	2.164	0.136	1.897	2.432
	Class-C	1.302	0.154	1.000	1.605
Waste Disposal (WD)	Class-A	1.928	0.149	1.635	2.222
	Class-B	1.372	0.133	1.110	1.634
	Class-C	1.247	0.150	0.951	1.542
Campaigning (C)	Class-A	2.003	0.143	1.720	2.285
	Class-B	1.147	0.128	0.895	1.400
	Class-C	1.180	0.144	0.895	1.464

Table 9: Estimated Marginal Means – Non-Government Organizations

Dependent Variable	Municipality	Mean	SE	95% Confidence Interval	
				Lower Bound	Upper Bound
Waste Collection (WC)	Class-A	1.268	0.070	1.130	1.405
	Class-B	1.130	0.062	1.008	1.253
	Class-C	1.065	0.070	0.927	1.204
Waste Treatment (WT)	Class-A	1.172	0.066	1.043	1.302
	Class-B	1.024	0.059	0.909	1.140
	Class-C	1.174	0.066	1.044	1.305
Waste Disposal (WD)	Class-A	1.254	0.064	1.129	1.379
	Class-B	1.034	0.057	0.923	1.146
	Class-C	1.066	0.064	0.940	1.192
Campaigning (C)	Class-A	1.160	0.079	1.004	1.315
	Class-B	1.024	0.070	0.885	1.162
	Class-C	1.327	0.079	1.170	1.483

4.1 Factor Analysis

Table 10: Significant Loadings of Variables on Varimax Factor 1

F.N.	Problems	Loading
8	Inadequacy and insufficiency of waste collection equipment	0.605
10	Water pollution	0.873
11	Air pollution	0.854
14	Noise Pollution	0.664
15	Odour from waste dumps/ landfills	0.789
16	Diseases and health problems	0.842
20	Improperly maintained landfills	0.779
21	Littering and unsanitary conditions around waste bins, waste dumps and landfills	0.853
23	Lack of professionalism in SWM	0.748
26	Improper complaint management and complaint redressal	0.526
27	Excess service fee	0.746

Table 11: Significant Loadings of Variables on Varimax Factor 2

F.N.	Problems	Loading
2	Untimely waste collection	0.700
4	Unexpected stoppage of waste collection and disposal	0.802
5	Deteriorated waste collection service quality	0.893
6	Inadequate number of community bins	0.703
7	Distance of collection point/ community bin	0.790
9	Out-dated equipment	0.740

Table 12: Significant Loadings of Variables on Varimax Factor 3

F.N.	Problems	Loading
12	Dust	0.826
13	Smoke & Fumes	0.817
24	Attitude of waste collection workers	0.671

Table 13: Significant Loadings of Variables on Varimax Factor 4

F.N.	Problems	Loading
18	Environmental degradation	0.809
19	Soil quality deterioration	0.854
28	Insufficiency of public campaigning efforts	0.690

Table 14: Significant Loadings of Variables on Varimax Factor 5

F.N.	Problems	Loading
1	Lack of waste collection service coverage	0.567
3	Absence of door to door collection	0.686
17	Floods due to blocked drains followed by diseases	0.640
22	Scavenging animals makes the surroundings of waste dumps unhealthy	0.599

Table 15: Significant Loadings of Variables on Varimax Factor 6

F.N.	Problems	Loading
25	Lack of support from Govt. and other bodies	0.709

Table 16: Significant Loadings of Variables on Varimax Factor 7

F.N.	Problems	Loading
29	Private participation makes SWM irresponsible	0.852

Two independent problems without any affiliation and not sharing any common features with one or more of the problems are traced out in Factor Analysis and represented in Table 15 and 16 termed Factor 6 and Factor 7, under 'Support from Government' (SFG) and 'Private Participation' (PP).

5. RESULTS AND CONCLUSION

In this study, the effectiveness of Solid Waste Management of Municipalities is examined.

5.1 Involvement of Other Agencies in Municipal Solid Waste Management

Variations in the four variables, namely, Waste Collection, Waste Treatment, Waste Disposal and Campaigning as a bundle are

evaluated, to test the statistical significance. The variation in the observed mean score in this regard is statistically significant as $p < 0.05$ in all cases except private companies.

A. Residents' Associations

1. Municipalities belonging to Class-B perform better in Waste Collection and Campaigning.
2. Class-A performs better in Waste Treatment and Waste Disposal Practices.

B. Political Parties

1. Municipalities belonging to Class-A perform better in Waste Collection, Waste Treatment and Waste Disposal Practices.
2. Class-C performs better in Campaigning Practices.

C. Community-Based Organizations

Class-A performs better in Waste Collection, Waste Treatment and Waste Disposal practices.

Class-C performs better in Campaigning practices.

D. Self-Help Groups

1. Class-B performs better in Waste Collection and Waste Treatment Practices.
2. Class-A performs better in Waste Disposal and Campaigning practices.

E. Non-Government Organizations

1. Regarding Waste Collection and Waste Disposal practices, Class-A performs better.
2. Municipalities belonging to Class-C perform better in Waste Treatment and Campaigning.

The Private Companies' performance in Waste Collection, Waste Treatment, Waste Disposal and Campaigning practices of Solid Waste Management seems to be not different in the selected Municipalities.

6. CONCLUSION

1. The majority of the households selected for the study have a monthly income of less than 30000.
2. While considering Components of MSW, the presence of Plastic, Paper and Compostable is found to be at higher levels, while the presence of Cardboard, Glass, Metal, Hazardous Waste, Electronic Waste and Construction & Demolition Waste is at lower levels.
3. Awareness levels regarding waste management are comparatively better in all groups of the public.
4. Majority of respondents are not getting any type of waste collection system from Municipalities or other agencies.
5. The study evaluated the Waste Treatment options used by Municipalities and found that advanced treatment options like, Refused Derived Fuel and Recycling are not used by any Municipality.
6. Through Factor Analysis, seven factors are identified. Through a Factor Analysis, twenty-nine potential problems faced by Municipalities are reduced to six underlying factors.
7. It is concluded that the Complaint Management System of the majority of the Municipalities is ineffective.

6.1 Limitations of the Study

1. The population for the study is large and heterogeneous.
2. During data collection from experts, it is revealed that except a few of them have very little knowledge regarding the financial, accounting and technological aspects.

6.2 Scope for Further Research

We have to believe in sustainability, and that any development should not be at the cost of security for the coming generation. In this context, the following topics will be suitable for further research in the area of SWM:

1. Hazardous Waste Management
2. Electronic Waste Management
3. Biomedical Waste Management
4. Solid Waste Management in Rural Areas of the State.

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