Case Study on Solid Waste Management in 8 Urban Local Bodies of Hassan District and Improvements Recommended under Swachh Bharat Mission Project

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ABSTRACT:
Managing municipal solid waste has become one of the major issues of urban administration. More and more Urban Local Bodies (ULBs) bodies are facing problems in properly managing solid waste. The present paper is about case studies on Solid Waste Management (SWM) in ULBs of Hassan district, Karnataka state (India). Hassan district is located in the Malnad and plain regions of state, the ULBs of the district have total population of around 3,47,037 generating total solid waste of around 145 tonnes per days with per capita waste ranging from 0.36 to 0.45 Kg per day. The solid waste collection efficiency in Hassan district ULBs is in the range of 79 to 95%. This paper represents existing solid waste management scenario of 8 ULBs of Hassan district and proposed improvement in terms of required resources and infrastructure as part of the Swachh Bharat Mission (SBM) to meet the SWM Rules 2016 and best practices.

Keywords: Hassan, Solid Waste Management (SWM), Swachh Bharat Mission (SBM), Urban Local Bodies (ULBs).

INTRODUCTION:

Increasing population in cities and improvement in quality of lives are resulting in increased generation of Solid Waste. Karnataka has urban population of 38.67% (Meghana and Roy, 2018). Total solid waste generation in urban areas of Karnataka is 11958 tonnes per day (TPD) Central Pollution Control Board (CPCB) Annual Report, 2018-19).Hassan district is one of the 30 districts in Karnataka, the district lies partly in the Malnad tract and partly in the southern maidan (plain) tract (District Census Handbook, 2011). Hassan district is urbanizing rapidly, growing fastest in Mysore division with Urban Rural Growth Difference (URGD) of 2.25 which is more than India's and Karnataka state's URGD rate of 1.6 and 2.03 respectively for the decade 2001-2011 (Meghana and Roy, 2018). Solid waste management in India is a major problem for most of the Urban Local Bodies (ULBs) irrespective of the population and size due to increasing environmental pollution concerns, aesthetic concerns and resource crunch (Deepak Choukanpally et al. 2020). In this paper, existing solid waste management practices of Hassan district ULBs are highlighted based on the work carried out by the Tata Consulting Engineers Limited (TCE) from 2015-2018. The project is as part of 'Swachh Bharat Mission' of central government. The solid waste management practices of Hassan district ULBs are discussed along with the proposal made as part of the project under Swachh Bharat Mission. The details of the Hassan district ULBs are given in Table 1. The ULBs map of Hassan district is given in Figure 1.

Table 1: Salient details of Hassan district

Population	17,76,421 3,76,763 (Urban Population around 21.21%)
Literacy Rate	76.06%
Urban Local Bodies	City Municipal Corporations (CMC) -2 nos. Town Municipal Corporations (TMC) -4 nos. Town Panchayats (TP) – 2 nos.
Per Capita income (2013-14)	Rs. 1,05,361

Source: 1.District Census Handbook, Part A and 2. Economic Survey of Karnataka 2015-16.

Figure 1: Hassan District Map with ULBs

SOLID WASTE GENERATION:

There is generation of around 145 TPD of solid waste from the ULBs of Hassan district as per the study conducted in 2016 by TCE. Hassan CMC generates highest waste of around 63 TPD and Alur TP generates lowest of 2.5 TPD. Per capita waste generation 0.36 Kg per capita per day (Arkalgud TP) to 0.45 Kg per capita per day (Channarayapatna TMC). The per capita waste generation of the ULBs is higher than CPCB assessment (CPCB, 2006) carried out for towns and cities with similar population, this can be because of increased rate of urbanization in Hassan district. As per studies, waste generation rate in Indian cities ranges between 200-870 grams/ day, depending upon the region's lifestyle and the size of the city (Annepu, 2012). The trend of waste generation in larger ULBs (i.e. TMC and CMC) is slightly higher than TPs.

The details of waste generation of all 8 ULBs are given in Table 2.

Table 2: Waste Generation of ULBs of Hassan District

Name of ULBs	Population as per 2011 census	Solid Waste Generation in TPD	Per capita waste generation (Kg/day)
Alur TP	6541	2.5	0.38
Arkalgud TP	16807	6	0.36
Arasikere CMC	53216	24	0.45
Belur TMC	21595	8	0.37
Channarayapatna TMC	40440	18	0.45
Hassan CMC	155006	63	0.41
Holenarasipura TMC	30080	13	0.43
Sakaleshapura TMC	23352	10	0.43
Total/ Average	**347037**	**144.5**	**Average=0.41**

Note: TP: Town Panchayat, TMC: Town Municipal Council, CMC: City Municipal Council[1],

[1] TPs are with population >15000-20000, TMCs : 20000-50000, CMC: population >50000.

COLLECTION AND TRANSPORTATION:

Solid waste collection and transportation is one of the important aspects of the solid waste management. Solid Waste is collected daily in all ULBs of Hassan district both from residences and commercial establishments. Average collection efficiency in ULBs of the district is around 84%, with the lowest of 79% in Channarayapatna TMC to highest of 95% in Hassan CMC, as per the MoUD report (2011) solid waste collection efficiency ranges between 70-90% in larger cities and less than 50% in smaller cities (Shyamala Mani, et al. 2015). Solid waste collection efficiency of all the ULBs of Hassan district is depicted in the Figure 2. The collection efficiency not being 100% can be attributed to lesser manpower and vehicles and missing out of outskirts of ULBs. It is observed that to achieve the higher collection efficiency, most of the staff and vehicles are working more than 5-6 hours for collection of waste covering 2-3 rounds of the designated areas of the towns.

Solid waste collection is done manually by collection workers and transportation of solid waste is done by using Auto tippers and Tractors in all the ULBs. The waste is transported daily to the processing and disposal site from the ULBs.

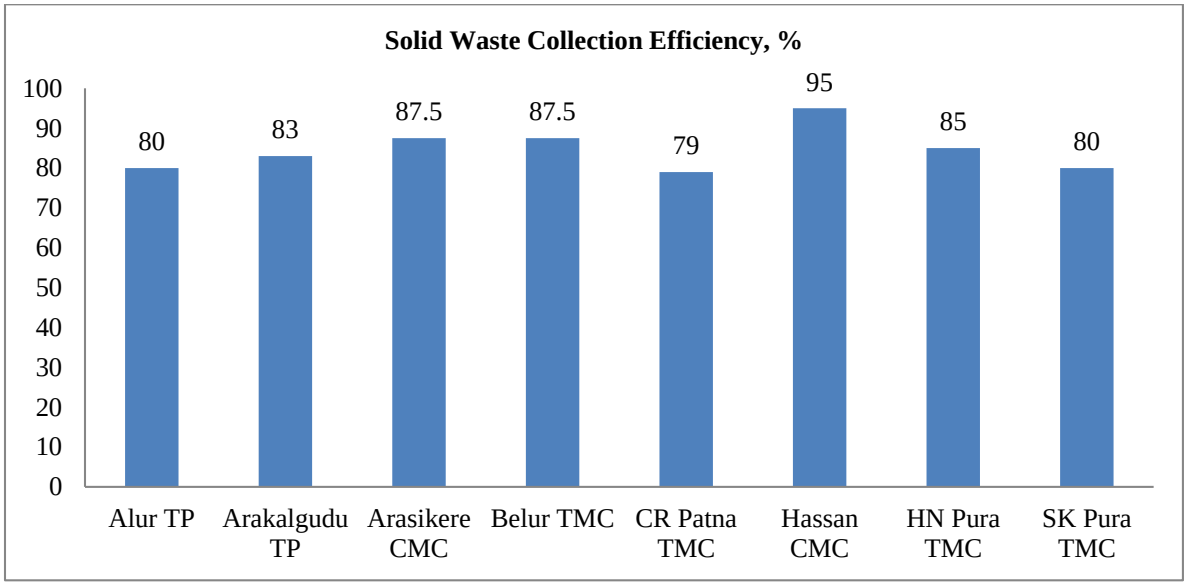

Figure 2: Solid Waste Collection efficiency in ULBs

PHYSICAL COMPOSITION OF SOLID WASTE:

The physical characterization of the municipal solid waste was carried out by collecting samples from Lower Income Group (LIG), Middle Income Group (MIG) and Higher Income Group (HIG) covering all social strata of ULBs along with fruits and vegetable markets and commercial areas. The waste was categorized as Organic waste, Cloths/ rag, Paper, Plastic and Inert wastes. The physical composition indicates around 54% waste as organic/ biodegradable waste, 22.81% plastics, 10.94% paper, 10.28% glass and inerts and 2.1% cloths and rags. The physical composition of the waste is in line with the various similar studies carried out (Kapil Dev Sharma et al. 2019, Ramachandra T.V et al. 2014, Deepak Choukanpally et al. 2020).

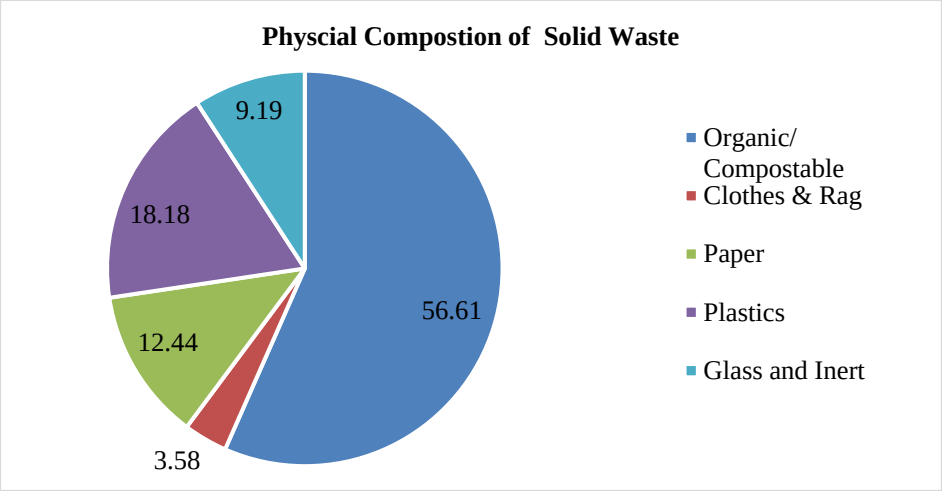

Figure 3: Physical composition of solid waste in Hassan district ULBs

PROCESSING AND DISPOSAL:

Open dumping of solid waste is predominated practice in the ULBs of Hassan district, this is due to shortage of workers, inadequate equipment and resources at processing and disposal sites and absence of civil infrastructure at site. In Indian cities and towns, over 81% of MSW annually is disposed at open dump sites without any treatment (Planning Commission Report, 2014).

Sakaleshapura TMC has practiced decentralized organic waste processing for 2013-15, but it was discontinued later.

All the ULBs are having own processing and disposal sites and in operation, the site belonging to Sakaleshapura TMC is not in operation due to public opposition. Existing processing and disposal infrastructure present with the ULBs are given in the table below.

Table 3: Details of Existing Processing and Disposal Sites

Sr. No.	Name of ULBs	Area of P & D Site (in Acres)	Facilities at P&D Site
1.	Alur TP	4.00	i.Waste receiving shed ii.Sanitary Landfill
2.	Arakalgudu TP	2.00	i. Waste receiving shed ii.Compost pits
3.	Arasikere CMC	15.00	i.Waste receiving shed ii.Windrow shed
4.	Belur TMC	5.06	i. Waste receiving shed ii. Windrow Platform iii. Vermi-compost pit shed
5.	Channarayapatna TMC	21.00	i.Waste receiving shed ii.Vermi Compost pits iii.Anaerobic leachate pond
6.	Hassan CMC	22.06	i. 40T Weigh bridge & Control room ii.Workers rest room iii.Waste receiving platform iv. Anaerobic leachate collection pond v.Sanitary Landfill
7.	Holenarasipura TMC	7.34	i. Workers rest room ii. Waste receiving shed iii. Dry waste shed
8.	Sakaleshapura TMC	11.00	i. Waste receiving platform ii. Compost pits

IMPROVEMENTS RECOMMENDED:

With a 3 months field visit to assess the ground conditions of the solid waste management in all the ULBs covering the collection vehicles, routes of collection and transportation, vehicles conditions, manpower for all SWM activities, solid waste processing and disposal practices and discussions with the ULB officials, improvements are recommended in-terms of required civil infrastructure, vehicles, equipment and additional manpower in overall solid waste management activities involving collection and transportation and processing and disposal.

Following sections give details of the improvement suggested/ provisions made under this project. The details are divided in civil infrastructure, vehicles and equipment and manpower. All the provisions are made after assessing the conditions at site in ULBs and as per the Normative Standards of Government of Karnataka and directions of Directorate of Municipal Administration (DMA).

Vehicles for door to door collection and transportation

Solid waste collection and transportation accounts almost 80-90% of the entire SWM expenditures of ULBs (Kapil Dev Sharma, 2019). The ULBs of Hassan district are having existing fleet of vehicles from their ULB fund and some ULBs have combination of own and outsourced agencies' vehicles. In order to achieve the 100% coverage in ULBs vehicles needs to increase from the existing numbers. Recommendations done to improve the door to door solid waste collection and transportation by adding vehicles are given in Table 4.

Table 4: **Improvements proposed in primary door to door collection**

Name of ULBs	Existing (A)	Proposed (B)	Additional requirement (B-A)
Alur TP	1	2	1
Arakalgudu TP	3	5	2
Arasikere CMC	9	14	5
Belur TMC	5	6	1
Channarayapatna TMC	0*	10	10
Hassan CMC	37	12#	25
Holenarasipura TMC	7	2	5
Sakaleshapura TMC	6	3	3##

Note: 1. *At present 5 nos. of collection vehicles are provided by Self Help Groups (SHGs), hence they have been considered in the calculations.

2. The vehicles proposed are 3 m^3 capacity with partition for dry and wet waste. The vehicles proposed are 4 wheeler likes of Tata Ace and Mahindra with hydraulic system.

Separate 2 nos. of collection vehicles are provided for meat waste collection in Hassan CMC for collecting waste from chicken, mutton and fish stalls.

Since Sakaleshapura lies in Ghat (hilly) region, the vehicles proposed are heavy duty with the types of Mahindra Bolero pickup for ease in vehicle movement in hilly regions and to reduce the frequent breakdowns.

3. Each collection vehicle is provided for 1200-1300 households/ shops.

4. The vehicles are proposed for the year 2017 and vehicles life expectancy is assumed 7 years.

5. Vehicles are proposed to cover the entire population of the ULBs to achieve 100% collection efficiency

6. ULBs like Channarayapatna and Hassan which are having commercial establishments/ shops more than 1000 have been provided with separate vehicles. The vehicle numbers provided above are inclusive of commercial waste collection vehicles.

7. In Channarayapatna and Hassan ULBs Refuse compactors are provided for secondary transportation as the processing and disposal (landfill) sites are far (more than 10 km) from the ULBs.

Equipment for solid waste processing

The ULBs have purchased the equipment and units required for the solid waste processing with the funds of 13th and 14th finance commission. However, these equipment are purchased without any scientific logic. In order to process the incoming solid waste

properly, various equipment and units are proposed in the project, the details are given in Table 5. Sanitary napkin/ diaper waste disposal is emphasized by providing sanitary napkin incinerators.

Table 5: **Improvements proposed in processing equipment**

ULBs	Hopper with conveyor belt (Nos.)		Baling Unit (Nos.)		Compost Screening Machine (4 mm) (Nos.)		Compost Screening Machine (16 & 40 mm each) (Nos.)		Sanitary Napkin Incinerator (Nos.)		Weighbridge (Nos.)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
Alur TP	0	1	0	1	0	1	0	0*	0	1	0	0
Arkalgud TP	0	0	0	1	0	1	0	0*	0	1	0	0
Arasikere CMC	0	1	0	1	1	0	0	2	0	2	0	1
Belur TMC	0	1	0	1	0	1	0	1(40 mm)	0	2	0	1
Channarayapatna TMC	0	1	0	1	0	1	0	1(40 mm)	0	2	0	1
Hassan CMC	0	1	0	2	1	0	0	2	0	2	1	0
Holenarasipura TMC	0	1	1	0	1	0	0	1(40 mm)	0	1	0	1
Sakaleshapura TMC	0	1	0	1	0	1	0	1(40 mm)	0	1	0	1

Note: * 1. Since Alur and Arakalgudu ULBs have waste generation less than 5 tons per day, it was considered not to provide 40 Screening machine/ Trommels and weigh bridge to reduce the operation & maintenance costs.
2. Weighbridge are not provided in Alur and Arakalgudu ULBs for the aforementioned reason.
3. All the ULBs are given sanitary napkin incinerators to reduce the disposal of napkins in the landfills and to reduce infection to workers involved in SWM activities.

Civil infrastructure for solid waste processing and disposal

With the implementation of Municipal Solid Wastes (Management & Handling) Rules, 2000 (MSW Rules) and as per Karnataka State Policy on Integrated Solid Waste Management, 2004, all the ULBs have own processing and disposal site with civil infrastructures like windrow processing sheds, compound wall, internal roads, electricity connection, water facility, workers rest rooms, security cabin etc., however the processing and disposal infrastructure (processing shed) provided are not sufficient to treat the present waste generation. Processing technology recommendations are made in order to maintain the continuity with existing solid waste processing i.e. windrow technology. Conventional windrow composting technology is adopted/ continued, which doesn't require technically skilled manpower and has lower O&M costs. To enable ULBs to process the projected quantum of solid waste generation as per the SWM Rules, 2016, following improvements are proposed in processing and disposal sites.

Table 6: **Improvements proposed in civil processing infrastructure**

ULBs	Processing shed including Windrow platform area (sq. m)		Sanitary landfill area (sq. m)		Anaerobic and Aerobic Leachate collection tanks (Nos.)	
	Existing	Proposed/ additional	Existing	Proposed/ additional	Existing	Proposed/ additional
Alur TP	225	150	1500*	0	0	2
Arkalgud TP	216	200	0	2200	0	2
Arasikere CMC	900	1000	0	4250	0	2
Belur TMC	954	150	0	2500	0	2
Channarayapatna TMC	1200	1500	0	3600	1#	1
Hassan CMC	1125	5000	4725*	0	1#	1
Holenarasipura	1200	1500	0	2000	0	2

ULBs	Processing shed including Windrow platform area (sq. m)		Sanitary landfill area (sq. m)		Anaerobic and Aerobic Leachate collection tanks (Nos.)	
	Existing	Proposed/ additional	Existing	Proposed/ additional	Existing	Proposed/ additional
TMC						
Sakaleshapura TMC	1000	500	0	1400	0	2

Note: * Alur and Hassan ULBs are having existing recently constructed sanitary landfill, hence no additional landfill is proposed in the study.
Channarayapatna and Hassan ULBs have anaerobic leachate collection pond, hence no additional units are proposed.

Manpower for solid waste collection, transportation and processing

At present, majority of the manpower is employed in street sweeping and solid waste collections in the town areas, the ULBs are having negligible presence of manpower in processing and disposal sites and this is affecting the processing of solid waste in all the ULBs. The processing and disposal sites have become open solid waste dump sites without processing. The manpower involved is mix of government employees/ workers and outsourced workers for carrying out SWM activities including street sweeping, solid waste collection, loader for collection, drivers etc., In this project, a detailed analysis is done to find out the number of manpower required for each activities and human resource is allocated/ rearranged so as to effective implementation of SWM activities and also to reduce the financial burden on ULBs.

In India, most sanitation workers are deployed without proper fixation of norms. In some states, four workers are appointed per 1,000 populations, in other states, one worker is assigned per 500 meters of road length (World Bank Institute, 2008). CPHEEO Manual on MSWM, 2016 also doesn't provide any guideline for manpower based on population, it has manpower guidelines for street sweeping, collection and transportation but not based on the population. In this project, as per the Karnataka state government order, 1 worker is engaged for every 700 population, for activities like street sweeping, solid waste collection, loading and processing (workers who are in handling of solid waste) in ULBs. This doesn't include workers engaged in driving of collection and transportation vehicles.

Table 7: **Improvements proposed in manpower**

Name of ULBs	Existing (A)	Proposed (B)	Additional requirement (B-A)
Alur TP	12	15	3
Arakalgudu TP	54	33	-21*
Arasikere CMC	111	99	-12*
Belur TMC	44	43	-1*
Channarayapatna TMC	68	76	8
Hassan CMC	214	258	44
Holenarasipura TMC	66	56	-10
Sakaleshapura TMC	49	47	-2

Note: * Arakalgudu, Arasikere and Belur ULBs were having manpower more than the required, hence the ULBs asked to reduce the manpower.

1. The above manpower includes the workers for street sweeping, solid waste collection, loaders, drivers, processing site workers.

2. As per the Karnataka state government order, 1 worker is engaged for every 700 population for activities like street sweeping, solid waste collection, loading and processing (workers who are in handling of solid waste) in ULBs. This doesn't include workers engaged in driving of collection and transportation vehicles.

FINANCIAL ANALYSIS:

The capital investment required for proposed infrastructure to improve the SWM facilities and operation and maintenance cost required for sustainable SWM for the ULBs are given in table below.

Table 8: Financial analysis of SWM Cost

Sr. No.	ULBs (A)	Population 2011 (B)	Total Capital Investment Cost in Rs. Lakhs (C)	Per capita capital cost for SWM in Rs. (D) = C/B/100000	Total &M Cost per year in Rs. Lakhs (E)	Per capita O&M cost for SWM per year in Rs. (F) = E/B/100000
1.	Alur TP	6541	71.77	1097.23	31.54	482.19
2.	Arakalgudu TP	16807	127.79	760.34	84.28	501.46
3.	Arasikere CMC	53216	291.09	547.00	267.52	502.71
4.	Belur TMC	21595	150.07	694.93	111.38	515.77
5.	Channarayapatna TMC	40440	333	823.44	206.59	510.86
6.	Hassan CMC	155006	590.08	380.68	695.16	448.47
7.	Holenarasipura TMC	30080	266.56	886.17	138.96	461.97
8.	Sakaleshapura TMC	23352	281.75	1206.53	126.86	543.25

It is seen that the per capita capital investment cost is ranging from Rs. 380.68 in Hassan ULB to Rs. 1206.53 in Sakaleshapura ULB. The lower capital cost requirement in Hassan ULB is due to newly set up sanitary landfill site, weighbridge, processing sheds and anaerobic leachate collection tank and higher population among all the ULBs. The higher capital cost in Sakaleshapura is attributed to provision of all new processing facilities like processing sheds (waste receiving and windrow), sanitary landfill, aerobic and anaerobic leachate collection tanks and weighbridge etc., The capital cost doesn't include the land purchase cost.

O&M cost per capita ranges from Rs. 448.47 in Hassan ULB to Rs. 543.25 in Sakaleshapura ULB.

The capital investment cost per capita is in the range of Rs. 900 (Planning Commission Report, 2014) and lesser than the Rs. 1200 (Swachh Maharashtra Mission Handbook, 2016). However, O&M costs are higher than the mentioned Rs. 269 per capita per year (Planning Commission Report, 2014), this can be due to consideration of salaries of existing government workers sweepers/ health officers/ environmental engineers' salaries engaged in SWM activities in the O&M cost.

The capital cost and O&M costs are higher for ULBs with lesser population and lower for ULBs with comparatively higher population.

This financial data underline the need of exploring centralized processing and disposal of municipal solid waste in order to save the land cost, equipment cost and labor cost.

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