Solid Waste Management of Srinagar City

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Abstract: Solid waste management is emerging as a big environmental issue in the world and Srinagar city is no exception. The current status of solid waste management is poor because the best and most appropriate methods from waste collection to disposal are not being used. The increasing generation of solid waste and its inadequate management is affecting the scenic beauty of this historic place. As the management is done through traditional and obsolete methods the city is facing acute environmental degradation and visual pollution. The aim of this study is to study the collection and transportation system of Municipal Solid Waste in the city. The study reveals that there is acute absence of waste segregation at the source hence all types of materials are being disposed along with municipal solid waste which make waste handling very risky. Solid waste is being collected manually by the help of sweepers. They are normally using wheel borrows, hand carts for the collection of solid waste from the streets. At most of the collection locations solid waste containers are not available and the solid waste is dumped on ground. The generated solid waste from these locations is being collected by the help of open body vehicles irregularly. Storage containers are not compatible with the existing system. It was also observed during the investigation that number of containers and collection vehicles are not sufficient to handle the generated waste. The collection process is deficient in terms of manpower and vehicle availability. Bin locations were found to be inappropriate, thus contributing to the inefficiency of the system. Lack of suitable facilities (equipment and infrastructure) and underestimates of waste generation rates, inadequate management and technical skills, improper bin collection, and route planning are responsible for poor collection and transportation of municipal solid wastes. The lack of governance and inadequate infrastructures are the major constrains in designing a suitable MSW management plan of the city.

Keywords: Collection, Transportation, Municipal solid waste, Waste management.

1. Introduction

Srinagar, the summer capital of the state of Jammu and Kashmir in India, is situated in the western part of the state of Jammu and Kashmir and is in the northern region of India. Srinagar is located at 34º 8´ N, 74º 83´ E, 1730 m above sea level. Temperatures in Srinagar range from 10º to 30º (Celsius) during summer and -1º to 7º (Celsius) during winters and average annual rainfall in Srinagar is 650 mm. The city lies on both banks of the Jhelum River, a tributary of the Indus River. The city is famous for its lakes and houseboats floating over them. Tourism is the most significant segment of the city's economy. The city of Srinagar has been serving as a gateway to some of the most scenic and beautiful places of the Indian subcontinent.
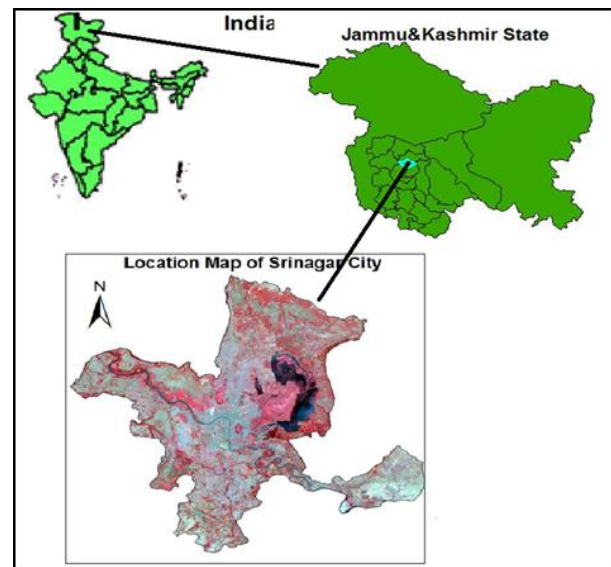

Fig. 1. Location of Srinagar City

Srinagar has a land area of approximately 279 Sq. Kms with a population of 12.03 lacs. Over the past two decades, MSW generation in Srinagar has increased tremendously from 180 tons in 1981 to 530 tons in 2011. This is largely as a result of rapid population growth and economic development in the country. The daily per capita generation of municipal solid waste in India ranges from about 100 g in small towns to 500 gm in large towns and in Srinagar it is 271 gm [1]. As per 2011 the city generated about 511 MT of solid waste per day while as around 260 MTs is being collected every day which is around 50 percent of the generated waste. However, the door to door collection facility has increased from only 23 percent in 2001 to 31 percent in 2011 to 60% in 2018. As per Solid Waste Management rules there should be 100% door to door waste collection. The generation of solid waste is growing in Srinagar due to growing population and inclusion of new areas. The city administration has been decentralized in 34 administrative wards with a total of 68 electoral wards in the city. Annexure 1 shows general ward wise information pertaining to area, population, generation, and shortage in each electoral ward of Srinagar City.

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11

Table 1
Status of solid waste

Particulars	Year		Year
Solid Waste	2001	2011	2014
Average generation (tons/day)	390	511	530
Average collection (tons/day)	234	260	382
Door –to-door collection	23	31	50

Source: Srinagar Municipal Corporation

Solid waste needs to be managed in a sustainable way to reduce the overall burden on the environment. Solid waste management (SWM) is the major problem for many urban local bodies (ULBs) in India, as urbanization, industrialization and economic growth have resulted in increased municipal solid waste (MSW) generation per person [2]. The waste generation is growing with rapid urbanization and resultant population growth. The census population of Srinagar city, population projections, and waste generations details has been described in the table.

Table 2
Projected Population and waste generation

Year	Projected population	Expected waste generation (MT/day)
2006	11,37125	335.00
2011	12,99,924	411.00
2016	14,85,187	506.00
2021	17,04757	627.00
2026	19,49,980	771.76

Source: Sector Project for Infrastructure Rehabilitation in J & K

There are serious deficiencies in solid waste Management in Srinagar. Srinagar Municipal Corporation is responsible for collection, transportation, treatment and disposal of solid waste [3]. Effective solid waste Management is the major challenge of this city as there is no segregation of waste at source. There is an urgent need to move to more sustainable solid waste Management, and this requires new management systems and waste management facilities. Current solid waste Management system is inefficient; having a negative impact on public health, the environment and the economy. MSWM encompasses planning, engineering, organization, administration, financial and legal aspects of activities associated with generation, storage, collection, transfer and transport, processing and disposal of municipal solid wastes in an environmentally compatible manner adopting principles of economy, aesthetics, energy and conservation. MSWM involves activities associated with generation, storage and collection, transfer and transport, treatment and disposal of solid wastes however in most Indian cities the SWM system comprises only four activities, i.e., waste generation, collection, transportation, and disposal. Poor collection and in adequate transportation causes the accumulation of municipal solid waste at every nook and corner.

The waste management system should be based on the current as well as future quantities and characterization of wastes to determines the appropriateness of different waste management and treatment options.

The management of MSW is going through a critical phase,

due to the unavailability of suitable facilities to treat and dispose of the larger amounts of MSW generated daily in metropolitan cities. Adverse impact on all components of the environment and human health occurs due to unscientific disposal of MSW.

Table 3
Demand-Supply Gap Assessment (in metric tons)

Estimated SWM Particular	2011 Current Level	2021 Demand	Gap	2032 Demand	Gap
Population	1192792	1555675	-	2090685	-
Total Generation	396	598	202	816	218
Total Collection	250	598	348	816	218

Source: Draft Master Plan for Srinagar Local Area 2012 – 2032

2. Waste collection

Waste collection is a critical component to waste management. The economic and environmental performance of the entire system can be impacted by the way that materials are collected and sorted. The collection point is an interface where waste generators and waste collectors meet and thus must be carefully managed if the system is to be effective.

Waste generators require waste collection with minimal inconvenience, while collectors must be able to collect waste in a way that is compatible with the planned treatment and processing methods if the waste management system is to be sustainable. The collection is very complex, difficult and costly process. Collection of solid waste typically consumes 60-80 per cent of the total solid waste budget of a community. Therefore, any improvement in the collection system can reduce overall cost significantly [4]. The collection practice adopted lacks "Segregation at source"- a practice mandated by SWMR 2016. Segregation is key to efficient solid waste management system as it separates out waste on the basis of its nature and characteristics, thus forming an important aspect that ensures efficient transportation, processing and treatment of waste.

A. Primary collection

The waste collection by Srinagar Municipal Corporation is very unorganized and unscientific. The vehicles used for primary collection at domestic level are wheel barrow, handcarts and tricycles. In the core areas of the city where the lanes are narrow only handcarts are used whereas in the outer areas, Hopper vehicles and tricycles are used. The wheel barrows and handcarts used by safai karamcharis are not maintained properly hence efficiency is reduced. Present design of handcarts is defective as the wheels of the cart are small and equipment is un-containerized. The capacity of the metallic handcart is only 28 kg and of wooden is 60 kg which are on lesser side; therefore, more number of trips is required for optimum efficiency [5]. These carts are not compatible with dustbins hence requires multiple handling and are unable to carry more waste. The sweeping and cleaning of city is done on the basis of a Single-tier system by forming "beats". In each beat there is one sanitation worker. Total numbers of sanitation

workers in 68 wards are 1041 and the total number of such "beats" in Srinagar city is about 2185.

Fig. 2. Handcart is not synchronized with secondary storage

The requirement of workers, tricycles and storage bins has not been calculated as per the actual requirement. There is also shortage of sweepers in the city. As per the requirement there should be 3751 workers but there are only 1041 safaikaramcharis. There is a total of 783 tricycles but for efficient solid waste management there should be 902 tricycles in the city and hence a shortage of 119 tricycles is there. Due to the shortage of workers and handcarts the area does not get cleaned daily as the shortage affects the performance of sweeper. Specifically shops / markets and other establishments, which normally start business after 9:30–10:00 AM and timing, do not synchronize with the work schedule of the sweepers, as by this time most of the collection procedure is over. Waste from these business communities again accumulate on streets and road as a result of which the city does not appear clean.
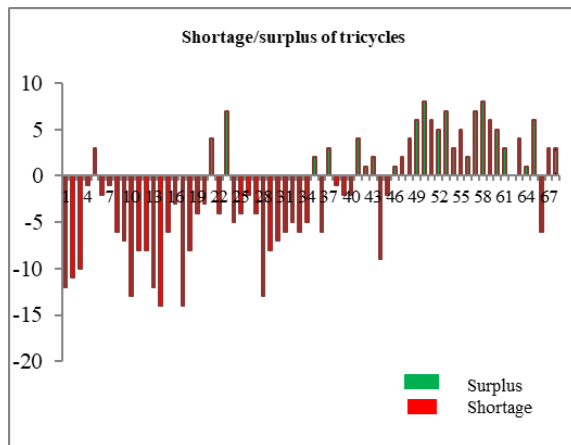

Fig. 3. Shortage/Surplus of Tricycles

The workers who are handling solid waste do not have any personal protection equipment's like uniforms, fluorescent jacket, hand gloves, raincoats, appropriate foot wear and masks. Double Handling of Waste is due to shortage of the infrastructure as handcarts are not properly distributed hence workers have to share the push carts. Double handling by the Sweeper for secondary transportation results in loss of productivity. Due to shortage of infrastructure there is only 60% door to door waste collection, the rest 40% remains uncollected on the streets.
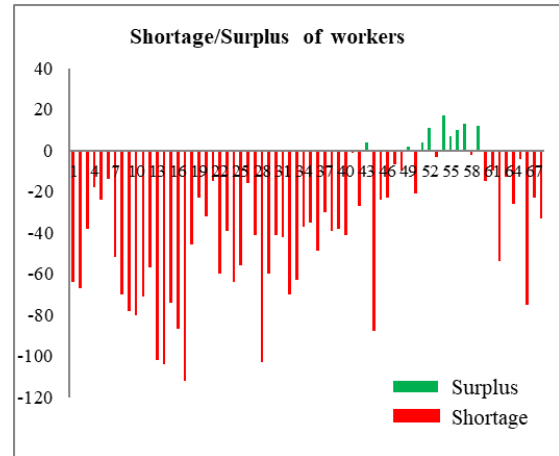

Fig. 4. Shortage/Surplus of Workers

B. Secondary collection

Most of the secondary waste collection is carried out through street sweeping. The traditional system of collection is adopted by placing the communal bins at different points along the street corners and points along the roads. The distribution of secondary collection points is inappropriate and not as per requirement. The collection bins are neither properly designed nor properly located and maintained. Most of the waste generated from various sources such as residential, street sweepings, garden, parks, offices and shopping complexes is collected in same community bin. The waste is collected from total number of 512 collection points out of which 372 are open hence contributing to health and environmental hazards and only 140 are containerized. As per Solid waste management rules $1m^3$ containers are required per 5000 population and hence 297 containers should be present but only 17 containers are present. The community bins are not washed at all resulting in unhealthy and unhygienic environment for users and workers. There is not periodic inspection of containers hence the floors, screen walls are damaged. Storage facilities have not been created and established by taking into account quantities of waste generation in a given area and distance required to be travelled by the waste collectors to deposit the waste at the storage facility.

Fig. 5. Inappropriate secondary storage leads to deposition of waste outside the bin

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13

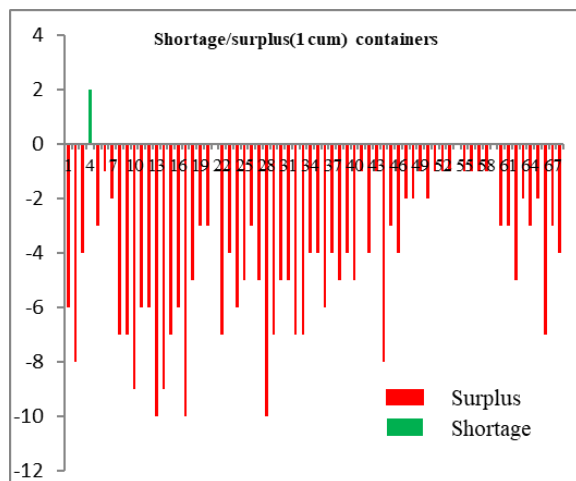Fig. 6. Inappropriate distribution of secondary storage points

Fig. 7. Shortage/Surplus of Containers

The containers/collection points are located in a public place (lacking ownership by the public) which, in many situations, leads to indiscriminate disposal of waste outside the container. Thus, the actual economy of this system mostly depends on public co-operation. It is therefore essential to pay more attention to improving the design, and operation and maintenance practices of a communal system to increase public acceptance, and to optimize the productivity of this system. The Efficiency in this stage remains under achieved by issues related to placement of bins, littering around bins, non-lifting of bins as per schedule without adequate management controls, such systems fail resulting in street corner littering. The design of waste storage containers/depots (secondary collection points) is not synchronous with the design of vehicles deployed for both primary and secondary waste collection.

3. Waste Transportation

Transportation is the second important stage of solid waste management system. The waste is transported from dustbins and open collection points by tipper trucks and dumper placers owned by Srinagar Municipal Corporation. Transportation system does not synchronize with the positioning and type of community waste storage facility. Each tipper makes two to three trips a day to the disposal site, whereas dumper placer

makes 8-10 trips a day with a capacity of 2.5-3.5 ton. The transportation system should be such that the waste should be collected at regular intervals at minimum cost.

Waste is not transported on a day to day basis leaving a backlog of waste to be transported. Transportation efficiency is affected due to uneven distribution of sweeper staff and non-synchronization with vehicle arrival time. Many transportation vehicles are not fully covered or only partially covered by tarpaulin, which is against the guidelines of Supreme Court. Records for the exact distance travelled and the quantity transported are not maintained due to non-functional milometer in the vehicles. There is almost negligible monitoring of transportation vehicles regarding the running of vehicles, operation and maintenance, fuel distribution and disposal control. Vehicles of Srinagar Municipal Corporation are not repaired regularly and no routine maintenance system exists. The vehicle operation is normally in single shift. Old vehicles, which have already outlived their economic life and utility, are still the part of SMC operative fleet. In the old city, day time lifting of solid waste has always been problematic. There are no fixed routes; drivers on their own have fixed the collection routes based on their experiences. There is no routing plan for waste collection in the city. Drivers on their own have fixed the collection routes based on their experiences. The tipper trucks required is 170 but after the waste is segregated at the source the capacity of the trucks will increase and hence only 61 trucks are required out of which 32 will be for biodegradable, 9 for recyclable and 20 for inert waste.

The types of vehicles used for transportation does not synchronize well with containers placed at depots or transfer stations hence multiple handling of waste occurs. The selection of the type of vehicles does not reflect the quantity of waste to be transported, travel distance, road widths, road conditions etc.

4. Conclusion

The total elimination of the waste is an impractical suggestion, rather than it should be managed in an effective manner. The municipal solid waste management system is the most poorly rendered, the systems applied are unscientific, outdated and inefficient. Poor conditions of containers, inadequate maintenance and non-replacement of worn-out collection vehicles contributed to behaviors such as littering and illegal dumping by citizens leading to insanitary living conditions. Poor management of finances and resources, and laxity among employees (leading to inconsistent service) were major contributing factors to mismanagement of solid waste. Infrastructural problems are the main impediment to sustainable waste management and should be the first priority for municipalities to improve waste collection and disposal. Inadequate service coverage and operational inefficiencies of services including an unskilled workforce is another major set of challenges faced by municipalities in providing sufficient waste services to citizens. Ineffective Technologies and Equipment, poor conditions of containers, inadequate

maintenance and replacement of worn-out collection vehicles contributed to behaviors such as littering and illegal dumping by citizens as some feel that they could not properly dispose of trash because trash bins and waste services are not properly maintained.

Municipal authorities that are responsible for managing MSW have budgets that are insufficient to cover the costs associated with developing proper waste collection, storage, treatment and disposal. The lack of strategic MSW plans, waste collection/segregation and a government finance regulatory framework are major barriers to achieving effective SWM in India. Limited environmental awareness combined with low motivation has inhibited innovation and the adoption of new technologies that could transform waste management in India. Public attitudes to waste are also a major hurdle to improving the waste system. Information on future quantities and characterization of wastes is essential as this determines the appropriateness of different waste management and treatment options. State-level procurement of appropriate equipment, vehicles and machinery is necessary for primary and secondary collection with effective systems for monitoring collection, transport and disposal. Waste management must involve waste segregation at source to allow much more efficient value extraction and recycling. Separating organic and inorganic waste would have significant benefits and should be the responsibility of the waste producer.

The municipalities need to invest more resources into a smaller but more skilled group of personnel instead of wasting money on a large but inefficient and ineffectual workforce. The local authorities should increase the number and optimize the distribution of litterbins on the streets and other public places as a measure to discourage people from littering. Solid waste management needs to be efficiently provided to the community to maintain aesthetic and public health standards. They should increase the number and optimize the distribution of litterbins on the streets and other public places as a measure to discourage people from littering. Municipal laws should have adequate provisions to deal effectively with the ever-growing problem of solid waste management to improve the system through proper and suitable planning.

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Annexure 1
Ward wise shortage /Surplus of SWM Infrastructure

Ward No.	Name	Population	Generation(Kg/Day)	Shortage/Surplus of Workers	Shortage/Surplus of Tricycles	Shortage/Surplus Containers(1cum)	Shortage of Tipper Trucks
1	Harwan	31926	12770	-64	-12	-6	-2
2	Nishat	39020	15608	-67	-11	-8	-2
3	Dalgate	20798	8319	-38	-10	-4	-1
4	Lal-chowk	12434	4974	-18	-1	2	-1
5	Rajbagh	15460	6184	-24	3	-3	-1
6	Wazir-bagh	12076	4830	-14	-2	-1	-1
7	Sarai-Balla	24283	9713	-52	-1	-2	-1
8	Mehjoornagar	37848	15139	-70	-6	-7	-2
9	Natipora	35498	14199	-78	-7	-7	-2
10	Chanapora	42926	17170	-80	-13	-9	-2
11	Baghat-Barzulla	33059	13224	-71	-8	-6	-2
12	Rawalpora	28937	11575	-57	-8	-6	-2
13	Sheikh Dawood colony	49467	19787	-102	-12	-10	-2
14	Batmallo	44570	17828	-104	-14	-9	-2
15	Allochi-Bagh	37086	14834	-74	-6	-7	-2
16	Magarmal-Bagh	39491	15796	-87	-3	-6	-2
17	NundReshi colony	52133	20853	-112	-14	-10	-2
18	Qamerwari	26273	10509	-46	-8	-5	-2
19	Parimpora	14977	5991	-23	-4	-3	-1
20	Zainakot	19077	7631	-32	-3	-3	-1
21	Bemina (A)	13486	5394	-15	4	0	-1
22	Bemina (B)	33738	13495	-60	-4	-7	-2
23	Shaheed Gunj	21886	8754	-39	7	-4	-1
24	Karan Nagar	31181	12472	-64	-5	-6	-2
25	Chattabal	25209	10084	-56	-4	-5	-2
26	Syed Ali Akbar	15545	6218	-16	-2	-3	-1

Ward No.	Name	Population	Generation(Kg/Day)	Shortage/Surplus of Workers	Shortage/Surplus of Tricycles	Shortage/Surplus Containers(1cum)	Shortage of Tipper Trucks
27	Nawab Bazar	24657	9863	-41	-4	-5	-1
28	Islamyarbal	48933	19573	-103	-13	-10	-2-
29	Ali Kadal	33860	13544	-60	-8	-7	-2
30	Ganpathyar	24034	9614	-41	-7	-5	-1
31	Malik-Agan	27420	10968	-42	-6	-5	-2
32	Barbarshah	35694	14278	-70	-5	-7	-2
33	Khan-khai-Moulla	32943	13177	-63	-6	-7	-2
34	S.R.Gunj	25653	10261	-37	-5	-4	-2
35	Aqil-Mir-khanyar	21920	8768	-35	2	-4	-1
36	Khawaja-Bazar	29872	11949	-49	-6	-6	-2
37	Safakadal	18764	7506	-30	3	-4	-1
38	IID-Gah	23313	9325	-39	-1	-5	-1
39	Tarabal	18760	7504	-38	-2	-4	-1
40	Jogilankar	24130	9652	-41	-2	-5	-1
41	Zindshah-sahib	5562	2225	-1	4	-1	-1
42	Hassnabad	19119	7648	-27	1	-4	-1
43	Jamia-Masjid	4899	1960	4	2	-1	-1
44	Mukhdoom sahib	41177	16471	-88	-9	-8	-2
45	Kawdara	16646	6658	-24	-2	-3	-1
46	Zadibal	18340	7336	-23	1	-4	-1
47	Madin-sahib	12369	4948	-7	2	-2	-1
48	Now-shera	10781	4312	-10	4	-2	-1
49	Zoonimar	3945	1578	2	6	-1	-1
50	Lal-Bazar	12310	4924	-21	8	-2	-1
51	Umarcolony	4519	1808	4	6	-1	-1
52	Soura	2663	1065	11	5	-1	-1
53	Buchpora	5561	2224	-3	7	-1	-1
54	Ahmad-Nagar	1963	785	17	3	0	-1
55	Zakura	2511	1004	7	5	-1	-1
56	Hazratbal	2696	1078	10	2	-1	-1
57	Tail-bal	3468	1387	13	7	-1	-1
58	Bud-Dal	5594	2238	-2	8	-1	-1
59	Locut-Dal	2186	874	12	6	0	-1
60	Dara	13114	5246	-15	5	-3	-1
61	Alesteng	14606	5842	-10	3	-3	-1
62	Palpora	27032	10813	-54	0	-5	-2
63	Maloora	11878	4751	-13	4	-2	-1
64	Laweypora	17238	6895	-26	1	-3	-1
65	Khumani Chowk	11145	4458	-4	6	-2	-1
66	Humhama	34982	13993	-75	-6	-7	-2
67	Pandrathan	14853	5941	-23	3	-3	-1
68	Khanmoh	18266	7306	-33	3	-4	-1