

STUDY OF TECHNOLOGICAL INTERVENTIONS IN COLLECTION AND TRANSPORTATION OF MUNICIPAL SOLID WASTE MANAGEMENT PRACTICES – A CASE OF AHMEDABAD CITY

Ar. Esha Dalal¹, Dr. Gayatri Doctor², Rahul Patel³

¹College of Architecture and Interior Design, SVIT Vasad, India

²Faculty of Management, CEPT University, Ahmedabad, India

³Masters of Urban Management, CEPT University, Ahmedabad, India

ABSTRACT

In today's scenario, to cater all services in a living habitat is very necessary part to fulfil the need of each and every individual to live a comfortable level of their living standard. Due to population upsurge and urbanization, solid waste management is one of the chief issues to deal with as it affects quality of life. Ahmedabad is the 7th largest city of India and generates about 4000 Metric tons of waste daily. Smart Cities are defined in various ways by different people, but all have an underlying concept that being as "smart" involves using information and communication technologies (ICT), the internet to address urban challenges.

The Ministry of Housing and Urban Affairs (MoHUA) under the Swachh Bharat Mission (SBM) -Urban designed the idea of Swachh Survekshan in which they have rated cities based on the innovative interventions undertaken by them to enhance cleanliness or swachhta. Swachh Survekshan toolkit of 2017 - 2018 have given importance to use technological parameters like Vehicle Tracking System (VTS), Biometric attendance systems etc, thus encouraging cities to incorporate them, especially in Primary Solid Waste Management.

This research paper studies the Primary Municipal Solid Waste Management in Ahmedabad with data collection and interactions with the municipal officials of Ahmedabad Municipal Corporation (AMC). It studies the implementation and usage of the Vehicle tracking System (VTS) - Ecoskipper in Ahmedabad. The study was done in 2018, includes analysis of existing scenario. A framework for the study was made to analyze the Vehicle Tracking System technology.

KEYWORDS

Collection, Transportation, Sweeping, Municipal Solid Waste Management, Technologies, Smart Cities, Internet and Communication Technologies.

1. INTRODUCTION

In today's world, cities are growing day by day. With increasing challenges like rapid urbanization, traffic, waste management, illegal constructions etc., the need for efficient city management becomes more important. Urban management plans on various levels of governance are playing a crucial role in managing the lifelines of the city and empowering the decision-making ability of the municipalities and policy making authorities to better manage the city. Ahmedabad is a city in Gujarat. The area of Ahmedabad city is 464.14 square kilometer. The

total population of Ahmedabad is 8.1 million [2]. The local government of the city is the Ahmedabad Municipal Corporation (AMC) which has six zones and 48 wards.

1.1. Solid Waste Management

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial, and commercial activities in each area. Further, according to its origin it is classified as domestic, industrial, commercial, construction or institutional; on content basis as organic material, glass, metal, plastic and according to hazard potential toxic, non-toxin, flammable, radioactive, infectious etc. [4]. Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. Several processes are involved in effectively managing waste for a municipal corporation. These include monitoring, collection, transport, processing, recycling, and disposal. [1].

Municipal solid waste (MSW) is the abridgment of the waste generated from domestic, commercial, and construction activities, collected and treated by municipalities. Exponential growth of population and urbanization, and the development of social economy, coupled with the improvement of living standard, has resulted in an increase in the amount of MSW generation throughout the world. [5].

Swachh Bharat Mission is a campaign launched on 2nd October 2014 by Prime Minister Narendra Modi, with an aim to achieve cleanliness in India. One of the primary objectives of this mission is Municipal Solid Waste Management. [6]. The Ministry of Housing and Urban Affairs (MoHUA) under the Swachh Bharat Mission (SBM) -Urban designed the idea of Swachh Survekshan in which they have rated cities based on the innovative interventions undertaken by them to enhance cleanliness or swachhta. Swachh Survekshan toolkit of 2017 and 2018 has given importance to use some technological parameters, thus encouraging cities to incorporate them, especially in Primary Solid Waste Management. The technological parameters mentioned in the Swachh Survekshan Toolkit, identified technologies such as Vehicle Tracking System (VTS), Biometric attendance systems etc. to be used in the cities.

2. SCENARIO ANALYSIS

The study done in 2018 includes analysis of existing scenario, impact of use of technology and issues in deployment. The city of Ahmedabad generates about 4070 Metric Tonnes Per Day (MTPD) Municipal Solid Waste. The bar chart in Fig 1 shows the classification of waste collected. Maximum waste is collected from door-to-door collection and through street sweeping. The Refuse Transfer station is the link between the Community Solid Waste Collection and Waste Disposal site. Fig 2 shows the basic operation involved for the collection and transfer station of the waste for household waste as well as for street waste.

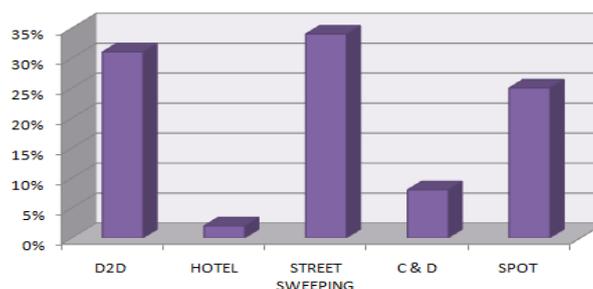


Figure 1. Classification of waste. Source: AMC

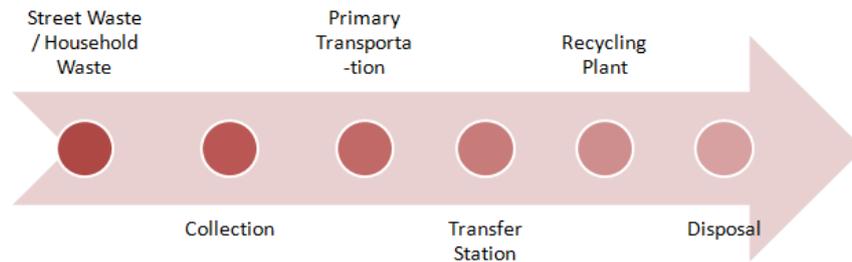


Figure 2. Operation involved for refuse transfer station. Source: AMC

Collection of household waste started in July 2009 in Ahmedabad as a part of gate to dump system. Approximately 1264 Metric Tonnes (MT) waste is collected per day between 7am to 2pm outsourced to 6 different contractors/private agencies and cover about 14 lakh residences in the city of Ahmedabad. Household waste is transported by 791 “Chhota Hathi” vehicles with a capacity of 1.5 tons each. Waste segregation is still an issue.

Road sweeping is done in two ways, i.e., manual, and mechanical. The street sweepers do manual sweeping. There are 12,500 sweepers in Ahmedabad and the time slots for manual sweeping is morning 6:30 am to 11:30 am and afternoon 3 pm to 6 pm. Mechanical sweeping, done by road sweeping machines between 10pm to 2am.

There are 1240 Public bins, placed at various public locations in the city for the convenience of citizens. At each location, there are two bins, one blue and another green, each of capacity 90L so that waste can be segregated. These public bins are collected through the small waste collecting vehicles.

There are two types of community bins at various locations in the city. There are 1050 Silver bins with a capacity of 1 ton which are collected by Refuse Compactors. 1091 green bins with a capacity 1.5-ton are collected by Bin lifters. Collection and transportation of these bins are outsourced to private agency.

Refuse Transfer Station (RTS) is the link between the community solid waste collection and the landfill site of any city. The total capacity of the six RTS is 2400 MT. Weighing and compaction of waste collected is done in RTS, before going to the landfill site. The landfill site is located at Pirana on the outskirts of Ahmedabad.

2.1. Technologies Identified

Fig 3 shows the list of technologies identified while interacting with the AMC. All The allotment of routes for door-to-door collection and monitoring and everything was checked by the Senior Supervisor.

	Technology	Ahmedabad
Monitoring	Vehicle tracking System	✓
	Bio-Metric System	✗
Mechanical	D2D Collection Vehicle	✓
	Refuse Compactor	✓
	Community bin lifter	✓
	Sweeping Machine	✓
	Refuse Transfer Station	✓
Information	Web Portal	✓
Complaint	Mobile Application	✓

Figure 3. Technologies identified

2.2. Vehicle Tracking System – Eco Skipper

Vehicle tracking system is one of the most important systems, which integrates GPS based tracking in the waste collecting vehicles of the collection process in the solid waste management process. The vehicles, installed with a GPS device, which provides a real-time data of the vehicles at different levels in the Urban Local Bodies (ULB). Before, vehicle-tracking system, the waste collection vehicles were tracked with the help of random checks by the Sanitary Sub Inspectors and the supervisors of the ward, whether the Point of interest (POI) is served or not.

A vehicle tracking system with GPS/RFID based monitoring system, known as Eco Skipper, started in July 2014. Infinium Solution Pvt. Ltd developed the software and AMC is the owner of the same. Total 1027 GPS devices are installed in all the vehicles being used, namely, chhotahaathi, bin lifters, refuse compactors. There is a 5 years contract for operations and maintenance of the system given to the developers Infinium Solutions Pvt. Ltd. The total cost of the software and maintenance for 5 years is approximately Rs 4.8 crores.

GPS devices, installed in moving vehicles to track the location of the waste collecting vehicles. It is a small device; each with one sim in it. Vehicles also have RFID tags for tracking. There are RFID readers installed in each ward office and Refuse transfer stations for reading these tags.

The Eco-skipper monitoring software allows access for AMC officials at the ward level, zonal level. Access has also been given to the contractors and to the Infinium team. The software covers the services of D2D waste collection, Waste collection from Community bins and Silver bins, Transportation of waste from Refuse Transfer Station to Dumpsite. Some of the important salient features of the software (Eco-Skipper) are a Zonal and ward level statistics, Live vehicle tracking, current vehicle status, details of POI and vehicle information, various reports like POI served/unserved report, Bin pickup reports, summary reports etc.

After installation of GPS/RFID tags in the vehicles, each vehicle assigned with a specific route for collection of waste depending on the number of point of Interests (POI). The vehicles travel their assigned routes. When the waste collecting vehicle reaches the POI, the software shows the POI as served. The sanitary inspectors and the sanitary sub inspectors at the ward offices crosscheck this tracking through their mobile devices or computers. Figure 4 shows the image of GPS Device and RFID Tag installed in the Vehicles.

Once the waste collected from a POI, the vehicle moves on to the next collection point. If in case, POI is missed by the waste collecting vehicle, the unserved POI is informed to the contractor's supervisor. A list of unserved POI's is generated on a daily basis but is not reflected in the payment to the contractor. AMC officials monitor collection of waste through Eco skipper software. If the AMC official encounters a problem, in collection system, he directly contacts

the concerned contractor of that area to resolve the issue. The contractor then takes appropriate action.



Figure 4. Technologies identified

3. ANALYSIS OF VEHICLE TRACKING SYSTEM

3.1. Impact of Vehicle Tracking System (VTS)

The vehicle tracking system has a huge impact on the waste collection coverage in the city as well as on the complaints registered regarding the waste collection. Figure 6 clearly shows the increase in the waste collection in the year of 2014, before July and after July. Simultaneously, there is also a decrease in the complaints received in the Customer Complaint Redressal System (CCRS) for door- to-door collection as can be seen in the Figure 6. Vehicle tracking system resulted in an increase in the total waste collected and a decrease in the complaints within six months of installation.

3.2. Major Findings

As on January 2018, data was analyzed to find the number of un-served bins in the Narangpura ward of central zone of Ahmedabad city. As on January 2018, data of each POI in all the twenty routes of the ward were analyzed. As a result, 21% of the POI found to be unserved in the ward.

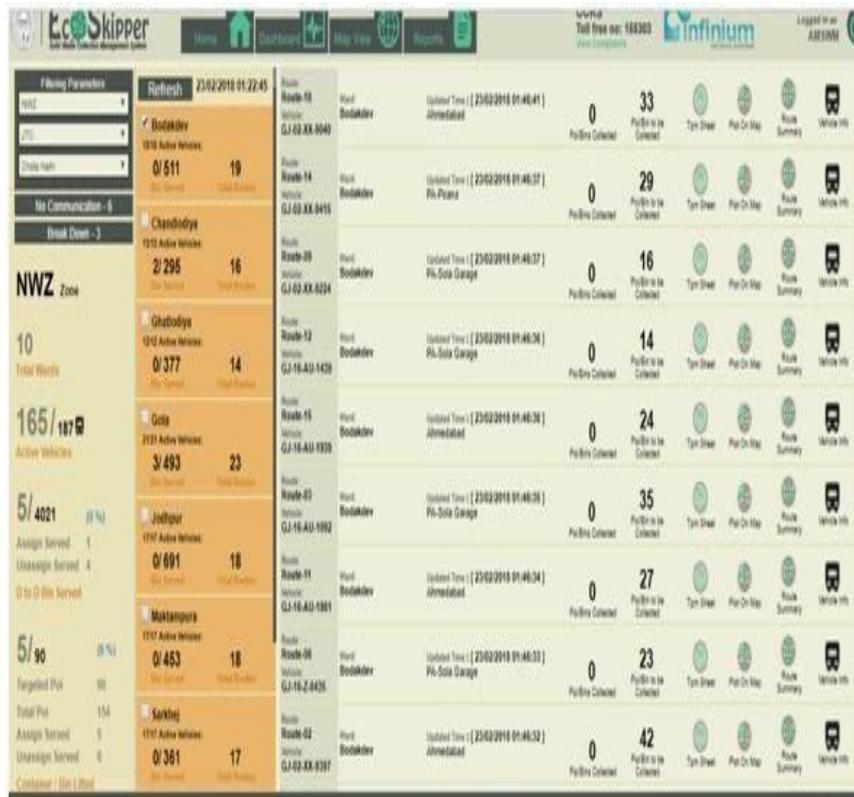


Figure 5. Eco skipper zone level data [3]

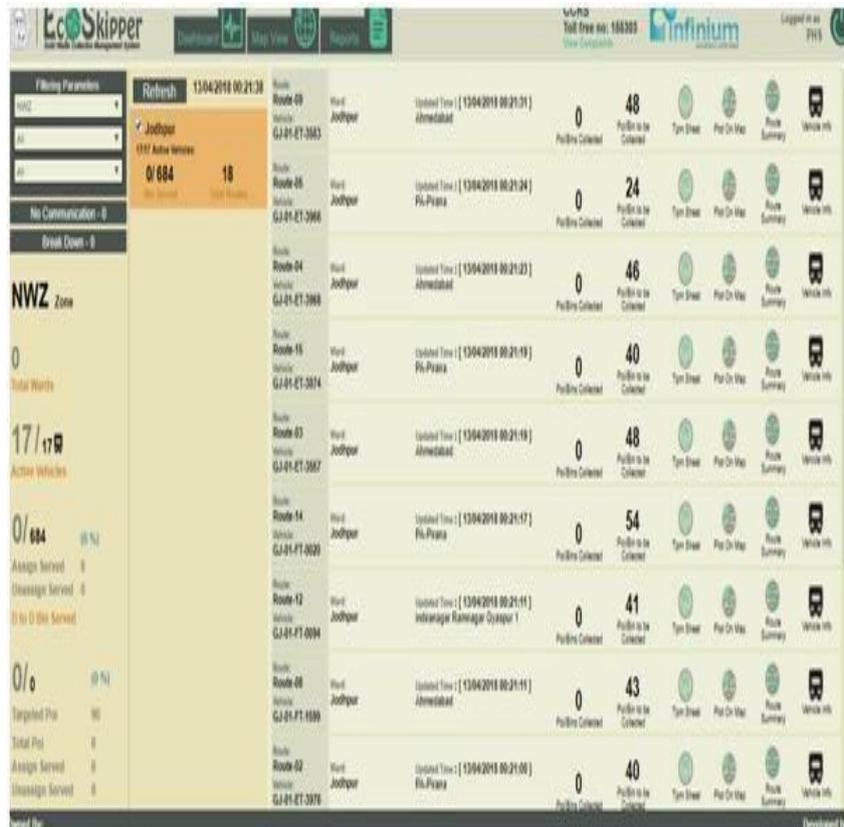


Figure 6. Eco skipper ward level data [3]

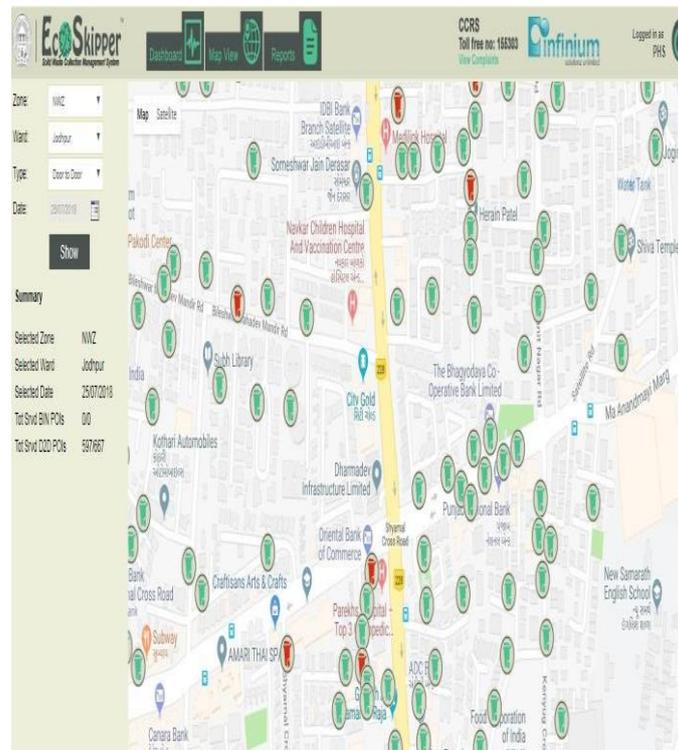


Figure 7. Vehicle tracking and indicating served and unserved POI [3]

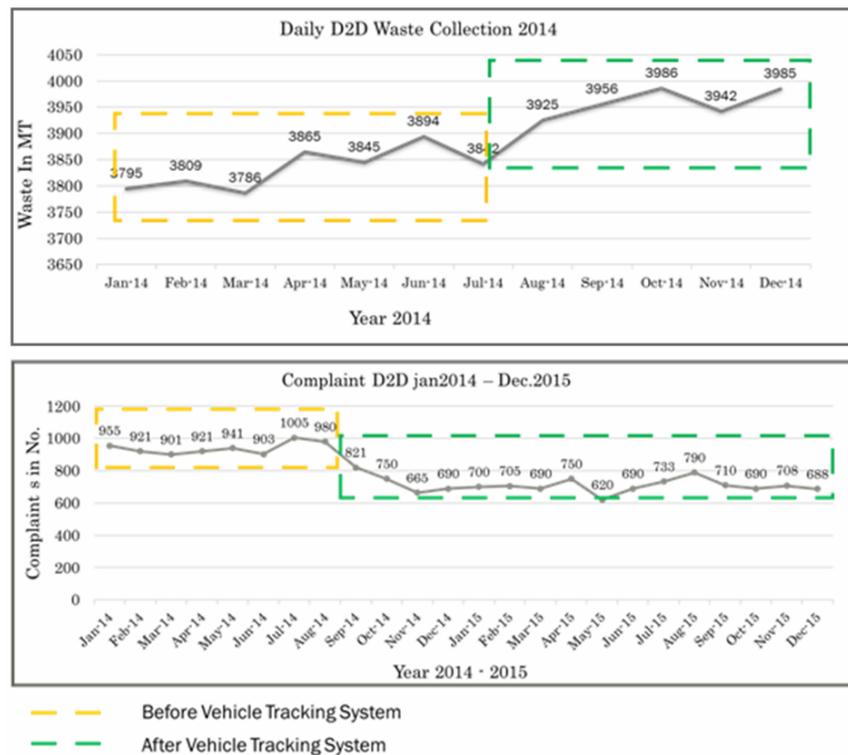


Figure 8. Increase in the waste collection and decrease in the complaints received [3]

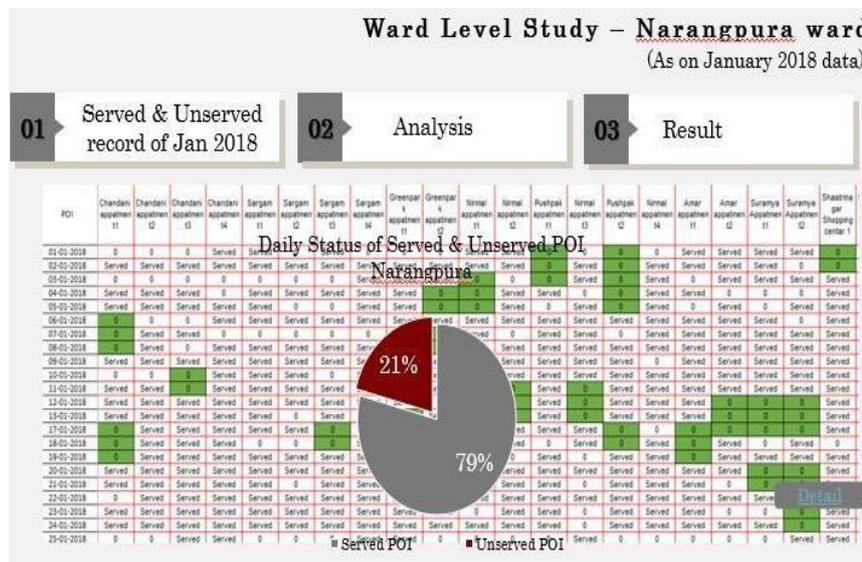


Figure 9. Ward level Study – Navrangpura Ward Jan 2018 [3]

There are some issues in the vehicle tracking system due to improper working of GPS device, wrong location of the vehicle. There is also difficulty in the tracking the vehicle as the boundary of the POI is imaginary. Server connecting issues also occur occasionally.

3.3. Framework

To understand the usage of a technology implementation like Vehicle tracking system requires a framework on the basis of which it can be evaluated. The framework involved identifying twenty-two parameters based on the observations, analysis and the parameters in the Swachh Survekshan. Once the parameters were identified, the Vehicle tracking System was evaluated by giving 5 points if that parameter is present and zero points if the parameter is lacking.

Table 1. Framework to analyse the VTS implementation

Sr.no	Question	Ahmedabad
1	Is there any vehicle tracking system present in the city?	5
2	Does the tracking system state the total number of POI?	5
3	Does the tracking system state the served unserved report?	5
4	Does the software permission give to contractors?	5
5	Does the software permission give to officials?	5
6	Does the software permission give to citizens?	0
7	Does the software provide different systems at different levels?	5
8	Does the software indicate active vehicles?	5
9	Does the software indicate location of POI on map?	5
10	Does the software indicate route of the vehicle?	5
11	Does the software indicate live location of the vehicle?	5
12	Does the software indicate vehicle detail?	5
13	Does the software indicate kms travelled?	5
14	Does the software indicate the vehicle speed limit?	0
15	Does the software provide data of these following levels?	
i	Ward level	5
ii	Zone level	5
iii	City level	0
16	Does the software cover the following primary waste collection Vehicles?	
	Door to door waste collection vehicle	5
	Container lifter	5
	Refuse compactor	5
	Hook Lifter	5
	Truck	5
	Sweeping machine	5
17	Does the software provide penalty amount?	0
18	Does the software provide TPM sheet?	5
19	Does the software check and indicate whether the vehicle travels the route provided by the TPM sheet.	0
20	Does the software indicate the amount of waste collected?	0
21	Does the software generate payment reduction for unserved POI?	0
22	Is the software linked with payment reduction?	0
Marks Obtained		105
Total Marks		145
Score (percentage)		72%

4. CONCLUSION

After a study of the primary municipal solid waste management system, data collection, analysis and interactions with the municipal officials of Ahmedabad Municipal Corporation (AMC) the study clearly shows that the vehicle tracking system (VTS) has an impact on the waste collection coverage in the city as well as on the complaints registered regarding the waste collection.

An analysis of ward level data of January 2018 of the Narangpura ward, has indicated that there are 21% unserved POI's and only 79% of the POI are served although the Ahmedabad Municipal Corporation is aiming for 100% waste collection.

The framework to analyze of the VTS implementation shows that the Ecoskipper software being used in Ahmedabad scores 72%. Parameters like access to citizen, payment deduction for unserved POI's, amount of waste collected etc are features which can be incorporated in updated versions of the software. The framework can be used to understand usage of the VTS implementation in the other cities as well.

Though the data was studied and analyzed in 2018 but even today the routes of the allotted vehicles are being monitored through the vehicle tracking system. Technology plays very important role in making various operations successful in managing the solid waste for the city. In 2021, Ahmedabad city was awarded the best cleanest city by Swachh Survekshan [7].

REFERENCES

- [1] Ministry of Environment, Forest and Climate Change (2016, April 8) Solid Waste Management Rules. *Gazette of India*. Retrieved July 2018, from http://www.moef.nic.in/sites/default/files/SWM%202016_0.pdf
- [2] <http://indiapopulation2018.in/population>
- [3] <http://ecoskipper.co.in/SwmDashboardOptimized.aspx>
- [4] Sharma, A. (2015). Generation, composition and management of SOLID waste in top Paloura, Jammu (J&K). Volume 6, No 2. doi:10.6088/ijes.6023
- [5] Karak, T., Bhagat, R., & Bhattacharyya, P. (2012). Municipal Solid Waste Generation, Composition, and Management: The World Scenario. *Critical Reviews in Environmental Science and Technology*, 42(15), 1509-1630. doi: 10.1080/10643389.2011.569871
- [6] Schemes and Programs - Swachh Bharat Mission. (2014, October). Retrieved July 2018, from Ministry of Housing and Urban Affairs (MoHUA): <http://mohua.gov.in/cms/swachh-bharat-mission.php>
- [7] <https://swachhsurvekshan2021.org/ImpDocs/SS2020fullreport.pdf>

AUTHORS

Ar. Esha Dalal has been in Academics since 5 years teaching at College of Architecture and Interior Design, SVIT Vasad. She has achieved Best Thesis Award in Masters of Urban Management, from CEPT University, Ahmedabad. She has been part of International Workshop “Urban Regeneration, Ferrara University, Italy. She is dedicated with her commitments, which proves her hardworking. Having Specialization in Urban Management, adheres her knowledge in various fields of Architecture like Design Studio, Research Methodology, Infrastructure Management, Project Management, Building Construction Technology. She has supportive approach to the best of her knowledge sharing with the students.



Dr. Gayatri Doctor has been in Academics for more than two decades after an initial experience in the IT industry. Currently, she is working as a Program Chair and Associate Professor, in Faculty of Management, CEPT University and is engaged in the field of Urban Management from a technology perspective, exploring various technologies, their applications in the urban context, user acceptance and challenges. Her interest areas are Smart Cities, E-Governance, Data Driven Service Operations, Open Data and emerging technologies in the urban context.

