

# CENTRALIZED AND DECENTRALIZED APPROACHES TO SOLID WASTE MANAGEMENT – A CASE STUDY

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## ABSTRACT

Rapid urbanization and alteration in lifestyle occurring across the globe has resulted in an uncontrolled generation of municipal solid waste. Various strategies have been tried and tested for obtaining a sustainable result in municipal solid waste management. Nonetheless, in most of the cases, they have created negative health, environment and socio-economic impacts, particularly in developing countries. Furthermore, the attitude of the common people towards the waste they generate, often acts as a barrier for adopting sustainable strategies for its management. Two main approaches are being followed in municipal solid waste management: a centralized and a decentralized approach. There exists an ongoing debate with regard to the efficiency of the two approaches. Taking the Thiruvananthapuram Municipal Corporation in Kerala, India as a case to observe, this paper examines the merits, demerits, and practicability of these two approaches, and tries to suggest a sustainable model to curb the issue of municipal solid waste management in urban settings.

**Keywords:** *solid waste management, centralized approach, decentralized approach, Thiruvananthapuram Municipal Corporation, Kerala*

## INTRODUCTION

Increase in the standard of living has a direct impact on the amount of municipal solid waste (MSW) generated. It also creates new challenges in the field of waste disposal. Countries across the globe are struggling to find sustainable solutions for the new challenges in the field of municipal solid waste management (MSWM) [1]. About 2.01 billion tons of MSW are produced globally per year, out of which about 33 % is not managed with

an environmentally friendly method [2]. The global trend of increased urbanization has resulted in decrease in the availability of space for proper MSWM in cities [3].

In most of the developing countries, MSWM is conventionally regarded as the responsibility of government and civic authorities, from the initial process of collection to the final step of disposal after the treatment process [4]. However, in many areas, the municipal authorities are apparently unsuccessful in

delivering satisfactory services due to many factors, which lead to pollution as well as sanitary and environmental problems, proliferation of insects, ground water contamination and financial damages in terms of losses occurred in MSW recycling and composting values [5, 6]. Mismanagement of MSW could also affect the environment in different ways; for example, open dumping could result in the discharge of organic and inorganic pollutants to the water bodies which in turn affect the public health in many ways as the surrounding community will be exposed to harmful products and disease carrying vectors [7]. Thus, sustainable MSWM needs to be one of the top concerns of any municipal governing body.

The paper intends to appraise, assess and make some preliminary reflections on the two common approaches followed in MSWM, “centralized and decentralized”, based on the experience of Thiruvananthapuram Municipal Corporation (TMC), Kerala, India. The paper examines the merits, demerits, and practicability of these two approaches, and tries to suggest a sustainable model to curb the issue of municipal solid waste management in urban settings. TMC is taken for study as it has a hands-on experience in the practice of both centralized and decentralized approaches in MSWM.

## **CENTRALIZED AND DECENTRALIZED MSWM**

There are two approaches to the management of MSW around the world: centralized MSWM and decentralized MSWM. However, in some regions, application of a mix of both approaches can also be observed. The centralized approach usually requires heavy infrastructures, therefore it requires more space and finance for transfer and management of MSW; while a decentralized MSWM requires considerably less infrastructures. Most importantly, it also perceives waste as a resource. It is said that the decentralized MSWM is suitable in some cases, including management of organic waste, whereas in

other cases, such as management of hazardous and biomedical wastes as well as recycling and recovery of inorganic materials, the centralized MSWM approach would be beneficial [8].

The selection of appropriate MSWM method needs to be carried out during the initial planning phase. When planning for an MSWM solution, the policy makers mostly pay extensive attention to the upgrading of technical specifications; but often, general social and ecological goals are disregarded. Instead of going towards exclusive technological upgrading, if a social component such as “citizen participation” is introduced during the planning of MSWM, the overall approach of MSWM may become sustainable as it increases the citizen consciousness for environment awareness [9, 10].

While comparing the merits of two approaches, “Manual on Solid Waste Management Systems” stated that centralized approach of MSWM reportedly has advantages over economies of scale, single monitoring point, and high-end technology and environmental controls [11]. On the other hand, Righi, et.al. have pointed out some people-centered advantages of the decentralized approach [12] such as:

- Short distance transport: Waste needs to be carried only for shorter distances, which reduces transport cost, pollution caused by emission of air pollutants, noise from trucks and also road traffic.
- Reduced storage of biodegradable waste: Biodegradable waste is usually treated at source while following decentralized approach, which in turn reduces its storage period. This practice will reduce the emission of bad odour and spread of disease carrying vectors to a certain limit.
- Benefits for local community: Due to smaller structure sizes and reduced quantities of waste being handled in decentralized facilities, chances of negative impacts from the system to nearby communities, in terms of livelihood loss and ecological destruction are less.
- Increased public acceptability: Due to above stated reasons and smaller size of the

infrastructure, decentralized MSWM facilities will enjoy better public acceptance.

It should be noted that the decentralized MSWM approach will take more time in the planning phase, as it needs to generate consensus among all the stakeholders. Moreover, the municipal body only plays the role of a facilitator in the decentralized MSWM approach. In the centralized MSWM approach, the municipal body controls the major share of the responsibilities, starting from collection, transportation, treatment, and final disposal [13].

Considering the case of developing countries, a study conducted in Indonesia has mentioned that centralized MSWM can be effectively implemented in some cities of Indonesia by bringing technological innovations in collection and transport of waste. However, it should also focus on maintaining the hygiene quotient and assigning private contractors for the purpose, in order to provide some kind of responsibility relief for the government administration. However, the expenditure for managing centralized MSWM process would be on a higher side. The same study also noted the failure of centralized plants in Medan and Surabaya, two large cities of Indonesia [14].

Studies have reported some major contrasting differences between centralized and decentralized MSWM approaches, as shown in Table 1 [15].

Table 1. Main differences between decentralized and centralized MSWM approach

Centralized MSWM approach	Decentralized MSWM approach
Transportation costs relatively high	Transportation costs relatively low
Economies of scale is non-adaptable to waste reduction	The local matter is a local resource adaptable to the reduction
Low-quality compost	High-quality compost
Advanced technology needed	Simple technology needed
Large facilities	Small facilities
High treatment cost	Low treatment cost

In the centralized MSWM, it can be observed that the waste is normally carried away from the city and deposited in a specific location. Considering that it is a large amount of waste in one place, the facility could endanger the ecological balance, social well-being, and economic prosperity of the adjoining areas. Studies have reported that areas where socially and economically backward people reside usually become the host location for centralized MSWM facilities. This practice can be considered as an example of discrimination and it has led to many struggles as well [16 - 18]. This discriminatory practice can be shown as the power-play of urban elites who do not wish to manage their waste in their own backyard, instead, they dump their waste to locations where socio-economically disadvantaged sections of the society reside. This tendency is termed as “Not in my backyard” (NIMBY), which can be defined as a widespread phenomenon related to the strong opposition of a community to some public-interest interventions in a local area, mainly “undesirable plants”, such as landfills, incinerators and thermoelectric power plants [19, 20].

The “NIMBY” syndrome of the urban elites usually leads to the construction of huge centralized plants in sub-urban areas or nearby villages. As pointed out earlier, this practice sometimes gives rise to protests and struggles from the neighbouring communities against the “facility” as they do not wish to bring somebody else’s waste into their backyard, spurred by the same “NIMBY” syndrome. The possibilities of such protests and struggles can be relatively reduced in the case of decentralization, as there is a strong component of community engagement in its application, which changes the attitude of the people towards the waste as they themselves own a major stake in its management. Accordingly, decentralized approach makes the citizen responsible for their MSWM and the municipal bodies play the role of facilitators [13].

## MSWM – KERALA’S SITUATION

MSWM in Kerala was not a serious concern until the state went through the process of industrialization in the post- Indian independence period. Like in every other country and as in every other state of India, the process of industrialization extended the amount of environment exploitation [21]. The practice of scavenging, waste collection and disposal was active during pre-independence period in the state. After the independence, due to changing life-style and urbanization, there was an increase in MSW generation with no adequate system for its management. Increasing urbanization led to rapid increase in the generation of MSW from urban households which make up 50 % of the total MSW generated [22]. Consequently, accumulation and putrefying piles of garbage in the public lands and on road sides remained an everyday unpleasant sight [23].

According to the Census 2011 itself, 47 % of the population in Kerala is urbanized and this population is responsible for the production of a major share of MSW [24]. As in majority of states in India, a “use and throw away” attitude prevails among the people of Kerala, which further deteriorated the situation. Most of the municipal bodies in Kerala are unable to handle the generated MSW systematically, since the amount of uncollected waste in the state itself is approximately 6,500 tons per day. Thus, the roadside, riverside and grounds in both urban areas and areas of urban transition become waste dumpsites [25].

Looking closely into the controversies related to faulty management of MSW in Kerala, it can be observed that most of the centralized MSWM facilities are both fully or partially inert and cause negative impacts on the nearby communities. Following cases of breakdown of centralized facilities for MSWM in several districts of Kerala can be taken into consideration: Kelugudai, Kallangana and Sheethancoil in Kasargode district, Pettipalam and Chelora in Kannur district, Njeliyanparamb in Kozhikkode district, Pirivusala in Palakkad district, Lalur and Chakkumkandam in Thrissur district,

Brahmapuram in Eranakulam district, Vaduvathur, Fathimapuram and Kunnathupara in Kottayam district, Kozhancheri in Pathanamthitta district, Kureepuzha in Kollam district, and the most notorious controversy at Vilappilsala in Thiruvananthapuram district [26].

Close scrutiny of each of the above sites of controversies have revealed that some of the factors which lead to the breakdown of the facilities are common. They include mismanagement of the centralized facilities either due to faulty design, outdated technology or due to indecorous behaviour of municipal workers. However, a more serious common factor observed in all these cases is the exploitation of socio-economically weaker sections of the society, which points to the fact that practice of an exclusive centralized approach could lead to “NIMBY” syndrome. Many struggles against mismanagement of MSW prompted the state government to bring some innovations in its MSWM approach.

## TMC’S EXCLUSIVE CENTRALIZED APPROACH

Thiruvananthapuram, the capital of the Kerala also houses the first municipal corporation (TMC) of Kerala. According to the census of 2011, TMC has a land area of 214.86 km<sup>2</sup> and a population of 986,578 with 190,610 households spread across 100 wards, generating 300 tons of MSW per day [24]. TMC practiced landfilling at multiple locations in the city till the end of the twentieth century. Although in the beginning this practice did not affect the city residents, as the quantity of MSW generation increased, the landfill sites started posing severe threats to the health of the city dwellers and the surrounding environment. There was severe outcry among the citizens against the practice of un-sanitary landfilling and as a result, all the designated landfill sites were closed by TMC by the end of 20<sup>th</sup> century. But even now, few landfill sites in the city are active [27, 28].

As an alternative solution for the MSWM, the TMC decided to construct Kerala's first "centralized MSW treatment plant" in the Chowalloor ward of Vilappilssala Grama Panchayat, a serene village about 14 km away from the city centre. In 2000, Poabs Envirotech Private Limited was commissioned to establish the "centralized MSW treatment plant" on a built-own-operate-and-maintain basis, where the company would perform the "plant operations" for thirty years and vacate the land [29].

Unfortunately, several flaws were reported in the construction of the "centralized MSW treatment plant" itself. Furthermore, the method of processing of waste and the inadequate safety features of the plant including lack of proper "leachate" treatment plant affected the smooth handling of MSW. The plant was supposed to manage the organic waste through the process of "windrow composting" and was only able to function if the segregated bio-waste was supplied in a specific quantity. However, most of the time not only the process did not happen, but also, lapses such as improper collection, segregation and transportation of MSW were also reported. In a study conducted in the third year after the establishment of the "centralized MSW treatment plant", it was found that not even a single household in TMC practices source level segregation of MSW [30].

Nevertheless, the ultimate victims of the malfunctioned "centralized MSW treatment plant" were the people of Vilappilssala Grama Panchayat. When the unsegregated MSW began to accumulate around "centralized MSW treatment plant", leachate began to flow from it and mix with the nearby water bodies including a rivulet named 'Meenampally'. The leachate also contaminated the ground water. The nearby community members who were primarily dependent on agriculture and animal husbandry for livelihood were drastically affected by the leachate flow. The water bodies became unfit for consumption and irrigation; the agricultural fields are also polluted by the leachate, which ultimately made animal grazing impossible. Severe health issues were also reported for humans as well

as domestic animals. Added to this was the social stigma that spread across the borders of the village resulting in decrease of land value and rejection of marriage proposals from the village [27, 31].

This scenario paved the way for one of the strongest protests against an MSWM facility in Indian history. The community members constituted a local organization called "Vilappilsala Janakeeya Samara Samithy" (Vilappilsala People's Protest Association) through community mobilization in order to protest against and close down the "centralized MSW treatment plant". After a period of severe struggle, which escalated from the District Court to the High Court and then to Supreme Court, they got justice from the National Green Tribunal. The "centralized MSW treatment plant" was ordered to shut down [32].

This case can be regarded as a case of TMC's "NIMBY" syndrome, which forced the TMC authorities to transfer their MSW to a village area for its management. The perils of this "evil conduct" by the TMC were borne by the community members of Vilappilsala. As mentioned in the previous sections, in this case also the socio-economically weaker sections of the society were forced to bear the ill-effects of waste produced by the power [16, 18]. Accordingly, it can be understood from this case that if anything goes wrong in a centralized MSWM system, the impact will be huge; the entire community residing in the vicinity will be affected. Also, all the city dwellers would be left with no option for MSWM as their only facility is not working.

#### **TRANSITION FROM CENTRALIZATION TO DECENTRALIZATION IN TMC**

After the closure of the "centralized MSW treatment plant" in Vilappilsala, the TMC was left with no active alternative for MSWM. Initially, TMC practiced the conventional methods of open burning and dumping which created severe negative health and environment impacts, and resulted in citizen

outcry [32]. So, taught by past experiences in managing a “centralized MSW treatment plant”, the TMC opted to choose the path of community-based decentralization in MSWM [33].

TMC started with the installation of “pipe compost units” made of poly-vinyl chloride in few chosen wards as a pilot project. But this initiative soon failed due to lack of citizen awareness initiatives and due to certain technical reasons; foul smell was being emitted continuously from the “pipe compost units” as there was no proper facility for aeration. Also, many “pipe compost units” were damaged in rodent attacks [34].

After these experiments, TMC planned to move ahead by implementing a comprehensive joint awareness and action plan for adopting a community based decentralized approach in MSWM. Thus, the TMC launched their flagship program for bringing decentralization in MSWM, “ente nagaram, sundara nagaram” (my city, beautiful city) in November 2015. The main strategy of this program was a “segregated source level solid waste management” at household level; where the biodegradable waste will be composted at source and the non-biodegradable waste will be segregated at source and transferred for recycling. Unlike previous initiatives, this program was more participatory and has integrated the concept of ethics, economics and efficiency for MSWM without concentrating only on adoption of modern technologies. Another highlight of this program is the massive awareness campaigns ranging from house-to-house surveys and sensitization activities, ward level awareness sessions and social media campaigns to make this initiative a participatory one [35].

Studies have reported positive results of initiatives taken by the TMC through “ente nagaram, sundara nagaram” (my city, beautiful city) program; progressive changes in the behavioural patterns of the residents and increase in the efficiency of household management of biodegradable waste (increased to 60 - 70 %.) [33]. Looking back, a study conducted in the year 2003 reported that

none of the houses in TMC limit was practicing source level segregation of waste [30].

The TMC has established many infrastructural facilities for the management of MSWM through a decentralized approach. Apart from the infrastructural establishments, several planned approaches to curb the generation of disposable waste (which cannot be managed properly once generated) were also launched by the TMC. One such initiative was the adoption of “green protocol” practices. Green protocol restricts the use of any kind of disposable items and also promotes the reduction of single-use plastic items. Now TMC’s MSWM initiative has a strong institutional mechanism; combining elected representatives, TMC officials, volunteers and private entities (for facilitating limited door-to-door collection, treatment, and transport and disposal services) [36].

Looking at the economics of MSWM in the case of the TMC, decentralization has proved to be economically viable when compared to the centralized approach which was followed previously. Operational cost of the centralized facility was approximately \$ 8086.36 per month, excluding transportation cost of waste from the houses to the plant. The transportation cost added another \$ 12,129.54 per month; increased use of trucks also raises the carbon foot print. Finally, additional manpower for those activities was about 1,900-man hours per day. But as of now, TMC is saving about \$ 2695.45 per month through decentralizing the MSWM activities [37].

The TMC has made a lot of progress since the closure of its “centralized MSW treatment plant” in Vilappilsala. From installing of “household composting devices” through giving subsidies, to setting up of “community aerobic composting facilities”, from “source level segregation” of waste, to setting up of “material recovery facilities”, from implementation of green protocol to introduction of mobile application for sustainable MSWM practices, several model community based and citizen-centred initiatives have been adopted by the TMC. But

are these initiatives optimal for TMC's MSWM needs?

### **THE GAPS IN TMC'S DECENTRALIZED MSWM APPROACH**

As mentioned before, TMC's MSWM is now better when compared to its previous scenario and many other municipal corporations across the country. However, this cannot be regarded as fully efficient, due to many gaps in its implementation.

First of all, TMC does not have an infrastructure within its limit for efficient management of sanitary wastes such as sanitary napkins and diapers. It is also reported that there is spatial disparity between the wards in the case of MSWM services obtained. The wards where the socio-economically weaker sections reside get fewer services when compared to wards where the rich reside. Therefore, it can be assumed that the effective implementation of decentralization in MSWM have not reached all the wards of TMC [38].

The TMC's capacity to handle the generated inorganic waste is doubtful, as it does not have effective infrastructure for plastic shredding and depends on the private players; often their capacity to handle plastic waste is subjected to scrutiny by the media and the public. It is said that a major proportion of the plastic waste is transported to Tamil Nadu for recycling, because the TMC does not have appropriate facility for its management [38]. Therefore, when the situations such as COVID-19 pandemic arise, movement of inorganic waste including plastic will come to a halt as there would be inter-state transport restrictions. The situation further deteriorates as TMC lacks sufficient "material recovery facilities" for facilitating the storage of inorganic waste in large quantities. Consequently, the entire process of inorganic waste management would stop.

Similarly, in the case of sanitary waste and other inorganic waste, there is no facility in TMC for the proper management of treated

bio-medical waste. The possibilities of managing such kind of wastes at source pose higher amount of risk, as it needs sophisticated infrastructure and more skilled personnel [39].

### **CONCLUSION**

Sustainable MSWM requires different management methods to minimize waste production and to maximize energy/material recycling and meet sustainable economic, environmental and social needs [40].

A close examination of the case of TMC's MSWM - a mix of MSWM approaches - could be suggested for achieving sustainability. Adoption of a decentralized approach as priority and implementation of a semi-centralized approach for the management of specific types of waste, such as treated sanitary waste, bio-medical waste and storing of inorganic waste could prove beneficial. Even within the semi-centralization concept, there is a component of decentralization at source level segregation, which is the key for the success in centralized MSWM. But state government is also proposing for "centralized waste to energy (WtE) plants" with an aim for power generation from MSWM. Experts in the field of "zero-waste" opined that the calorific value of the bio-waste produced in Kerala is low and would not result in high energy yield through incineration, which is also the reason why most of the WtE plants established in India have failed [41].

The approaches of decentralized MSWM and centralized MSWM (as a limited approach in managing sanitary waste, bio-medical and inorganic waste) can be integrated to form an "integrated solid waste management". The concept of "integrated solid waste management" is based on the fact that the waste stream is made up of different components and the disposal of each waste should also be carried out separately; therefore, the concept of segregation holds much value [42].

Integrated solid waste management is based on four basic principles: equity, effectiveness, efficiency and sustainability. Equity: all the people should be given access to suitable waste management model, considering the environmental and health reasons. Effectiveness: the chosen waste management model should lead to safe removal of all sorts of waste. Efficiency: the waste management model should be devised in such a way that the benefit from it is at an optimal level, while the incurred cost must be minimal. Sustainability: the waste management system should be adapted to the local conditions and should be a practical in terms of technical, environmental, social, economic, financial, institutional and political perspective. It should also be a sustainable in terms of its existence, without depriving the resources in which it exists [43].

As for the decentralized approach, the concept of “integrated sustainable waste management” also considers the municipal body and all the stakeholders, including the waste generators, formal and informal institutions associated with MSWM as active stakeholders [44].

A plan for “integrated solid waste management” should be developed from the current MSWM approach followed by the TMC, where the roles of the municipal body and the entire stakeholders including the waste generators, formal and informal institutions associated with MSWM should be clearly defined. If so, the gaps found, such as spatial differences in the implementation of services, issues in inorganic waste management, sanitary waste management, biomedical waste management and so on can be effectively resolved.

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