2-Node Decentralized Flow in Municipal Biodegradable Waste Management Value Stream for Municipal Cities of India

Ar. Aditya Anand[1]

Assistant Professor, Department of Architecture and Planning,

Centre of Design Excellence,

Vivekanand Global University, Jaipur

Master's: M Arch, IIT Roorkee, 2022

Bachelor's: B Arch, NIT Patna, 2020

Affiliations: COA, IGBC AP

Contact: 7004914586

Address: Vivekananda Global University, VIT Road, Jagatpura, Jaipur, PIN - 303012

Abstract. Being addressed in SDG Goals 11,12,13, and 14 (UNDP, Sustainable Development Goals, 2015), municipal solid waste management is now considered a global issue. There is a need to increase the efficiency of the current MSWM system to manage the growing amount of generated waste with the current management capacity. The paper investigates the resource consumption at various stages of the MSWM (especially for biodegradable waste) system and identifies the value and value stream. The value stream is visualized by identifying the stages of MSWM practices (Nodes) and the value they add to the process. Furthermore, identified nodes that do not add any value and consume resources are eliminated to create a 2-Node model from a 4-node existing model to improve the efficiency of the complete management process.

Keywords: Municipal Solid Waste Management (MSWM), Biodegradable Waste (b_dW), Value, Value-Stream, sustainable development

[1] Corresponding author, Assistant Professor,

Introduction

The increasing urbanization has posed several management challenges to all the urban local bodies, and the developing countries are struggling to achieve the UN SDGs 2030 report (UNDP, The Sustainable Development Goals Report 2020, 2020). The management of Municipal Solid Waste (MSW) is one of the major challenges for urban local bodies. Solid waste volumes are increasing daily with the growing urban population, and urban local bodies are constantly struggling to scale up with the increasing solid waste generation (NITI Aayog, 2021). This scenario is a threat to a sustainable built environment, and it is crucial to handle the waste in a manner where it does not pose a threat to the sustainability of the built environment (Chadar & Keerti, 2017)

Efforts to bring improvement in Municipal Solid Waste Management (MSWM) in India through policy to design and innovation are in place. The lean approach helped to improve performance in the automobile to construction sectors; in MSWM too researchers are exploring the same applicability using research techniques like multi-criteria decision-making, indicator-based performance mapping, and case-study methods.

The value stream mapping (VSM) is one of the stages in lean approach which includes set of all the specific actions required to bring a specific product (whether a good, a service, or, increasingly, a combination of the two) through the three critical management tasks of any business: the problem-solving task, which runs from concept to detailed design and engineering to product launch, the information management task, which runs from order-taking to inventory management and the physical transformation task proceeding from raw material to a finished product in the hands of the customer (Womack & Jones, 1996, 2003). This value-stream is maintained by creating flow within the process.

This paper investigates the applicability of the lean approach in MSWM practices, such as value stream mapping (VSM) and appropriate value-added interventions for improving the flow of bio-degradable waste (b_dW). The paper reviews data from 28 municipal cities (Biswas, et al., 2021) and compares the present 4-Node system (Fig.1) to a proposed 2-Node system (Fig. 3) through value stream mapping (VSM).

The VSM technique identifies processes carried out at specified nodes that add value to the process of MSWM. The value addition at specified nodes are analysed, and the nodes that do not add any value but consume resources are suggested to be eliminated from the system to reduce resource expenses and increase the handling capacity of municipal bodies.

Eliminating processes that are consuming resources and not adding any value will provide better opportunity and resources for the processes that add value. Additionally, with reduced resource consumption, the ULBs can manage more MSW under their limited resource.

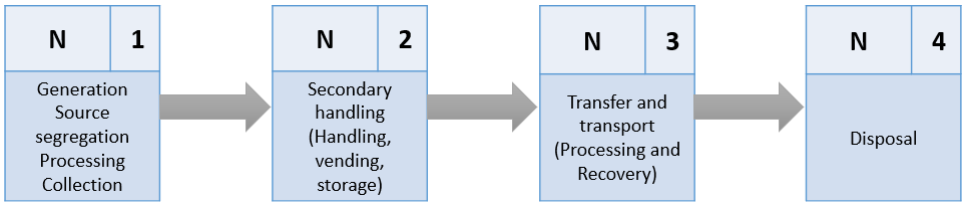


Figure 1: Current(4-Node) flow process for MSWM

Methodology

Data from 28 municipal cities from India are sourced from secondary source (Biswas, et al., 2021). Common data are extracted to analyse the generation to disposal pattern of MSW. Relative values for total waste and corresponding b_dW for city groups are presented with graph plotting to identify the share of b_dW in total waste (Fig 1). Furthermore, Population range-wise generation of b_dW and the share of b_dW in total generated waste is analysed, which identified importance of creating flow in the b_dW value stream and the effectiveness of 2- node decentralized system for efficient b_dW management.

Value stream exploration for better-performing eight selected cities is investigated further; the value stream for b_dW vs total municipal waste is mapped for comparison. The flow process in b_dW management of best-performing cities is reviewed, and lessons are learned in the form of intervention basket.

Results and Discussion

I. Comparative analysis for total MSW generation to Biodegradable Waste generation.

The calculated mean value of total generated waste is 711.4 TPD and that of b_dW is 372.3 TPD (Biswas, et al., 2021). Apart from some cases, a higher share of b_dW in total waste, approximately 60%, is observed for cities having a higher population range (More than five lakhs) (Fig.2). As the amount and contribution of b_dW in total MSW generation increases, the resources used by ULBs for handling and management of the same increases in a similar manner. It becomes critical in such cases to use the resources judiciously to make the process efficient and sustainable. The stages in the SWM system that adds actual value towards the SWM process exists at Node 1 and Node 3, Node 2 and Node 4 on other hands that includes transportation and disposal, not adding any true value to the b_dW management and there is also scope for eliminating these nodes which will be discussed in next section.

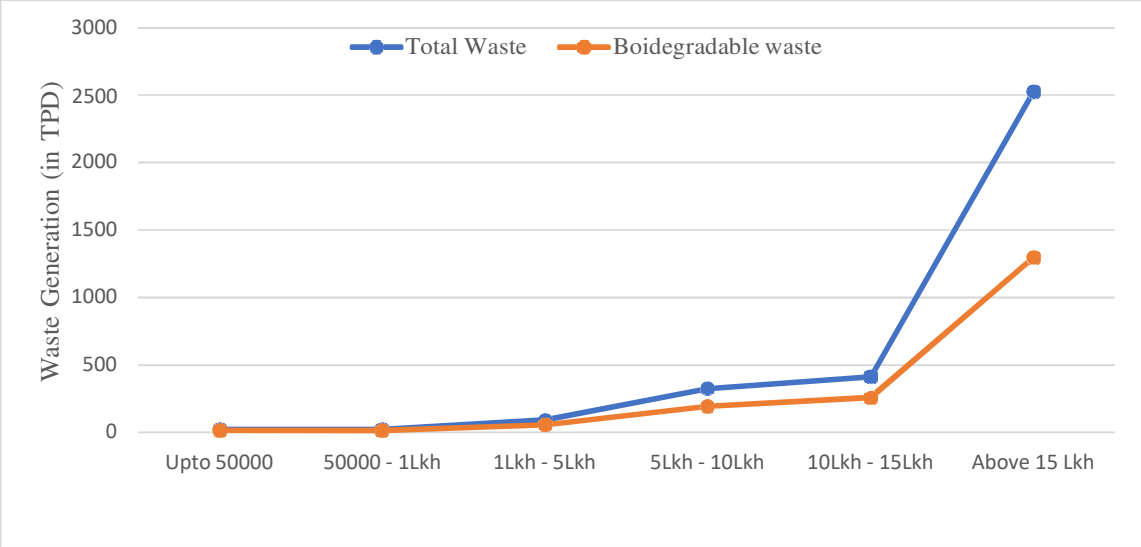


Figure 2: Total generated MSW to Biodegradable waste

Table 1: Review table for selected eight best-performing cities (Biswas, et al., 2021).

S.No	City – Managing Body	Amount of b_dW (% of total MSW)	Approach towards better MSWM	Lesson Learnt
1.	Bobbili – Bobbili Municipal corporation	34	Promoting on-site composting, Decentralised composting	Combination of centralized and decentralized composting for efficient management
2.	Mysuru – Mysuru City Corporation	55	Decentralized Zero-waste management units	Zone-wise, Decentralised Processing provides efficiency, convenience, and accessibility.
3.	Vengurla – Vengurla Municipal Council	82	Incentives for On-site processing	Providing incentives encourages on-site processing, more efficient for bulk waste generators.
4.	Vijayawada	59.47	On-Site Composting, community kitchen	Promoting on-site composting increases the efficiency of the system and benefits the community.
5.	Panchgani	75	Combination of centralized and decentralized processing	Combination of centralized and decentralized composting for efficient management
6.	Paradeep	56	Introducing Local women self-help groups	Local self-help groups help efficient and decentralized processing, create awareness
7.	Thiruvananthapuram	67	Community MCF, Source-level treatment, 40% on-site processing	Providing subsidies for setting up on-site composting and methanation facilities encourages people for on-site treatment.
8.	Alappuzha	74	Community involvement	Community involvement promotes on-site processing

II. Flow Analysis of best performing cities

The flow analysis of best performing cities (specifically in b_dW management) has reflected the decentralized management of b_dW as a common factor of their success (Table 1). The examples listed in the table collects the b_dW and decomposes them locally or promotes on site processing. The success of these examples creates a scope to manage the b_dW through on-site processing or decentralised processing which will be and efficient and sustainable to manage by implementing 2 Nodes (Fig.3) only.

Both these findings provided the opportunity to propose a 2-Node flow (Fig.3) instead of the existing four node-system (Fig 1). Limiting the flow in two nodes shows significant value addition and lesser resource consumption. It makes the process convenient and efficient, as experienced in the above best-performing cities. The replication of the same with a view of eliminating 4 nodes into a 2-Node system could be the guiding process for managing bodies. It will help visualize the MSWM from a perspective of Value addition and resource consumption within the system.

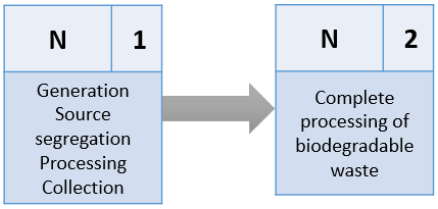


Figure 3: 2- Node bdW management

Conclusion

Waste is an inherent result of economic activity, like any metabolic system. (Ludwig, Hellweg, & Stucki, 2003). The paper emphasizes looking at MSWM from the value and Value stream management perspective and implementing an economic model for SWM (especially for b_dW management).

The lean value-addition to the Flow through improvising four node-system to a 2-node system brings several advantages.

a) Decentralized local b_dW management.
b) reduced transportation (cost savings and lower environmental impact)
c) reduced the time gap between generation and processing.
d) The surrounding environment is better and pleasant, limiting the release of CH_4, which is a GHG.
e) Local processing leading to a sense of competition among neighboring localities.

f) Local livelihoods.
g) Incentives and subsidy schemes promoting decentralized management can create sustainable MSWM system.

A basket of interventions is proposed to transform the 4-node system into a 2-node system both at Node 1 and Node 2.

a) Providing Performance-based rewards.
b) Linking bulk waste generators with the local people.
c) Zone-wise processing units.
d) Establishing on-site subsidized processing units
e) Promoting local self-help groups.
f) Continuous awareness programs.

Eliminating processes that are consuming resources but not adding value to the system will improve the system's efficiency, and the 2-node model could be the guiding way.

Eliminating the generated b_dW at node 2 will provide better opportunities and resources for managing waste from other categories and reduce the impact of b_dW on local surroundings and the environment.

Originality/Value

Based on secondary source- data, value stream mapping on MSWM for Indian cities is uniquely conducted. Decentralized 2-Node biodegradable waste management is proposed following lean-approach based value-stream mapping and creating Flow through intervention baskets. This can be replicated in other municipal areas to strengthen the flow and make India “Swatch Bharat” and the SDGs.

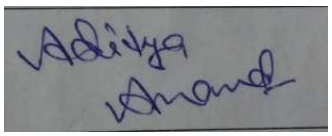
Acknowledgement
The presented work is carries out by the author. No funding is received in the process.

Conflict of Interests Statement
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration Letter
I confirm that the manuscript "**2-Node Decentralized Flow in Municipal Biodegradable Waste Management Value Stream for Municipal Cities of India**" has been read and approved by all the named authors, and they have contributed significantly to the paper. This is also to declare that the paper has not been published earlier in full or as part or been sent to some other journal for consideration for publication. The paper is also free from any plagiarism/self-plagiarism. There is no conflicts of interest associated with this paper. The authors would be fully responsible if the paper is found to violate any copyright law in future.

Ethical Statement
I affirm that the research presented in this paper has been conducted with utmost integrity and adherence to ethical principles. All data and results reported are accurate and authentic, and any intellectual contributions from others have been appropriately acknowledged.

Signature of Author



References

Biswas, A., Chaudhary, K., Singh, R., Tewari, S., Singh, S., & Parida, S. (2021). *Waste-Wise Cities, Best practices in municipal solid waste management.* NITI Aayog, CSE.

Chadar, S., & Keerti, C. (2017). Solid Waste Pollution: A Hazard to Environment.

Ludwig, C., Hellweg, S., & Stucki, S. (2003). *Municipal Solid Waste Management, strategies and technologies for sustainable solutions.* springer.

Nathiya , V., & Thandapani, V. (2019). SOLID WASTE MANAGEMENT: ITS SOURCES, COLLECTION, TRANSPORTATION ANDRECYCLING. *International Journal of Advanced Research*.

NITI Aayog. (2021). *SDG INDIA Index & Dashboard 2020-21, partnership in the deacde of action.* Retrieved from https://niti.gov.in/writereaddata/files/SDG_3.0_Final_04.03.2021_Web_Spreads.pdf (niti.gov.in)

NITI Aayog. (2021). *SDG INDIA Index & Dashboard 2020-21, partnership in the deacde of action.* NITI Aayog.

UNDP, U. (2015). *Sustainable Development Goals.* Retrieved from https://www.undp.org/content/dam/undp/library/corporate/brochure/SDGs_Booklet_Web_En.pdf

UNDP, U. (2020). *The Sustainable Development Goals Report 2020.* Retrieved from https://unstats.un.org/sdgs/report/2020/The- Sustainable-Development-Goals-Report-2020.pdf

Womack, P., & Jones, D. (1996, 2003). *Lean Thinking, Banish waste and create Wealth in your organization.* Simon & Schuster.